(For The Candidates Admitted From 2022 Onwards)
HOLY CROSS COLLEGE (AUTONOMOUS), TIRUCHIRAPALLI –620 002
COURSE CONTENT AND SCHEME OF EXAMINATIONS
SCHOOL OF LIFE SCIENCES
PG & RESEARCH DEPARTMENT OF BIOTECHNOLOGY
CHOICE BASED CREDIT SYSTEM
LEARNING OUTCOMES-BASED CURRICULUM FRAMEWORK (LOCF)
UG COURSE PATTERN B.Sc. BIOTECHNOLOGY

Seme	Part	Course	Title of the Paper	Code	Hrs/ Week	Credit	Marks
I	I	Language	Tamil paper I/ Hindi paper I / French paper 1	U22TL2GEN01	3	3	100
	II	English	English Paper 1	U22EL1GEN01	3	3	100
	III	Major Core -1	Cell Biology	U22BT1MCT01	4	4	100
	III	Major Core -2	Microbial Technology	U22BT1MCT02	4	4	100
	III	Major –Core-3 Practical - 1	Main Practical I- Cell Biology and Microbial Technology	U22BT1MCP03	5	3	100
	III	Allied-1	-	U22BT1ALT01	4	2	100
	III	Allied-2	-	U22BT1ALP02	4	2	100
	IV	EVS	Environmental studies	U22RE1EST01	2	1	100
	IV	Value Education	Bible/Catechism/Ethics	U22VE2LVE01/ U22VE2LVB01/ U22VE2LVC01	1		-
	VI	Extra credit	Internship/Field Work/Field Project- 30 hours. Extra Credit	U22EX1INT01	-	2	100
	VI	Service Oriented Course			`	`	`
				Total	**30**	**22+ 2**	**900**

Semester	Part	Course	Title of the Paper	Code	Hrs/ Week	Credit	Marks
II	I	Language	Tamil paper II/ Hindi paper II / French paper II	U22TL2GEN02	3	3	100
	II	English	English Paper II	U22EL2GEN02	3	3	100
	III	Major Core 4	Bioinstrumentation	U22BT2MCT04	4	4	100
	III	Major Core 5	Bioprocess Technology	U22BT2MCT05	5	4	100
	III	Major Core-6 Practical - 2	Main Practical II- Bioinstrumentation and Bioprocess Technology	U22BT2MCP06	4	3	100
	III	Allied 3	-	-	4	2	100
	III	Major Skill based Elec- 1	Dairy Microbiology (Lab cum Theory)/ Computer Literacy for Biotechnology	U22BT2SBT01/ U22BT2SBT02	2	1	100
	IV	Skill Based Course-1	Soft Skill Development	U22SS2SBC01	2	1	100
	IV	Skill Based Course -2	Rural Enrichment and Sustainable Development	U22RE2SBC02	2	1	100
	IV	Value Education	Bible Studies /Catechism / Ethics	U22VE2LVE01/ U22VE2LVB01/ U22VE2LVC01	1	1	100
	VI	Extension	RESCAPES-Impact study	U22EX2RES01		1	100

		Activities					
	VI	Extra Credit	Online Course	U22EX2ONC01	-	1	100
	VI	Summer Internship/Field Work/Field Project 30 hours- Extra Credit		U22SP2ECC02	U22EX2INT02	2	100
	VI	Service Oriented Course		-	-	-	-
				Total	**30**	**23+4**	**1200**

Semester	**Part**	**Course**	**Title of the Paper**	**Code**	**Hrs/ Week**	**Credit**	**Marks**
III	I	Language	Tamil paper III/ Hindi paper III/ French paper III	U22TL3GEN03	3	3	100
	II	English	English Paper III	U22EL3GEN03	3	3	100
	III	Major Core 7	Molecular Genetics (Theory cum Lab)	U22BT3MCT07	5	4	100
	III	Major Core 8	Biostatistics & SPSS(Theory cum Lab)	U22BT3MCT08	5	4	100
	III	Major Elective	Botany/Biochemistry/Zoology	U22BT3MET01	4	3	100
	III	Major Skill based Elective- 2	Public Speaking & Scientific writing /Entrepreneurial Biotechnology	U22BT3SBT03/ U22BT3SBT04	2	1	100
	III	Allied-4	-	-	4	2	100
	IV	Non Major Elective-1	Any Dept.	U22BT3NMT01	2	2	100
	IV	Gender Studies	Gender Studies	U22WS3GST01	1	1	100
	IV	Value Education	Bible Studies II/Catechism II/Ethics II	U22VE3LVB02/ U22VE3LVC02/ U22VE3LVE02/	1		
			Online course	U22EX3ONC02		1	
	VI	Internship/Field Work/Field Project - 30 hours. Extra Credit		U22EX3INT03	-	2	100
	VI	Service Oriented Course			-	-	-
				Total	**30**	**23+2**	**1000**

Semester	**Part**	**Course**	**Title of the Paper**	**Code**	**Hrs/ Week**	**Credit**	**Marks**
IV	I	Language	Tamil paper IV/ Hindi paper IV/ French paper IV	U22TL4TAM04	3	3	100
	II	English	English Paper IV	U22EL4GEN04	3	3	100
	III	Major Core 9	Bioinformatics & Computational Analysis (Theory cum Lab)	U22BT4MCT09	5	4	100
	III	Major Core-10	Cheminformatics	U22BT4MCT10	4	4	100
	III	Major Elective-	Botany/Biochemistry/Zoology	U22BT4MET02	4	3	100
	III	Allied-5	-	-	4	2	100
	III	Allied-6	-	-	4	2	100
	IV	Value Education	Bible II/Catechism II/ Ethics II	U22VE4LVB02/ U22VE4LVC02/	1	1	100

				U22VE4LVE02			
	IV	NME -2	Any Dept.	U22BT4NMT02	2	2	100
	VI	Extra Credit	Online Course	U22OC3ECT02	-	1	100
	VI	Extension Activity outside the class hours from Semester I –IV-SOC	Any one activity based on the Student's choice (15 Activities)	U22EX4SOC01		2	100
	VI	Extension Activities	RESCAPES-Impact study	U22EX4RES02		1	100
	VI	Internship/Field Work/Field Project 30 hours- Extra Credit		U22EX4INT04	-	2	100
				Total	**30**	**24+ 6**	**1200**

Allied Courses offered

Semester	Part	Course	Title of the Paper	Code	Hrs/ Week	Credit	Marks
I	III	Allied – 1 (Biochem)	Basics of Bioinformatics	U22BT1ALT01	4	2	100
I	III	Allied – 2 (Biochem)	Basics of Bioinformatics-Practical	U22BT1ALP02	4	2	100
II	III	Allied – 3 (Biochem)	Biostatistics	U22BT2ALT03	4	2	100
IV	III	Allied-6 (Bioinfo)	Biostatistics for bioinformatics with SPSS	U22BT2ALT04	4	2	100

Major Elective Courses offered

Semester	Part	Course	Title of the Paper	Code	Hrs/ Week	Credit	Marks
III	III	Major Elective-	Forensic Sciences	U22BT3MET01	4	3	100
III	III	Major Elective-	Biological techniques	U22BT3MET02	4	3	100
IV	III	Major Elective	Forensic sciences	U22BT4MET03	4	3	100

Non Major Elective Courses offered:

Semester	Part	Course	Title of the Paper	Code	Hrs/ Week	Credit	Marks
III	IV	Non Major Elective	Biotechnology in Agriculture	U22BT3NMT01	2	2	100
IV	IV	Non Major Elective	Functional food and Neutraceuticals (theory cum lab)	U22BT4NMT02	2	2	100

(For The Candidates Admitted From 2022 Onwards)
I B.Sc. BIOTECHNOLOGY - I Semester

Course Title	**MAJOR CORE 1 – CELL BIOLOGY**
Code	**U22BT1MCT01**
Course Type	**Theory**
Semester	**I**
Hours/Week	**4**
Credits	**4**
Marks	**100**

CONSPECTUS

This course focus on the structure and basic function of prokaryotic and eukaryotic cells, and the cellular components with underlying meiosis and mitotic cell division and throws an insight response to environmental, physiological changes, alterations of cell function by mutation.

COURSE OBJECTIVES

1. To relate the structural and functional properties of prokaryotic and eukaryotic cells.
2. To understand the ultrastructure and functions of cellular components for protein trafficking and cell permeability.
3. To identify the events of autonomous and semi-autonomous organelles in the cell.
4. To demonstrate the organization, ultrastructure and chemistry of chromosomes.
5. To criticize the mechanism of cell cycle during meiosis and mitosis.

UNIT I: **12 HRS**

Cell theory and Cell Structure

1.1. Discovery of Cell and Cell theory.
1.2. Cell as basic unit of life: Viral, bacterial, fungal, plant and animal cells.
1.3. Ultra structure cell: Prokaryotic & eukaryotic cell

Extra reading/Keywords*:* *Stem Cell*

UNIT II: **12 HRS**

Cellular Components

2.1. Plasma Membrane- ultrastructure, unit membrane and fluid mosaic models, Modifications.
2.2. Permeability functions- passive, facilitated, active, exo and endocytosis. Introduction to signal transduction. Ribosomes- structure, composition & assembly and functions.
2.3. Endoplasmic Reticulum- Ultra structure, types, functions- protein trafficking and other functions. Golgi Complex- Ultra structure, Role in cell secretion.

Extra reading/Keywords*:* *Vesicular traffic in secretion*

UNIT III : **12 HRS**

Nucleus and Mitochondria

3.1. Nucleus- Ultrastructural organization, functions nucleolus, nuclear membrane.
3.2. Semi-autonomous organelles- mitochondria-ultra structure, chemistry and functions. Chloroplast – structure and endosymbiotic theory.
3.3. Lysosome- polymorphic forms, cytochemistry and functions.

Extra reading/Keywords: *Red hot mitochondria*

UNIT IV: **12 HRS**

Chromosome

4.1 Chromosomes-organization, chemistry, functions, centrosome.
4.2 Structure of specialized chromosomes - Polytene and Lampbrush-Organization and functions.
4.3 Cytoskeleton-microfilaments and intermediate Filaments, microtubules role of cytoskeleton in motility.

Extra reading/Keywords*:* *Free chromosomal region.*

UNIT V: **12 HRS**

Cell Division

5.1. Cell division-mitosis – stages, spindle mechanics and mitotic inhibitors.
5.2. Meiosis – stages and significance
5.3. Cell cycle control. Senescence and necrosis.

Extra reading/Keywords*:* *Check points of cell cycle*

Note: Texts given in the Extra reading /Key words must be tested only through Assignment and Seminars.

PRESCRIBED TEXT BOOKS

- Verma P.S., & Agarwal V.K., (2016). Cell Biology. S. Chand and Company Ltd, New Delhi.
- Agarwal V.K., (2020). Molecular Biology. S. Chand and Company Ltd., New Delhi.

SUGGESTED REFERENCE BOOKS

- Harvey Lodish., Arnold Berk., Chris A. Kaiser., Monty Krieger., Anthony Bretscher., Hidde Ploegh., Angelika Amon., Matthew P. Scott., (2018). Molecular Cell Biology. VII edition Freeman W.H., & Company, New York.
- Geoffrey M. Cooper & Robert E. Hausman., (2013). The Cell- A Molecular Approach. Sinauer Associates, Inc 6th Edition.
- Gerald K., (2013). Cell Biology. VII edition International Student Version, Wiley publication.
- De Robertis D.P., (2012). Cell and Molecular Biology. 8th Edition, Lippincott Williams and Williams.
- Stephen R., Bolsover *et al*., (2004). Cell Biology, A Short Course. John Wiley& Sons Publishing.
- Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter, (2002). Molecular Biology of the Cell. IV edition, Garland Publishing, New York.

WEBSITE REFERENCES

- https://www.cellbio.com/education.html
- https://www.onlinebiologynotes.com
- https://thebiologynotes.com/
- https://www.microscopemaster.com/

Note: Learners are advised to use latest edition of books

COURSE OUTCOMES

CO No.	Course Outcomes	Cognitive Level (K1-K6)
CO-1	Recall the detailed structural aspects of prokaryotic and eukaryotic cells and its functions to understand various human syndromes.	**K1**
CO-2	Explain the structure and organization of chromosome, to study the aberrations, gene expression related to genetic disorder.	**K2**
CO-3	Apply their knowledge in cellular mechanism their anomalies with the knowledge of cell cycle events, its regulation and association of checkpoints in programmed cell death.	**K3**
CO-4	Correlate the intricate relationship between various cellular components and their corresponding functions for cell signaling mechanism in relation to the development of life.	**K4**

(K1=Remember, K2=Understand, K3=Apply, K4=Analyze, K5=Evaluate, K6=Create)

PO – CO MAPPING

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9
CO 1	2	3	2	1	1	2	3	3	3
CO 2	2	2	-	-	2	1	3	2	3
CO 3	3	3	1	1	3	2	3	3	2
CO 4	2	3	1	-	2	1	2	3	3

PSO – CO MAPPING

CO/PO	PSO1	PSO2	PSO3
CO1	2	1	1
CO2	3	2	2
CO3	2	2	3
CO4	3	3	2

(For The Candidates Admitted From 2022 Onwards)

I B.Sc. BIOTECHNOLOGY - I Semester

Course Title	**MAJOR CORE 2 – MICROBIAL TECHNOLOGY**
Code	**U22BT1MCT02**
Course Type	**Theory**
Hours/Week	**4**
Credits	**4**
Marks	**100**

CONSPECTUS

This course deals with the knowledge of identification and gene transfer mechanism of beneficial & pathogenic microbes related to clinical microbiology and other industrial applications of microbes. The student gains basic knowledge of the characteristic features and taxonomical classification of microorganisms.

COURSE OBJECTIVES

1. To isolate and characterize the microbes using different methods from the various environmental sources.
2. To distinguish the bacteria on their characteristic features and elucidate the phenomenon of gene transfer and replication for their survival.
3. To translate the biology of virus, algae, fungi on its pathogenic interaction with plants, animals and human beings.
4. To evaluate the methods of estimating population density of animals and plants and designate the importance of microbes on bio-production and bio-degradation.
5. To formulate a unique method to detect and identify the role of novel microbial strain in environment and integrate them with beneficiary associated lives.

UNIT I : **12 HRS**

Introduction

1.1. Whittaker's classification and characteristic features of microorganisms- virus, bacteria, algae, fungi and protozoa, microbial association. Scope of microbiology.

1.2. Methods in microbial culture, sterilization, inoculation and incubation, preparation of pure culture and maintenance.

1.3. Nutritional requirements, types of culture media, culture and growth characteristics. Current methods of microbial identification

Extra reading/Keywords: *Symbiosis of prokaryotic cell and origin of eukaryotic cell*

UNIT II: **12 HRS**

Bacterial Taxonomy

2.1. Bacteria-classification of bacteria based on morphology-shape and flagella, staining, nutrition and extreme environment, Bergey's manual of classification.

2.2. Bacterial respiration, bacterial photosynthesis and reproduction. Bacterial taxonomy.

2.3. Gene transfer mechanism- conjugation, transformation and transduction.

Extra reading/Keywords: *Phylogenetic tree*

UNIT III : **12 HRS**

Virus

3.1. Viruses-classification of virus based on their. Genetic material – RNA & DNA. Viral host. plant viruses-CMV and TMV

3.2. Animal viruses – HIV, hepatitis virus, human papilloma virus, bacterial viruses – bacteriophage, M13. ICTV classification of viruses.

3.3. Algae – N2 fixation, cyanobacteria. Fungi – Mushrooms, Superficial mycosis, spirullina, Candida – oral and vaginal**.**

Extra reading/Keywords: *TMV using carborandum*

UNIT IV: **12 HRS**

Medical Microbiology

4.1. Study of common bacterial and viral diseases in man- causative organisms, mode of transmission, pathogenicity, symptoms and preventive measures.

4.2. Diseases of gastro-enteric system. Cholera, Typhoid and Viral hepatitis. Respiratory system- Influenza, Pneumosnia and Tuberculosis.

4.3. Nervous system- Meningitis, Leprosy, Tetanus, Polio, Rabies and Herpes. Genital system-

Gonorrhea, Syphilis and Candidiasis. Rheumatic fever and AIDS. Covid 19.

Extra reading/Keywords: *Giardia.*

UNITV: 12 HRS

Environmental and Industrial Microbiology

5.1. Common air and soil microbes. Food microbiology. Microbial food spoilage, food poisoning, physic- chemical methods in food preservation.

5.2. Water microbiology- common pathogenic microbes in water. Basic design of fermenter, industrial fermentation of ethanol, penicillin and enzymes.

5.3. Dairy microbiology- pasteurization, fermented milk products-curd and cheese.

Extra reading/Keywords: *Biogeochemical cycle, Plastic degrading microbes*

Note: Texts given in the Extra reading /Key words must be tested only through Assignment and Seminars.

PRESCRIBED TEXT BOOKS

- Jeffry, C., Pommerville Jones and Bartlett., (2006). Fundamentals of Microbiology, Seventh Edition.
- Prescott L.M., Harley J.P., Klein D.A., (2006). Microbiology. sixth edition. McGraw –Hill, New York.
- Brenner, D.J., Krieg, N.R., Staley, J.T., (2005). Bergey's manual of systematic bacteriology. Vol. II edition, New York: Springer.

SUGGESTED REFERENCE BOOKS

- Gerard J. Tortora., Berdell R. Funke., Christine L. Case., (2015). Microbiology: An Introduction. XII edition, Pearson Education.
- Jacquelyn G. Black., (2008). Microbiology Principles and Explorations. seventh edition.
- Glazer and Nikaido, (2007). Microbial Biotechnology. II edition, Cambridge University Press.
- Gerard, J., Tortora, Berdell R., Funke, Christian L., Case (2006). Microbiology*:* An Introduction. Ninth edition, Benjamin Cummings Publication.
- Jay, J.M, Loessner, M.J. and Golden, D.A., (2005). Modern Food Microbiology. 7th edition, CBS Publishers and Distributors, Delhi, India.
- Adams, Martin. R., Moss, Maurice, O., (2004). Food Microbiology. Third edition, Royal Society of Chemistry Cambridge.
- John, L.I., and Catherine, A.I., (2004). Introduction to Microbiology – A case History Approach. Thomson Asia Pvt. Ltd.
- Ronald M. Atlas, Richard Bartha. R., (2004). Microbial Ecology - Fundamentals and applications. Pearson education limited.

WEBSITE REFERENCES

- https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6428495/
- https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7150083/
- https://europepmc.org/article/pmc/pmc7150148
- https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3427559/

Note: Learners are advised to use latest edition of books.

COURSE OUTCOMES

CO No.	Course Outcomes	Cognitive Level (K1-K6)
CO-1	Identify microbiological techniques and classify the nutritional types of microorganisms to isolate and characterize new group of microbial cultures	**K1**
CO-2	Associate the concepts of microbial diversity towards global genetic resources conservation for environmental richness.	**K2**
CO-3	Articulate the bacterial identification and characteristics features with inherent physiological processes for disease diagnosis and identifying industrially important microbes.	**K3**
CO-4	Investigate the pathogenesis of various disease caused by microbes and correlate their clinical manifestations to be used in disease management and prevention	**K4**

CO-5	Persuade the microbial processes used in food, agricultural and industrial products by scientific methods and expertise in industrial biotechnological applications.	**K5**

(K1=Remember, K2=Understand, K3=Apply, K4=Analyze, K5=Evaluate, K6=Create)

PO – CO MAPPING

CO/PO	PO1	PO2	PO3	PO4	PO5	PO 6	PO7	PO8	PO9
CO1	**3**	2	1	-	1	2	2	3	3
CO2	2	**3**	1	-	2	**2**	-	2	3
CO3	2	3	1	-	1	2	3	2	3
CO4	3	2	-	2	2	2	2	1	2
CO5	2	**2**	-	1	1	2	-	3	2

PSO – CO MAPPING

CO/PSO	PSO1	PSO2	PSO3
CO1	**3**	**2**	**1**
CO2	**2**	**1**	**2**
CO3	**3**	**3**	**3**
CO4	**3**	**3**	**3**
CO5	**2**	**2**	**1**

(For The Candidates Admitted From 2022 Onwards)

I B.Sc. BIOTECHNOLOGY - I Semester

Course Title	**MAJOR CORE 3: PRACTICAL I – CELL BIOLOGY AND MICROBIAL TECHNOLOGY**
Code	**U22BT1MCP03**
Course Type	**Practical**
Semester	**I**
Hours/Week	**5**
Credits	**3**
Marks	**100**

CONSPECTUS

The course imparts specific skills on performing microbial isolation and identification approaches, learn the techniques pertaining to preparation, sterilization of microbiological media, analyzing the results and discussing the observations.

COURSE OBJECTIVES

1. To differentiate structural and functional variations between prokaryotic and eukaryotic cells.
2. To illustrate the detailed structural aspects of cell organelles.
3. To compare and contrast the different stages of mitosis and meiosis.
4. To perform the isolation, identification and examination of microbes.
5. To employ the efficiency of sterilization techniques (pasteurization) for the improved food quality.

I. Cell Biology

1. Identification of plant, fungi, bacteria and animal cells.
2. Identification of different types of human cells.
3. Preparation of polytene chromosomes in salivary gland of *Chironomous* larva
4. Study of mitotic stage in onion root tip.
5. Study of mitosis and meiosis from permanent slides.
6. Preparation of buccal cells.
7. Study of meiosis in Grasshopper testis.

II. Microbial Technology

1. Isolation of microorganism using serial dilution, spread plate, pour plate and streak plate methods.
2. Colony counting.
3. Identification of microbe – Microscopic, color and morphology.
4. Identification of bacteria – Simple & Gram's staining.
5. Identification of products of metabolic pathways (IMViC).
6. Starch plate assay.
7. Test for motility in micro-organism.
8. Single colony isolation and measurement of growth rate.
9. Alkaline phosphatase test to check the efficiency of pasteurization of milk.
10. Isolation of spoilage microorganisms from spoiled vegetables/fruits.
11. Preparation of Yogurt and Dahi.
12. A visit to any educational institute/industry to see an industrial fermenter, and other downstream processing operations.

PRESCRIBED TEXT BOOKS

- Saravanan, R., & Dhachinamoorthi., (2019). A Handbook of Practical Microbiology. Chand.
- S. Dubey, R.C., Maheshwari, D, K., (2012). Practical Microbiology. Second Edition.

SUGGESTED REFERENCE BOOKS

- Lorrence H Green (Editor), Emanuel Goldman., (2021). Practical Handbook of Microbiology. 4th edition.
- Renu Gupta., Seema Makhija., Ravi Toteja., (2018). Cell Biology: Practical Manual. Paperback.
- Julio E.Celis., (1998). Cell Biology*:* A Laboratory Handbook. Second edition, Vol 4.

WEBSITE REFERENCE

- https://laboratoryinfo.com/
- https://www.microscopemaster.com/
- http://www.ihcworld.com/_protocols/lab_protocols/cell-biology-lab-manual-heidcamp.htm

COURSE OUTCOMES

CO No.	Course Outcomes	Cognitive Level (K1-K6)
CO-1	Identify the structural difference between plant, animal, bacterial and fungal cell	**K1**
CO-2	Execute the isolation of microbes by microbial techniques for the production of fermented milk product in food industry.	**K2**
CO-3	Integrate the phases of mitotic and meiotic cell division and biochemical test results to promptly identifying the microorganisms.	**K3**
CO-4	Prescribe the spoilage of milk, vegetables, fruits and other food products by various assays and the acquired knowledge could be applied for quality analysis of various food products.	**K4**

(K1=Remember, K2=Understand, K3=Apply, K4=Analyze)

PO – CO MAPPING

CO/PO	PO1	PO2	PO3	PO4	PO5	PO 6	PO7	PO8	PO9
CO1	1	2	2	1	2	2	2	3	3
CO2	3	2	1	1	1	2	3	3	2
CO3	3	1	-	-	2	1	3	3	3
CO4	3	1	3	1	2	1	3	3	3

PSO – CO MAPPING

CO/PO	PSO1	PSO2	PSO3
CO1	2	2	-
CO2	1	3	2
CO3	3	1	3
CO4	3	3	3

(For The Candidates Admitted From 2022 Onwards)
I B.Sc. BIOTECHNOLOGY- I Semester

Course Title	**ALLIED 1 – Basics of Bioinformatics**
Hours/Week	**4**
Code	**U22BT1ALT01**
Course Type	**Theory**
Credits	**2**
Marks	**100**

CONSPECTUS

The course deals with the basic concepts of computational challenges (and their solutions) in the analysis of large biological data sets and meritoriously to know the application of bioinformatics tools universally.

COURSE OBJECTIVES

1. To classify different types of Biological Databases.
2. To articulate the various tools and methodologies used in multiple sequence alignment, phylogenetic analysis and genetic diversity analysis observed in biological sequences.
3. To correlate the various computational methods and tools used for protein secondary structure prediction and genome analysis.
4. To relate the numerous approaches in prediction of protein three dimensional structure.
5. To compute the complex interactions within biological systems and modelling the biological systems through conceptual and mathematical approaches towards drug designing.

UNIT I: 12 HRS

Overview of Bioinformatics

1.1. Bioinformatics – History, Scope, Application, Bioinformatics in India, Future of Bioinformatics. Human Genome Project.

1.2. Introduction to Biological Database, Types of Biological databases, Nucleotide Sequence Databases- Genbank, DDBJ, EMBL.

1.3. Protein Sequence Databases- Swissprot, TrEMBL. Protein Structure Database- PDB. Derived Databases- Prosite, Pfam. Literature Databases- Pubmed, OMIM. Chemical databases- pubchem..

Extra reading/Keywords: *Newly developed databases.*

UNIT II: 12 HRS

Sequence Analysis

2.1. Sequence alignment: Dot Plot, Dynamic Programming. Local and Global alignment concepts – dynamic programming methodology – Needleman and Wunsch algorithm, Smith-Waterman algorithm.

2.2. Sequence alignment methods- Pairwise sequence alignments – BLAST, FASTA.

2.3. Multiple sequence alignment – Progressive and iterative method, Tools for multiple sequence alignment.

Extra Reading/Key words*:* *Statistical methods and scoring functions.*

UNIT III: 12 HRS

Protein Structure Prediction

3.1. Protein Secondary structure prediction – Use of sequence pattern, leucine zipper, coiled coil.

3.2. Trans membrane, signal peptide, cleavage site Chou-Fasman, Garnier-Osguthorpe-Robson (GOR) methods.

3.3. Prediction of 3D structures by comparative modeling.

Extra reading/Keywords: *Tools and software packages used in homology modeling.*

UNIT IV : 12 HRS

Phylogenetic Analysis

4.1. Phylogenetic trees – Construction, Rooted and un-rooted tree representation.

4.2. Methods – Distance based and Character based method.

4.3. Softwares for phylogenetic analysis, Bootstrapping strategies.

Extra reading/Keywords: *Evolutionary analysis.*

UNIT V: **12 HRS**

Computer-aided Drug Design

5.1. CADD - Concepts and Principles, Virtual Screening.

5.2. Drug design – structure based drug drug - Molecular docking. Ligand based drug design – Pharmacophore, QSAR.

5.3. Virtual Screening - Molecular Dynamics - Pharmacophore generation.

Extra reading/Keywords: *Software for molecular docking and dynamics.*

Note: Texts given in the Extra reading /Key words must be tested only through assignment and Seminars.

PRESCRIBED TEXT BOOKS

- Baxevanis., & B,F., (2005). Ouellette. Bioinformatics: A practical Guide to the Analysis of Genes and Proteins. Wiley- Interscience, Hoboken, NJ.
- Attwood, T.K., & Parry Smith, D,J., (2004). Introduction to Bioinformatics. 1st Edition, Pearson Education Ltd, New Delhi.

SUGGESTED REFERENCE BOOKS

- Arthur M. Lesk., (2003). Introduction to Bioinformatics. Oxford University Press, New Delhi.
- David, W., Mount., (2001). Bioinformatics Sequence and Genome Analysis. Cold Spring Harbor Laboratory Press.
- Higgins, D., and Taylor, W., (2000). Bioinformatics- Sequence, structure and databanks. Oxford University Press, New Delhi.
- Jeffrey *et al*., (2000). Structural genomics and its importance for gene function analysis. Nature Biotechnology. 18:283 – 287.

WEBSITE REFERENCE

- https://personal.utdallas.edu/~son051000/comp/EdelmiroMoman.pdf
- https://libguides.bates.edu/bioinformatics/sequencealignment#:~:text=The%20Basic%20Local%20Alignment%20Search%20Tool%20 (BLAST)
- https://www.profacgen.com/pharmacophore-
- https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6030848/
- https://www.biologicscorp.com/blog/protein-structure-prediction-methods

Note: Learners are advised to use latest edition of books.

COURSE OUTCOMES (CO):

CO No.	Course Outcomes	Cognitive Level (K1-K6)
CO-1	Explore the various applications of BLAST and FASTA in understanding differences in evolutionary patterns.	**K1**
CO-2	Exemplify the biomaterial cite and their uses in the pharmaceutical industry primes to novel drug development.	**K2**
CO-3	Transform the key concepts of ‘omics approaches in the direction of the targeted drug development, analyzing biological data, protein Visualization Tools such as Rasmol and Swiss pdb.	**K3**
CO-4	Categorize evolution tree, cladogram, retrieve the biological information accessed through various information resources to identify the disorders and its mode of insertion.	**K4**
CO-5	Compute the docking, and molecular simulation, to critique the Computer-Aided Drug Designing concerning the human care.	**K5**

(K1=Remember, K2=Understand, K3=Apply, K4=Analyze, K5=Evaluate, K6=Create)

PO – CO MAPPING

CO/PO	PO1	PO2	PO3	PO4	PO5	PO 6	PO7	PO8	PO9
CO1	3	1	2	-	1	2	3	3	3
CO2	3	3	2	-	2	2	2	3	3
CO3	2	3	2	-	1	-	3	2	3
CO4	3	2	-	-	2	-	2	2	2
CO5	2	3	1	1	-	1	3	3	3

PSO – CO MAPPING

CO/PSO	PSO1	PSO2	PSO3
CO1	3	3	2
CO2	**2**	3	**3**
CO3	**2**	3	3
CO4	2	**3**	2
CO5	**3**	-	**2**

(For The Candidates Admitted From 2022 Onwards)
I B.Sc. BIOTECHNOLOGY - I Semester

Course Title	ALLIED 2– Basics of Bioinformatics Practical
Hours/Week	4
Code	U22BT1ALP02
Course Type	Practical
Credits	2
Marks	100

CONSPECTUS

The course imparts specific skills on use of various biological databases and to attain basic knowledge about the software to extract information from large databases and to use this information in sequence alignment and computer modeling.

COURSE OBJECTIVES

1. To retrieve information from different biological databases.
2. To perform sequence alignment for the protein and the nucleic acid sequences.
3. To correlate the various computational methods and tools used for protein secondary structure and tertiary structure prediction.
4. To analyze the phylogentic relationship between different organisms.
5. To compute the interactions between the protein and the ligand molecules.

Practical

1. Nucleotide Sequence database - Genbank, DDBJ, EMBL.
2. Protein sequence databases - NCBI - Protein, Uniprot-KB.
3. Protein structure databases - PDB.
4. Chemical database - Pubchem, Drugbank.
5. Derived databases - Prosite, Pfam.
6. Bibliographic databases - Pubmed, MEDLINE, BioMed Central.
7. Sequence similarity search tool - BLAST, FastA.
8. Pair wise sequence alignment - EMBOSS Needle, EMBOSS Water.
9. Multiple Sequence Alignment - Clustal Omega, ClustalX.
10. Phylogenetic analysis - Simple phylogeny.
11. Homology Modeling - SWISS-Model workspace.
12. Secondary structure prediction - Jpred 4.
13. Structure conversion tool - Smile translator, Open Babel.
14. Docking – Patchdock.
15. Structure visualization tools - Rasmol, Pymol.

(For The Candidates Admitted From 2022 Onwards)
I B.Sc. BIOTECHNOLOGY – II Semester

Course Title	**MAJOR CORE 4 – BIOINSTRUMENTATION**
Total Hours	**60**
Code	**U22BT2MCT04**
Course Type	**Theory**
Semester	**II**
Hours/Week	**4**
Credits	**4**
Marks	**100**

CONSPECTUS

The Student learns a strong foundation in the principle and working mechanism of various biological techniques and instrumentation.

COURSE OBJECTIVES

1. To describe the fundamental principles and working of different types of microscopes and lab instruments.
2. To interpret the phenomenon of spectroscopy and the applications of analytical spectroscopic techniques in research and development.
3. To outline the basic concepts of centrifugation techniques and their applications in separation of molecules.
4. To explicate the working principle of chromatography in the separation of macromolecular compounds from natural source.

UNIT I: 12 HRS

Microscopy

1.1. Principle and applications of Light microscope, Bright field, Dark field, Phase contrast, Inverted microscopy.

1.2. Electron (TEM, SEM and STEM) microscopy, scanning tunneling and high voltage electron microscopy.

1.3. Confocal scanning light microscopy, Fluorescence Microscope. CLSM and AFM- their uses and image processing methods.

Extra Reading /Key words: *Cryo-Electron Microscopy.*

UNIT II: 12 HRS

Spectroscopic Techniques

2.1. Analytical Techniques- Working principle and applications of redox and pH meter. Measurement of pH. Use of Indicators, Electrometric Determination of pH, Buffer Systems which Resist Changes in pH. Colorimetry- principles, instrumentation and applications, micro colorimetry -DSC and ITC. Types of electrodes.

2.2. Spectroscopy- Basic principles of spectroscopy, the Law of Absorption, Types-UV and visible, fluorescence, gamma ray and infrared spectroscopy, Nuclear Magnetic Resonance (NMR), Electron Spin Resonance (ESR), Surface plasma resonance.

2.3. Circular Dichroism spectroscopy, X-ray crystallography, Flame photometry, Atomic absorption and emission spectrophotometry- Principle, instrumentation and application.

Extra Reading (Key words*): Raman spectroscopy in antibiotic discoveries.*

UNIT III: 12 HRS

Centrifugation

3.1. Concepts of relative centrifugal force, sedimentation coefficient. Factors affecting Sedimentation velocity, Standard Sedimentation Coefficient.

3.2. Types of rotors- Fixed-angle Rotors, Vertical-tube rotors, Swinging-bucket Rotors, Wall Effect. Working principle and Instrumentation of Desktop centrifuge, High speed centrifuge, Rate Zonal Centrifuge, Isopycnic Centrifuge.

3.3. Principle and applications of Preparative Centrifuge-Differential and Gradient centrifuge, Analytical centrifuges- Ultra centrifuge.

Extra Reading /Key words: *Separation of cell organelles, genomic and plasmid DNA.*

UNIT IV: **12 HRS**

Chromatography

4.1 Principle and applications of plane chromatography, Paper, Thin layer, Column, Adsorption chromatography, Partition chromatography.

4.2. Ion-exchange, Affinity and Gel permeation, HPLC, HPTLC, Liquid-Liquid chromatography, Gas-liquid, GC-MS, LC-MS.

4.3. Mass spectrometry- Ionization, Mass Analyzers, Detectors Applications of Mass Spectrometry MALDI TOF.

Extra Reading /Key words: *UPLCMS.*

UNIT V: **12 HRS**

Electrophoresis and Blotting Techniques

5.1. Principle and applications of Paper electrophoresis, cellulose acetate, continuous flow and capillary electrophoresis.

5.2. Principle and application of Agarose Gel Electrophoresis (AGE), Polyacrylamide gel electrophoresis - PAGE and SDS – PAGE, Zone electrophoresis, Immunoelectrophoresis, Isoelectric focusing, DGGE.

5.3. High Voltage Electrophoresis, RNA electrophoresis, PFG, 2D gel electrophoresis and 2D-DIGE. Blotting techniques – Southern, northern and western blotting, Zoo blot, Dot blot.

Extra Reading /Key words: *Microchip in separation of DNA fragments, hPAGE.*

Note: Texts given in the Extra reading /Key words must be tested only through assignment and Seminars.

PRESCRIBED TEXT BOOKS

- Upadhyay, A., Upadhyay, K., and Nath, N., (2002). Biophysical Chemistry. Himalayan Publication House, New Delhi.
- Wilson K., Walker., (2000). Practical Biochemistry– Principles and Techniques. Fifth edition, Cambridge University Press, Cambridge.

SUGGESTED REFERENCE BOOKS

- Keith Wilson., & Jhon Walker., (2010). Principles and Techniques of Biochemistry and Molecular Biology. Seventh Edition, Cambridge University Press, Cambridge.
- Walker, John M., Rapley, Ralph, (2008). Molecular Biomethods Handbook. 2nd ed., Humana Press.
- Prescott, L.M., Harley, J.P., Klein, D.A., (2006). Microbiology. Sixth edition. McGraw –Hill, New York.

Note: Learners are advised to use latest edition of books

COURSE OUTCOMES

CO No.	Course Outcomes	Cognitive Level (K1-K6)
CO-1	Highlighting the underlying working principle of various lab instruments with their scientific applications.	K1
CO-2	Interpret the role of centrifugal and frictional force towards the biological samples separation and principle for developing new bio instruments.	K2
CO-3	Implementing the principles and applications of MALDI TOF, MS, Centrifugation techniques to identify and isolate new novel bioactive compounds.	K3
CO-4	Correlating the spectroscopic and blotting techniques in their research projects and utilizes them in screening of metabolites/molecules.	K4

(K1=Remember, K2=Understand, K3=Apply, K4=Analyze, K5=Evaluate, K6=Create)

PO – CO MAPPING

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9
CO 1	2	3	2	-	2	2	3	3	3
CO 2	2	2	1	1	2	1	3	2	2
CO 3	3	3	1	1	3	2	3	3	2
CO 4	2	3	1	2	2	1	2	3	3

PSO – CO MAPPING

CO/PO	PSO1	PSO2	PSO3
CO1	1	3	2
CO2	2	3	2
CO3	2	2	3
CO4	3	3	3

(For The Candidates Admitted From 2022 Onwards)
I B.Sc. BIOTECHNOLOGY – II Semester

Course Title	MAJOR CORE 5 – BIOPROCESS TECHNOLOGY
Total Hours	75
Code	U22BT2MCT05
Course Type	Theory
Semester	II
Hours/Week	5
Credits	4
Marks	100

CONSPECTUS

This subject puts emphasis on the basic engineering principles of bioprocess and also highlights the modern application of biotechnological process and the role of bio process engineer in biotechnological industry.

COURSE OBJECTIVES

1. To explain the historical development of bioprocess techniques, role of microbial strains and culturing methods in fermentation technology.
2. To comprehend the types and design of a fermenter in microbial mass growth culturing and examine in detail, the mechanics involved in design and operation of bioreactors.
3. To determine the absolute process parameters of industrial microbes and attempt to produce new varieties of industrial microbes for various purposes.
4. To appraise the downstream process methods of purifying fermented products.

UNIT I: **12 HRS**

Introduction

1.1. Historical development of bioprocess technologies, Introduction to fermentation process, Microbial biomass, enzyme, metabolites.

1.2. Improvement of strains for increased yield and for other desirable characters- mutation, selection and recombination. Range of bioprocess technology and its chronological development. 1.3. Types of microbial culture and its growth kinetics– Batch, Fedbatch and Continuous culture, Addition of Precursors and metabolic regulators to media.

Extra Reading/Key words: *Pre and probiotics, Insilico screening.*

UNIT II: **12 HRS**

Design of Bioreactor

2.1. Basic function of a bioreactor, Design and construction of a bioreactor- Body construction, construction material, Temperature control, Aeration and agitation system-Agitator, Stirrer glands and bearings, Sparger, Baffles.

2.2. Valves and steam traps- Pressure-control valves, Gate valve, Piston valve, Needle, plug, ball, pressure retaining valve, steam traps.

2.3. Types- Specialized bioreactors, Membrane bioreactors, Tower bioreactors, Fluidized bed bioreactors, Immobilized system and Packed bed reactors, Photobioreactors, Airlift, Stirred, Packed glass bead fermenter.

Extra Reading/Key words: *Principle of Sourdough in food fermentation.*

UNIT III: **12 HRS**

Industrial Fermentation

3.1. An overview of aerobic and anaerobic fermentation processes, Designing of media for fermentation processes, Solid Substrate fermentation and submerged fermentation.

3.2. Process parameters- measurement of temperature, pressure and pH, dissolved Oxygen, foam, design and usage of various commercial media for industrial fermentations,

3.3. Thermal death kinetics of microorganism's, batch and continuous heat sterilization of liquid media.

Extra Reading/Key words: *kinetic model – black box model*

UNIT IV: **12 HRS**

Downstream Processing

4.1. Recovery and purification of fermented Products-Biomass separation, foam separation, Cell disintegration- Physical, chemical and enzymatic methods, filtration, centrifugation, precipitation.

4.2. Separation of solid and liquid phases, Isolation and purification techniques for proteins and other

products based on different physico-chemical properties.

4.3. Principles of bioprocess control- bioprocess automation and application of computers in bioprocessing, Components of a computer linked system.

Extra Reading/Key words: *Electroflocculation.*

UNIT V: **12 HRS**

Industrial Application

5.1. Production of microbial biomass (*Spirulina*, yeast), SCP extracellular enzymes, production of Microbial products.

5.2. Products obtained by industrial microbiological fermentation; Alcoholic beverage – Beer, Wine, Organic acid – citric acid.

5.3. Antibiotic – Penicillin, Amino acids – Glutamic acid, Vitamin – B12. Brief account of Steroid biotransformation

Extra Reading/Key words: *GO immobilization, Magnetic support matrix.*

Note: Texts given in the Extra reading /Key words must be tested only through assignment and Seminars.

COURSE OUTCOMES

CO No.	Course Outcomes	Cognitive Level (K1-K6)
CO-1	Highlighting the knowledge on the mechanics involved in bioreactor designing, operation and the role of computers in bioprocess control.	**K1**
CO-2	Exemplifying the methods of isolation, screening and preservation of industrially important microbes in improving the strains.	**K2**
CO-3	Examining the industrial scale production and therapeutic applications of enzymes and deconstruct the design of immobilized enzyme reactors	**K3**
CO-4	Apply the biomass separation methods and produce commercially valued fermented products by manipulating and enhancing their recovery and purification methods;	**K4**

(K1=Remember, K2=Understand, K3=Apply, K4=Analyze, K5=Evaluate, K6=Create)

PRESCRIBED TEXT BOOKS

- Stephen J.Hall., Peter Stanbury., & Allan Whittakker., (2015). Principles of fermentation. Elsevier publications.
- H.N. Thatoi, B.B. Mishra., (2012). Microbial Biotechnology: Methods and Applications. Narosa publishing house India Ltd.
- Whitaker, Hall S.J., (2004). Principles of Fermentation Technology. 2nd ed., Butterworth Heinemann, Oxford, edition.
- Casida, L.E., (1999). Industrial Microbiology. New Age International Pvt. Ltd., New Delhi.

SUGGESTED REFERENCE BOOKS

- Stanbury, PF., Whitaker, A., (2003). Principles of Fermentation Technology. Pergamann Press, Oxford.
- Cruger, W.A., (2003). A Textbook of Industrial Microbiology. Panima Publishing Corporation, New Delhi.
- Shuler. M. L. F. Kargi., (2003). Bioprocess engineering: Basic Concepts. Prentice Hall, Engelwood Cliffs.
- Samuel, C., Prescott, Cecil. G. Dunn (2002). Industrial Microbiology. First Edition, Agrobios (India) Ltd.

Note: Learners are advised to use latest edition of books.

PO – CO MAPPING

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9
CO 1	2	3	2	1	2	1	1	3	2
CO 2	2	2	1	1	2	2	2	3	3
CO 3	3	3	1	1	2	2	3	3	3
CO 4	2	3	1	2	2	1	2	3	3

PSO – CO MAPPING

CO/PO	PSO1	PSO2	PSO3
CO1	2	3	3
CO2	2	3	2
CO3	2	3	2
CO4	3	3	3

(For The Candidates Admitted From 2022 Onwards)
I B.Sc. BIOTECHNOLOGY – II Semester

Course Title	MAJOR CORE 6 – PRACTICAL II: BIOINSTRUMENTATION AND BIOPROCESS TECHNOLOGY
Total Hours	60
Code	U22BT2MCP06
Course Type	Theory
Semester	II
Hours/Week	4
Credits	3
Marks	100

CONSPECTUS

This course emphases the basic design and principles of bioprocess. Also highlights the modern application of biotechnological process in biotechnological industry.

COURSE OBJECTIVES

1. To understand the molarity, normality calculations that can able to prepare chemicals.
2. To handle pH meter, UV spectrophotometer to analyze the optical density.
3. To determine the compound using chromatography techniques.
4. To validate the microbes from various sources and understand its industrial importance.
5. To produce single cell proteins and wine.
6. To test quality of milk and BOD/COD levels.

A. Instrumentation

1. **Preparation of Solutions:**
   a) Molarity
   b) Normality
   c) Percentage
   d) Calculation of Moles
   e) Micromoles
   f) Nanomoles
   g) ppt&ppm
2. To familiarize in the use of pH meter and Colorimeter.
3. One-dimensional Ascending & Descending Paper chromatography of Amino acids & sugars.
4. Two-dimensional Ascending & Descending Paper chromatography of Amino acids.
5. Chromatographic separation of carotenes of flower and pigments using column.
6. Separation of polar and non-polar lipids by thin layer chromatography.
7. Demonstration-GC MS MS, IR, AAS, X-Ray Crystallography.

B. Bioprocess Technology

1. Enumeration of Microorganisms from bread.
2. Determination of TDT & TDP.
3. Analysis of Aflatoxin by TLC.
4. Qualitative analysis of milk.
5. Isolation of industrially important microorganism.
6. Production & estimation of biomass (SCP), dry weight & Wet weight methods.
7. Production of wine.
8. Immobilization of cells and enzymes.
9. Determination of Microbial growth curve - effect of pH and temperature on microbial growth curve.
10. Waste water quality indicator – COD and BOD.

COURSE OUTCOMES

CO No.	Course Outcomes	Cognitive Level (K1-K6)
CO-1	To describe the methods for proper handling and care of laboratory equipment and observe and identify the instrumentation accurately.	**K1 & K2**
CO-2	To employ the use of specific techniques to specific biological applications and to choose the best eco-friendly and ethical laboratory practices with regard to handling of microorganisms and culture.	**K2**
CO-3	To analyze and infer experimental results of various techniques and to correlate them to the working principles of the technique.	**K3**
CO-4	To measure quantitatively and qualitatively using different kinds of laboratory instrumentation and to find errors in the working of the instrument when the need arises.	**K4**

(K1=Remember, K2=Understand, K3=Apply, K4=Analyze)

PO – CO MAPPING

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9
CO 1	2	3	2	1	1	2	3	3	3
CO 2	2	2	3	2	2	1	3	2	3
CO 3	3	3	1	1	3	2	3	3	2
CO 4	2	3	1	3	2	1	2	3	3

PSO – CO MAPPING

CO/PO	PSO1	PSO2	PSO3
CO1	2	1	1
CO2	3	2	3
CO3	1	2	2
CO4	3	3	2

(For The Candidates Admitted From 2022 Onwards)
I B.Sc. BIOCHEMISTRY – II SEMESTER

Course Title	ALLIED-3– BIOSTATISTICS
Total Hours Code	60
Hours/Week	4 Hrs./Wk.
Code	U22BT2ALT03
Course Type	Theory
Credits	2
Max Marks	100

CONSPECTUS

The student understands the scope of collection and classification of data in biology. She learns the different ways of presenting data, and understand the application of various tools to design an experiment, interpret and make decisions on the data collected.

COURSE OBJECTIVES

1. Acquire the principles of study design and its implications for valid inference.
2. Accomplish evidence based clinical practice to evaluate and apply prior research findings precisely.
3. Analyze the computational probability hypothesis.
4. Attain a clear specification about the SPSS software.
5. Practically explore the scientific report based statistical analysis.

UNIT I:

SCOPE OF BIOSTATISTICS **12 HRS**

1.1. Definition; Scope of Biostatistics, Variables in biology; Population and sampling, sampling distribution; Difference between parametric and non – parametric statistics; Data Collection, Classification, Tabulation.

1.2. Statistical Package for Social Sciences (SPSS) – Introduction to SPSS for windows

1.3. Data entry on SPSS – Variable naming- Analysis of data – Formulation of frequency tables.

Extra Reading/Key words*:* *Statistics in Bioinformatics.*

UNIT II:

CENTRAL TENDENCY & DISPERSSION **12 HRS**

2.1. Measures of central tendency – Mean, Median, and Mode.

2.2. Measures of dispersion – Range, Quartile deviation, mean deviation and Standard deviation.Skewnes and kurtosis.

2.3. Diagrammatic representation – Bar and pie chart – histogram – frequency polygon, Frequency Curve – Logarithmic curves –Scatter plot and line graphs.

Extra Reading/Key words: *Matlab,Minitab*

UNIT III:

CORRELATION **12 HRS**

1.1. Correlation – Types; methods – Graphic, mathematical

1.2. Pearson's correlation co-efficienl, Rankcorrelation co-efficient.

1.3. Regression – Simple linear regression- regression equation and regression line.

Extra Reading/Key words*:* *Probability in Bioinformatics*

UNIT IV:

PROBABILITY **12 HRS**

4.1. Elements of probability – Probability distribution – Binamial, Poisson, Normal,

4.2. Test of significance – hypothesis testing- Type I error, Type II error, level of significance.

4.3. Student 't'test - One sample't' test, Independent sample and Paired't' test.

Extra Reading/Key words: *Matlab,Minitab*

UNIT V:

ANALYSIS OF VARIANCE **12 HRS**

5.1. Chi – square; Application of chi – square test. Chi – square test for Goodness fit;

5.2. Test for Independence of Attributes.

5.3. F' test – Analysis of Variance (ANOVA) – Oneway ANOVA – Two way analysis of variance. Introduction to Multrovariate statistics.

Extra Reading/Key words*: Dataport, Datamining*

Note: Texts given in the Extra reading /Key words must be tested only through assignment and Seminars.

COURSE OUTCOMES

CO No.	Course Outcomes	Cognitive Level (K1-K6)
CO-1	Ability to understand the various statistical issues in logical and methodological manner.	**K1**
CO-2	Enumerate sampling frame, distribution of sample, sampling errors, survey and linear study with constant coefficient.	**K2**
CO-3	Determine appropriate solution to scientific problems from quantitative and qualitative data with an unbiased and consistent approach.	**K3**
CO-4	Apply statistical hypothesis testing methods including F" test, chi square test, ANOVA to identify the significance between biological variables.	**K4**

(K1=Remember, K2=Understand, K3=Apply, K4=Analyze, K5=Evaluate, K6=Create)

PRESCRIBED TEXT BOOKS

1. Jerold. H. Zar., (2010). Biostatistical analysis. Fifth Edition, Prentice Hall.

BOOKS FOR REFERENCE

1. Batschelet.E., (1991). Introduction to Mathematics for Life Scientists. 2nd Edition, Springer International Student Edition., Narosa Publishing House, New Delhi.
2. Forthofer, L Introduction to Biostatistics, Academic Press, 1995.
3. Robert R. Sokal and F.J. Rohlf, Introduction to Biostatistics (Biology- Statistics Series), W.H. Freeman & Company, New York, 1987.
4. Gupta SC and V.K. Kapoor, Fundamentals of Mathematical, Statistics, 11th Edition, Sultan Chand & Sons, New Delhi, 2002

Note: Learners are advised to use latest edition of books.

PO – CO MAPPING

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9
CO 1	1	2	-	1	1	-	2	3	2
CO 2	1	1	1	2	2	1	2	2	1
CO 3	2	2	1	1	1	-	3	3	2
CO 4	2	3	2	1	3	1	2	2	3

PSO – CO MAPPING

CO/PO	PSO1	PSO2	PSO3
CO1	2	2	1
CO2	3	2	2
CO3	1	3	2
CO4	3	2	2

(For The Candidates Admitted From 2022 Onwards)
I B.Sc. BIOTECHNOLOGY – II Semester

Course Title	MAJOR SKILL BASED ELECTIVE-1 DAIRY MICROBIOLOGY (Theory Cum Lab)
Total Hours	30
Hours/Week	2
Code	U22BT2SBT01
Course Type	Theory Cum Lab
Credits	1
Marks	100

CONSPECTUS

The student will learn the composition and processing of dairy products. In addition, students will learn the significance of different food microorganisms, their control and other related aspects.

COURSE OBJECTIVE

1. Summarize the physic chemical properties of milk;
2. Describe different dairy products and classification;
3. Comprehend the microbes that spoil dairy foods;
4. Demonstrate the role of beneficial microbes in dairy industries;
5. Obtain hands on training to survey, detect contamination and adulteration in Milk;

UNIT I:

COMPOSITION OF MILK **5 HRS**

1.1: Composition of milk, factors affecting composition of milk

1 . 2 . Properties Physical and Chemical properties-

1.3. Physical state of milk, Flavor Color, Freezing point, Specific gravity, Effect of heat, Acid, Alkali and Enzymes on milk.

Extra Reading/Key words: *Starter culture*

UNIT II:

DAIRY PRODUCTS **5 HRS**

2.1. Technology of Butter, Ice cream, Skim & Whole milk powder, Cheese

2.2. Classification of dairy products, Cottage Cheddar Cheese

2.3. Fermented Milk - Butter milk, yoghurt, Acidophilus milk.

Extra Reading/Key words: *Bio preservation of food*

UNIT III:

DAIRY SPOILAGE **4 HRS**

3.1.Dairy spoilage

3.2. Microbial flora of milk,

3.3. Sources of milk contamination.

Extra Reading/Key words*:* *Spoilage microbes*

UNIT IV:

MICROBIOLOGY OF DAIRY PRODUCTS **6 HRS**

4.1. Microbiology of dairy products: Microbiology of cream, butter and ice-cream

4.2. Microbiology of indigenous dairy products such as khoa, peda, yoghurth, acidophilus milk, koumiss, cultured butter milk, cheese and other fermented milk products

4.3. Application of rennet and microbial rennet substitutes in cheese making.

Extra Reading/Key words: *Intermediate moisture foods (IMF)*

UNIT V: (PRACTICAL) (Report will be submitted) **10 HRS**

1. Visit to diary testing lab /or any agency of food standards
2. Market survey of milk and milk products
3. Detection microbes in milk
4. Detection of Adulterants
5. Detection of adulterants in Cane Sugar
6. Detection of Starch in Milk
7. Detection of Cellulose in Milk
8. Test for Presence of Skimmed milk Powder in Natural milk (Cow, buffalo, goat, sheep)

Extra Reading/Key words*:* *Heavy metal contamination in food producs*

Note: Texts given in the Extra reading /Key words must be tested only through assignment and Seminars.

COURSE OUTCOMES

CO No.	Course Outcomes	Cognitive Level
CO-1	Understand the properties of milk and the effect of heat and alkali on milk production.	**K1**
CO-2	Summarize the process of different dairy products and their Industrial applications	**K2**
CO-3	Determine and identify the microbes that spoil the dairy products and their source of contamination after packaging.	**K3**
CO-4	Integrate the quality of dairy products and formulation with the help of beneficial microbes	**K4**

(K1=Remember, K2=Understand, K3=Apply, K4=Analyze, K5=Evaluate, K6=Create)

PRESCRIBED TEXT BOOKS

1. Dairy Microbiology, (2015). 2nd edition, Agrobios Publishers, Jodhpur, India.
2. Manual of methods of analysis of foods, milk and milk products (2015).Food Safety And Standards Authority Of India Ministry Of Health And Family Welfare Government Of IndiaNew Delhi.

SUGGESTED REFERENCES:

1. Stanbury, P.E, Whitaker, A. and Hall, (2016). S.J. Principles of fermentation technology. Third Edition.
2. Sridhar, S., (2010). Industrial Microbiology. Dominant Publishers, New Delhi.
3. Clark, D.P and Pazdernik, N.J., (2009). Biotechnology applying the genetic revolution. Elsevier Academic Press, UK.
4. Casida, L.E., (2007). Industrial Microbiology. New age international (P) Ltd., New Delhi.
5. Marth, E.H and Steele, J.L., (2001). Applied Dairy Microbiology.
6. Downes, F.P and Ito, K., (2001). Compendium methods for the Microbiological Examination of Foods. 4 th edition, APHA, Wahington, DC.
7. Doy le, M.P., Beuchat, L.R. and Montville, T.J., (2001). Food Microbiology, Fundamentals & Frontiers. 2nd edition ASM Press Washington DC.
8. Frazier, W.C and Westhoff, D.C., (1988). Food Microbiology, 4th edition, Tata McGraw-Hill Publishing Company, New Delhi.

Note: Learners are advised to use latest edition of books.

PO – CO MAPPING

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9
CO 1	-	3	2	1	3	1	2	3	2
CO 2	2	3	2	-	3	1	3	3	2
CO 3	2	3	2	1	3	2	3	3	3
CO 4	2	3	1	-	3	2	2	3	2

PSO – CO MAPPING

CO/PO	PSO1	PSO2	PSO3
CO1	3	3	1
CO2	3	3	2
CO3	2	3	2
CO4	3	3	3

(For The Candidates Admitted From 2022 Onwards)
I B.Sc. BIOTECHNOLOGY – II Semester

Course Title	MAJOR SKILL BASED ELECTIVE-1 COMPUTER LITERACY FOR BIOTECHNOLOGY
Total Hours Code	30
Hours/Week	2
Code	U22BT2SBT02
Course Type	Theory
Credits	1
Max Marks	100

CONSPECTUS

The course is designed to aim at imparting a basic knowledge on computer in day today life and to use the computer for basic purposes of preparing their personnel/business letters, viewing information on Internet (the web), sending mails, using internet banking services etc.

COURSE OBJECTIVES

1. To provide hands-on use of Microsoft Office 2013 applications Word, Excel, Access and PowerPoint. Completion of the assignments will result in MS Office applications knowledge and skills.
2. To understand the recent application domains of internet in everyday life.
3. To exhibit knowledge to secure corrupted systems, protect personal data, and secure computer networks in an Organization.
4. To equip students with modern and more current developments in the Banking Sector; precisely the application of the internet, computers and other electronically-based gadgets that facilitate the operations and practices of banking, locally and in international transactions.
5. To determine and analyze software vulnerabilities and security solutions to reduce the risk of exploitation

UNIT I: OFFICE PACKAGES: 6 HRS

1.1. MS- Word: Creation of Documents (letters, Bio- data, etc). Creation of Tables, Formatting Tables (Time table, Calendar, etc) Working with Mail Merge (Circular letters).

1.2. MS – Excel: Creation of Worksheet (Mark Sheet, Pay Slip, PF Contribution list, etc). Excel Function. Creating charts (Line, Pie, Bar, etc).

1.3. MS- Power Point: Creation of Presentations (Duplicate and New slides, Layouts, View, Slide show, etc.,).

1.4. Working with objects (Movie, Sound, Word, Excel, etc.,) Working with Transition and Animation effects (Text, Object, Pictures)

Extra Reading/Key words: *Units of Data Storage.*

UNITII: SMART DEVICES AND ONLINE TRANSACTIONS 6 HRS

2.1.Smart devices - Smart phone, Tablet PC, Smart TV, Smart Camera, Smart Watch and Smart Oven.

2.2. Operating system for Smart phones- Apple iOS, Android, Windows 10, Benefits of Smart Phones.

2.3. E-Commerce and M-Commerce: Components of E-Commerce- types, and benefits of each (B2B, B2C, C2B, C2C). Applications of M-Commerce- Mobile ticketing, mobile money transfer, mobile banking, mobile marketing and advertising.

2.4. Payment methods in M- Commerce- Premium rate telephone numbers, Direct mobile dealing, Macro, Micro payment servicesand mobile wallets.

Extra Reading/Key words: *Google play for Android Phones.*

UNIT III: SOCIAL NETWORKING AND CYBER SECURITY 6 HRS

3.1 Social Networking Sites: Characteristics of Social Networking Website-

3.2 Social Networking Services (Facebook, SnapChat, Instagram, Whatsapp, Pinterest, Linkedin and Twitter) Advantages and Disadvantages of Social Network.

3.3 Cyber law: Evolution and Historical events in cyber law. Case studies- Article taken from Media. Building blocks of cyber law (Netizens, Cyber space and Technology).

3.4 Cyber Crime, Electronic and Digital devices, Intellectual Property, Data Protection and Privacy. Merits and Demerits of Cyber crime.

Extra Reading/Key words: *How to stay out of trouble from Social Network.*

UNIT IV: APPLICATION OF COMPUTER LITERACY **6 HRS**

4.1. Computer Literacy for Banking Scheme and Applications:

4.2. Banking products-ATM card, Banking Instruments-Cheque, Demand Draft (DD), Banking Services Delivery Channels.

4.3. Know Your Customer (KYC), Opening of bank account and documents required, Types of bank accounts

4.4. Bank's services including remittances, loan, mobile banking, Overdraft, Pension etc.

Extra Reading/Key words: *Social Security Schemes-Atal Pension Yojana (APY)*

UNIT V: POLICIES & LAWS **6 HRS**

5.1. Government, federal, state, city, local and other public datasets- Data APIs, Hubs, Marketplaces, Platforms, Portals, and Search Engines.

5.2. Enigma, National Government Statistical Web Sites

5.3. Open Data Census, Socrata OpenData- provides easy access to government, NGO, and other public domaindatasets. Census India, Open Government Data (OGD) Platform, India.

5.4. Competitive exams: IIT-JAM, JEST,TIFR GS, JNUEE, NEST, BINC, GATE, CSIR.

Extra Reading/Key words*:* Applications of IECT

Note: Texts given in the Extra reading /Key words must be tested only through Assignment and Seminars.

COURSE OUTCOMES

The learners will be able to:

CO No.	Course Outcomes	Cognitive Level
CO-1	Describe the usage of computers and why computers are essential components in business and society.	**K1**
CO-2	Utilize the Internet Web resources and evaluate on-line e-business system.	**K2**
CO-3	Apply the categories of programs, system software and applications. Organize and work with files and folders.	**K3**
CO-4	Critically assess the social and ethical implications of computer technology in their daily life.	**K4**

(K1=Remember, K2=Understand, K3=Apply, K4=Analyze, K5=Evaluate, K6=Create)

SUGGESTED REFERENCE

1. Bittu Kumar (2017) Mastering Ms-Office, ISBN: 9350578786, V&S Publishers

WEBSITE REFERENCES

1. https://www.webopedia.com/DidYouKnow/Hardware_Software/mobile-operating-systems-mobile-os-explained.htmlhttps://makeawebsitehub.com/social-media-sites/
2. https://www.tutorialspoint.com/information_security_cyber_law/information_security_cyber_law_tutorial.pdf
3. https://www.tutorialspoint.com/information_security_cyber_law/information_security_cyber_law_tutorial.pdf
4. https://www.irjet.net/archives/V4/i6/IRJET-V4I6303.pdf

Note: Learners are advised to use latest edition of books.

PO – CO MAPPING

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9
CO 1	2	3	3	1	1	1	3	3	2
CO 2	2	2	-	-	2	1	3	2	3
CO 3	3	3	1	1	3	2	3	3	2
CO 4	2	3	1	-	2	1	2	3	3

PSO – CO MAPPING

CO/PO	PSO1	PSO2	PSO3
CO1	3	1	1
CO2	3	2	1
CO3	1	1	3
CO4	3	3	2

(For The Candidates Admitted From 2022 Onwards)
II B.Sc. BIOTECHNOLOGY - SEMESTER - III

Course Title	MAJOR CORE 7 – MOLECULAR GENETICS (Theory Cum Lab)
Total Hours	75
Hours/Week	5 hrs./Wk.
Code	U22BT3MCT07
Course Type	Theory Cum Lab
Credits	4

CONSPECTUS

This course focus on the basic concepts of Genetics, mechanism of sex determination, inheritance of genes, metabolic disorder and its management, types of mutation, cancer genetics, Molecular diagnosis of various diseases.

COURSE OBJECTIVES

1. To understand the outline of genetics and hereditary relationship among different genus and species.
2. To relate the fundamental molecular principles of genetics and testing of defect genes in various diseases.
3. To explore various genes involved in cancer and their molecular diagnosis in human.
4. To validate the various screening methods that can be methods implemented to social and legal aspects.
5. To experience the fundamentals of genetics via hands on lab experiments.

UNIT I: **15 HRS**

Mendelian Genetics

1.1 Overview of Mendelian genetics: Human chromosomes: Structure and chemical nature – Linkage and crossing over

1.2 Chromosomal aberrations and abnormalities – Heterochromatin and euchromatin

1.3 Cell Division: Mitosis and Meiosis - Karyotyping and chromosomal banding–molecular cytogenetics: FISH, Fiber FISH and m–FISH.

Extra Reading/Key words: ***Epigenome***

UNIT II: **15 HRS**

Genetic Testing

2.1 Genetic testing: Detection of genetic defects – Gene polymorphism: candidate genes approach

2.2 Metabolic and genetic disorders: cardiac disorders – DNA analysis in Duchene Muscular Dystrophy

2.3 Molecular diagnosis: Sickle cell anemia and β-Thalassemia, retinoblastoma, cystic fibrosis, Alzheimer's – Genetics of human syndromes – X–linked CGD: molecular aspects.

Extra Reading/Key words: ***Duchenne muscular dystrophy***

UNIT III: **15 HRS**

Cancer Genes & Molecular Pathology

3.1 Cancer genes: Types of oncogenes – Molecular diagnostics of cancer markers – Stability of the genome - Tumor imaging and staging–Tumor suppression: mode of action and mutation in p53

3.2 Gene therapy for cancers – cell cycle control - BRCA genes–Telomeres in Cancers and aging.

3.3 Molecular pathology: from genes to disease and from disease to genes – Epigenetics - Comparative genomics for human disease gene identification – Proteomic tools in human disease diagnosis.

Extra Reading/Key words: ***Inherited biological traits***

UNIT IV: **15 HRS**

Molecular Forensics

4.1 Genetic Testing: Materials for testing: DNA, RNA or protein – Mutational screening: Loss of function and gain of function.

4.2 Molecular Forensics: Contributions of Alec Jeffrys – DNA as evidence – DNA fingerprinting – Paternity dispute– Personal identification and identity of descent by molecular methods

4.3 National laboratories – CDFD – Prenatal molecular diagnosis: CVS and amniocentesis – preimplantation test – Medico, legal, social, ethical and legal aspects of molecular diagnostics.

Extra Reading/Key words: ***LINES, SINES***

UNIT V: **15 HRS**

PRACTICAL

1. Karyotyping of normal and abnormal chromosome sets. (Analyzing a medical report)

2. Identification of inactivated X chromosome as Barr body
3. Preparation of Human chromosomes and G banding.
4. Preparation of Pedigree chart of some common phenotypic characters of human and study on patterns of inheritance.
5. Studies of a Model organism: Identification of normal and mutant flies (*Drosophilamelanogaster*)
6. Preparation of *Drosophila* polytene chromosomes.

Extra Reading/Key words: *Pseudogenes*

Note: Texts given in the Extra reading/Key words must be tested only through assignment andSeminars

PRESCRIBED TEXT BOOKS

1. Ajoy Paul, (2011). Text Book of Genetics- from Genes to Genomes- Books and Allied (P) Ltd,Kolkata. Third Edition.
2. Alice Marcus, (2009). Genetics, MJP Publishers. Chennai.
3. Gardner, M. J., Simmons. D. P. Snustad., (2006). Principles of Genetics, 8th edition – John Wiley and Sons, Inc.
4. Verma P.S. and Agarwal, V.K., (1988). Genetics. S. Chand & Company Ltd, New Delhi.

SUGGESTED REFERENCE BOOKS

1. Strickberger, M.W., (2008). Fourth Edition. Genetics –Printice Hall.
2. Lewin, B., (1997). GenesVI Oxford University Press, Oxford, New York, Tokyo.
3. Benjamini E, Coico R and G. Sunskise., (2000). Immunology a short course. IV edn.(Chapters 1–13) Wiley – Liss publication, NY.
4. John M. Walkser, Ralph Raplay., (2005). Biomedical Methods Hand Book. Humana Press.
5. Goldsby R.A. Kindt T.I and Osborne B.A., (2000). Kuby Immunology. IV edn. S WH FreemanandCo, NY.
6. Jack J. Pasternak, Wiley–Liss and Sons Inc., (2005). An introduction to Human Molecular Genetics Mechanisms of Inherited Diseases. II Edn. N J, USA.
7. Julian Little, Muin J. Khoury, Wylie Burke, (2003). Human Genome Epidemiology: A Scientific Foundation for Using Genetic Information to Improve Health and Prevent Disease. Oxford University Press.
8.Muller, Young Churchill Livingstone, (2002). Elements of Medical Genetics. II edition.
9. Strachan, T. and A.P. Read. (2004). Human Molecular Genetics. 3rd Edn. GarlandScience, UK.

Note: Learners are advised to use latest edition of books.

WEBSITE REFERENCES

- http://depts.washington.edu/genetics/courses/genet371b-aut99/overheads/pdfs/all_lect.pdf
- https://main.mohfw.gov.in/sites/default/files/Cancer%20Genetics.pdf
- https://www.cancer.org/cancer/understanding-cancer/genes-and-cancer/gene-changes.html
- https://www.cancer.org/cancer/risk-prevention/genetics/family-cancer-syndromes.html

COURSE OUTCOMES

The learners will be able to

CO No.	Course Outcomes	Cognitive Level (K1-K6)
CO-1	Recall the basic structure of chromosome and recognize the Chromosomal abnormalities, inheritance patterns observed in the individuals raised from one generation to another	**K1**
CO-2	Depict the pattern of inheritance from the pedigree analysis of the family history carrying a particular trait and be proficient with the testing and detection of various genetic disorders.	**K2**
CO-3	Outline the molecular patterns in forensics and their role in medical, ethical and legal aspects of molecular diagnosis.	**K3**
CO-4	Correlate the function, association and diagnosis of various genes in involved in cancer and identify the gene responsible for various disease through molecular diagnosis.	**K4**
CO-5	Perceive genetic factors associated with various cancer categories and the significant role of gene therapy in preventing cancer.	**K5**

(K1=Remember, K2=Understand, K3=Apply, K4=Analyze, K5=Evaluate)

PO – Programme Outcomes, PSO – Programme Specific Outcomes, CO- Course Outcomes

PO – CO MAPPING

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9
CO 1	2	3	-	-	-	-	1	2	2
CO 2	3	2	3	-	1	1	2	3	3
CO 3	3	3	3	3	3	3	3	3	3
CO 4	2	3	3	3	3	3	3	3	3
CO5	2	2	2	3	3	-	3	3	3

PSO – CO MAPPING

CO/PO	PSO1	PSO2	PSO3
CO1	2	1	1
CO2	2	3	3
CO3	3	3	3
CO4	3	3	3
CO5	3	2	3

(For The Candidates Admitted From 2022 Onwards)

II B.Sc. BIOTECHNOLOGY - III SEMESTER

Course Title	MAJOR CORE 8– BIOSTATISTICS & SPSS (Theory Cum Lab)
Total Hours	75
Hours/Week	5
Semester	III
Code	U22BT3MCT08
Course Type	Theory cum Lab
Credits	4
Marks	100

CONSPECTUS

This paper enables the student to describe the fundamental concepts, procedures, applications of statistics; the main principles of probability, statistical theory and the mathematical foundation which can be applied to other fields such as Actuarial Science and Computer Science. The students learn to use statistical package for social sciences (SPSS) to enter and edit data and apply different tests to derive conclusions and to apply the knowledge in her future research.

COURSE OBJECTIVES

1. Demonstrate a solid understanding of hypothesis testing and choose, apply appropriate statistical methods for analyzing one or two variables.
2. Derive the theoretical mathematics of statistical inferences and perform linear regression model fitting and diagnosis.
3. Execute the statistical analysis by using SPSS software for data management and data analysis and learn to perform basic software analysis.
4. Apply statistics analysis in scientific reports based on statistical analysis for scientific collaboration with public health related scientists in epidemiology, health management and policy environmental health sciences, nutrition, health behavior and health education
5. Practically explore the scientific report based statistical analysis.

UNIT I **15 HRS**

Basics of Statistics

1.1 Basics of Statistics - Nature of biological and clinical experiments – collection of experimental data Variables in biology; Population and sampling, sampling distribution

1.2 Difference between parametric and non - parametric statistics; Data Collection, Classification, Tabulation.

1.3 Statistical Package for Social Sciences (SPSS) - Introduction to SPSS for windows - data entry on SPSS - Variable naming- Analysis of data - Formulation of frequency tables. Applications of SPSS.

Extra Reading/Key words: ***Statistics in Bioinformatics.***

UNIT II: **15 HRS**

Measurement of Central Tendency

2.1 Measures of central tendency of a set of observations - Purpose of statistical investigations - arithmetic mean - mean of grouped data - median – mode - range, mean deviation, variants and standard deviation. Skewness and kurtosis.

2.2 Diagrammatic representation - Bar and pie chart - histogram - frequency polygon,

2.3 Frequency Curve – Logarithmic curves –Scatter plot and line graphs.

Extra Reading (Key words): ***Creating a data for the analysis of central tendency***

UNIT III: **15 HRS**

Correlation and Regression

3.1 Correlation - Types; methods - Graphic, mathematical- Karl Pearson's correlation co-efficient, Rank correlation co-efficient.

3.2 Regression - Simple linear regression- regression equation and regression line.

3.3 Test for correlation and regression coefficients – Chi-square test for goodness of fit and independence of attributes -' test - Analysis of Variance (ANOVA) - One way ANOVA - Two way analysis of variance, Simple problems based on biochemical data.

Extra Reading/Key words: ***Statistics module, rating scales***

UNIT IV: **15 HRS**

Basics of Probability

4.1 Basic Concepts of Probability - Sample space and events - Probability distribution - Binomial, Poisson, Normal, Test of significance - hypothesis testing- Type I error, Type II error, level of significance.

4.2 Student 't' test - One sample 't' test, Independent sample and Paired 't' test.
4.3 Simple problems involving the estimation of probabilities - Normal Distribution and Binomial distribution – Z-score, P-value and E-value.

Extra Reading/Key words: ***Probability in Bioinformatics, Matlab, Minitab***

UNIT V: 15 HRS

ANALYSIS OF VARIANCE

5.1 Chi – square; Application of chi – square test. Chi – square test for Goodness fit; Test for Independence of Attributes.
5.2 F' test – Analysis of Variance (ANOVA) – Oneway ANOVA – Two way analysis of variance. . Introduction to Multrovariate statistics.

Extra Reading/Key words*: Dataport, Datamining*

Note: Testing for this paper will be done in the lab by external examiner. Students will work out problems using SPSS package.

PRESCRIBED TEXT BOOKS

1. A. Rajathi and P. Chandran (2011). SPSS for you.
2. Jerold. H. Zar. (2010). Biostatistical analysis. Fifth Edition, Prentice Hall.

SUGGESTED REFERENCES

1. Snedecor, G.W & William, G., (1975). Statistical Methods. Havard University, Oxford & IBH Publications Co., Calcuta. Bombay, New Delhi.
2. Sokal, R and James F.R., (1973). Introduction to Biostatistics. W.H. Freeman & company, Toppan company, Ltd., Tokyo, Japan.
3. Robert L. Miler John Maltby & co., (2002). SPSS for Social Scientists. Palcrave Macmillan, New York.
4. Millie R.L., Ciaran A., Fullerton D.A., and Maltby., (2002). SPSS for Social Scientists.(Version 9, 10, 11). Consultant Editior - Jo. Campling, Publishers Palcrave Macmillan, (UK, USA) Printed in China.
5. Einspruch E.L., (2004). Next steps in SPSS Sage Publications, International Education and Professional Publishers, Thousand Oaks, London, New Delhi.

Note: Learners are advised to use latest edition of books.

WEBSITE REFERENCES

- https://www.researchgate.net/publication/352992776_BIOSTATISITCS_AND_RESEARCH_METHODOLOGY_Unit-1_Subject_Code_BP801T_B_Pharm_IV_th_Year_-VIII_th_Semester_Session_2020_-21
- https://www.hsph.harvard.edu/wp-content/uploads/sites/565/2019/09/HST190_Lecture_1.pdf
- https://www.cartercenter.org/resources/pdfs/health/ephti/library/lecture-notes/env-health-science-students/ln-biostat-hss-final.pdf

COURSE OUTCOMES

- **The learners will be able to:**

CO No.	Course Outcomes	Cognitive Level (K1-K6)
CO-1	Define the principal concepts about biostatistics and recognize the definition of statistics, its subject and its relation with the other sciences.	**K1**
CO-2	Restate the principal concepts about biostatistics, collect data relating to variable/variables which will be examined and calculate descriptive statistics from these data.	**K2**
CO-3	Analyze the data relating to variable/variables of convenient sample by using sampling theory.	**K3**
CO-4	Identify the distribution form of relating to the variable/variables and recognize the normal distribution, to interpret the data via normal distribution.	**K4**
CO-5	Evaluating the link between a single or a series of exposures, where the outcome is continuous but the exposures are either numerical, categorical, or a combination of both, can be determined using correlation or by applying linear regression analysis.	**K5**

(K1=Remember, K2=Understand, K3=Apply, K4=Analyze, K5=Evaluate)

PO – Programme Outcomes, PSO – Programme Specific Outcomes, CO- Course Outcomes

PO – CO MAPPING

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9
CO 1	1	2	-	1	1	-	2	3	2
CO 2	1	1	1	2	2	1	3	3	2
CO 3	2	2	1	1	1	-	3	3	2
CO 4	2	3	2	1	3	1	2	2	3
CO5	1	2	-	1	1	-	2	2	1

PSO – CO MAPPING

CO/PO	PSO1	PSO2	PSO3
CO1	2	2	1
CO2	3	2	2
CO3	1	3	2
CO4	3	2	2
CO5	2	2	3

(For The Candidates Admitted From 2022 Onwards)
II B.Sc. BIOTECHNOLOGY - SEMESTER - III

Course Title	MAJOR SKILL BASED ELECTIVE 2- PUBLIC SPEAKING AND SCIENTIFIC WRITING
Total Hours	30
Hours/Week	2
Semester	III
Code	U22BT3SBT03
Course Type	Theory
Credits	1
Marks	100

CONSPECTUS

This course aims to display different types of speeches to face the public. Also demystify the writing process and teach the fundamentals of effective scientific writing.

COURSE OBJECTIVES

1. To understand of the process of preparing an effective public speech
2. To acquire skills for informative speech, persuasive speech, crisis speech
3. To demonstrate important aspect of literature survey before writing an article
4. To provide an ideal knowledge for dissertation & thesis writing
5. To explain the process of writing and publishing research articles

UNIT I: **6 HRS**

Introduction to speaking skill

1.1 The process of preparing a speech – Audiences Analysis. Developing confidence, practice speeches, Presentation Skills. Ethics of public speaking.

1.2 Selecting a Topic and Purpose, Organizing the Speech, Types of Organizational Arrangements, Outlining the Speech.

1.3 Adapting to audiences, evaluation techniques and listener needs.

Extra Reading/Key words: Ethical Speaker.

UNIT II: **6 HRS**

Types of Public Speeches

2.1 Introductory speech, informative speech, persuasive speech, crisis speech, special occasion speeches.

2.2 Sensory aids in public speaking, managing speech anxiety.

2.3 Improving listening and note-taking skills, the four stages of listening and the different types of listening

Extra Reading/Key words: Speech anxiety symptoms.

UNIT III: **6 HRS**

Literature Analysis

3.1 Subject analysis, literature survey, data collection, utilizing library for research writing

3.2 On line tools – Google scholar, Data Analysis and Evaluation.

3.3 Hypothesis framing and objective of the study.

Extra Reading/Key words: Literature Database.

UNIT IV: **6 HRS**

Dissertation & Thesis Writing

4.1 Abstract, Contents, Objective & scope of the study.

4.2 Introduction, review of literature, results, discussion

4.3 Summary and Conclusion, Reference.

Extra Reading/Key words: Computational advances in Dissertation writing.

UNIT V: **6 HRS**

Research Paper Writing

5.1 Manuscript Structure – authors, title, abstract, keywords, introduction, materials and methods, results & discussion, acknowledgement, declarations.

5.2 Reference writing, abbreviations, appendix, plagiarism, ethics, copyrights, language.

5.3 Journals and Publications- e–journals, national & international journals, impact factor, citations, h-index, i10 and i20 index. Submitting an article, revising, editing, proof reading – publication.

Extra Reading/Key words: Types of publications.

Note: Texts given in the Extra reading /Key words must be tested only through assignment and Seminars.

PRESCRIBED TEXT BOOKS

- Sinha, S.C. and Dhiman, A.K., (2002). Research Methodology. Ess Publications.
- Kothari, C.R., (1990). Research Methodology: Methods and Techniques. New Age International. 418p.

SUGGESTED REFERENCE BOOKS

- Chris Anderson., (2016). TED talks: the official TED guide to public speaking. Publisher: Headline Publishing Group, London.
- Lucas, S., Simeon, L., & Wattam, J., (2008). The art of public speaking. Toronto: McGraw-Hill Ryerson.
- Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., (2002). An introduction to Research Methodology. RBSA Publishers.

Note: Learners are advised to use latest edition of books.

WEBSITE REFERENCES

- https://study.com/academy/course/public-speaking-study-guide.html
- https://www.baycollege.edu/_resources/pdf/academics/academic-resources/open-education/principles-public-speaking.pdf
- https://www.edx.org/course/rhetoric-art-of-persuasive-writing-public-speaking
- https://www.worldscientific.com/worldscibooks/10.1142/12059#t=aboutBook
- https://www.studysmarter.co.uk/magazine/scientific-writing/
- https://sites.duke.edu/scientificwriting/

COURSE OUTCOMES

CO No.	Course Outcomes	Cognitive Level (K1-K6)
CO-1	Validate knowledge of public speaking principles and concepts	**K1**
CO-2	Apply methods of organizing a speech through an outline	**K3**
CO-3	Able to carry out literature survey for effective writing using online tools.	**K3**
CO-4	Categorize knowledge about dissertation and thesis writing, towards a quote and paraphrase sources and avoid plagiarism.	**K4**
CO-5	Appraise the process of scientific writing and arbitrate public speaking skills.	**K5**

(K1=Remember, K2=Understand, K3=Apply, K4=Analyze, K5=Evaluate)

PO – Programme Outcomes, PSO – Programme Specific Outcomes, CO- Course Outcomes

PO – CO MAPPING

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9
CO 1	3	2	3	1	3	1	2	-	1
CO 2	3	2	3	1	3	1	2	-	1
CO 3	2	3	2	2	2	2	1	1	2
CO 4	2	2	3	3	2	3	3	1	1
CO5	3	2	2	2	1	1	3	1	1

PSO – CO MAPPING

CO/PO	PSO1	PSO2	PSO3
CO1	2	2	1
CO2	2	2	2
CO3	3	2	1
CO4	3	3	2
CO5	3	1	1

(For The Candidates Admitted From 2021 Onwards)
II B.Sc. BIOTECHNOLOGY – SEMESTER III

Course Title	**MAJOR SKILL BASED ELECTIVE: 2- ENTREPRENEURIAL BIOTECHNOLOGY**
Code	**U22BT3SBT04**
Course Type	**Theory**
Semester	**III**
Hours/Week	**2**
Credits	**1**
Marks	**100**

CONSPECTUS

Entrepreneurship education promotes students think outside the box and nurture unconventional talents and skills for development of viable commercial product. This course aims at teaching the skills of converting basic biology knowledge into sustainable business by providing novel/innovative solutions to the existing challenges in the field of biotechnology and by providing better alternatives to the existing approaches.

COURSE OBJECTIVES

1. To understand of the field of entrepreneurship and start-ups.
2. To acquire skills to succeed in the commercial world and promoting students for translating discoveries in Biotechnology.
3. To demonstrate important aspect of entrepreneurship is to understand business economics, market demands and strategies and legal as well as proprietorship aspects.
4. To provide an ideal interdisciplinary knowledge of biotechnology, economics, business management and legal framework for an aspiring entrepreneur.
5. To learn and compare the design of small, medium & large scale industry.

UNIT I: **6 HRS**

Introduction to Entrepreneurship

1.1 Creativity & Entrepreneurial personality and Entrepreneurship in Biotechnology, pillars of bio-entrepreneurship and major start-ups in Biotechnology.

1.2 Concept and theories of Entrepreneurship, Entrepreneurial traits and motivation, Nature and importance of Entrepreneurs.

1.3 Government schemes for commercialization of technology.

Extra Reading/Key words*:* *Biotech Consortium India Ltd.*

UNIT II: **6 HRS**

Project Management

2.1 Business ideas and concept of project, project formulation, project design and network analysis, project report, project appraisal.

2.2 Financial analysis: Ratio analysis, Investment process, Break even analysis, Profitability analysis, Budget and planning process.

2.3 Factors affecting biotech business: (finance, infrastructure, equipment, manpower, resources, project location, end product, quality issues, etc).

Extra Reading/Key words: *Ripple Sustainability Efforts.*

UNIT III: **6 HRS**

Biotech Industries and Technology

31. Emerging industries with examples from Transgenic, Environmental biotechnology, New drug development, DNA chip technology, Stem cell research, Tissue engineering.

3.2 Core concept of Market: Identification and evaluation of market potential of various bio entrepreneur sectors.

3.3 Marketing research- concept and techniques, marketing consultancy, bio-learning module. Ethics and IPR in biotech-Industries – Fundamentals of ethics in business, Ethical dilemmas in biotech industry.

Extra Reading/Key words: *IPR.*

UNIT IV: **6 HRS**

Funding for Biotech Business

4.1 Financing alternatives, Venture Capital funding, funding for biotech in India, Exit strategy, licensing strategies, valuation, support mechanisms for entrepreneurship.

4.2 Bio entrepreneurship efforts in India, difficulties in India experienced, organizations supporting biotech growth, areas of scope.

4.3 Funding agencies in India, biotech policy initiatives.

Extra Reading/Key words: *Biotechnology Ignition Grant, BIRAC.*

UNIT V: **6 HRS**

Design of Biotech Enterprises

5.1 Desirables in start-up, Setting up Small, Medium & Large scale industry, Quality control in Biotech industries, Location of an enterprise.

5.2 Steps for starting a small industry, incentives and subsidies, exploring export possibilities.

5.3 Licensing, Registration, and other legal Requirements for start-ups/companies

Extra Reading/Key words: *Digital Marketing.*

Visit: IV to start-ups/small companies with report submission.

Note: Texts given in the Extra reading /Key words must be tested only through assignment and Seminars.

PRESCRIBED TEXT BOOKS

- Martin Gross Mann., (2003). Entrepreneurship in Biotechnology: Managing for growth from start-up.

SUGGESTED REFERENCE BOOKS

- Yali Friedman., (2008). Best Practices in Biotechnology Education: Published by Logos Press.
- Hyne D., & John Kapeleris., (2006). Innovation and entrepreneurship in biotechnology: Concepts, theories & cases.
- Vasant Desai., (2005). Dynamics of Entrepreneurial Development and Management by Vasant, Himalaya Publishing House.

Note: Learners are advised to use latest edition of books.

COURSE OUTCOMES

CO No.	Course Outcomes	Cognitive Level (K1-K6)
CO-1	Recognizes the scope for entrepreneurship in biosciences and utilize the schemes promoted through knowledge centers and various agencies.	**K1**
CO-2	Acquire entrepreneurial skills, understand the various operations involved in venture creation, and identify scope for entrepreneurship in biosciences.	**K2**
CO-3	Gain necessary knowledge about funding agencies for developing their start-up.	**K3**
CO-4	Competent to transform their life science knowledge into biotech business.	**K4**

(K1=Remember, K2=Understand, K3=Apply, K4=Analyze, K5=Evaluate, K6=Create)

PO – CO MAPPING

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9
CO 1	1	2	1	1	1	2	3	1	3
CO 2	1	2	3	3	1	2	3	2	3
CO 3	3	2	2	1	1	2	3	3	3
CO 4	3	1	1	2	3	3	2	3	2

PSO – CO MAPPING

CO/PO	PSO1	PSO2	PSO3
CO1	1	2	3
CO2	1	3	2
CO3	2	3	1
CO4	3	2	1

(For The Candidates Admitted From 2022 Onwards)

II B.Sc. - SEMESTER - III

Course Title	**MAJOR ELECTIVE – FORENSIC SCIENCES**
Total Hours	**60**
Hours/Week	**4**
Semester	**III**
Code	**U22BT3MET01**
Course Type	**Theory**
Credits	**3**
Marks	**100**

CONSPECTUS

To make the learners to present the theory of forensic science, its development and progress over time. The students will also be familiarized with the sample collection, evaluation and forensic organizations. The course aims to elaborate the different techniques used in forensic investigations with the principals involved.

COURSE OBJECTIVES

1. Apprehend the basic concepts and scope of forensic science in crime investigations.
2. Comprehend the method of collection and analysis of biological samples in investigations.
3. Evaluate the blood stain pattern analysis and its types.
4. Analyze the methods used in developing fingerprint in assessing the samples, evaluating and profiling of DNA sample.

UNIT I **12 HRS**

Forensics

1.1 Introduction- definition, nature and purpose of forensic science; functions of the forensic science laboratories, laws and principle of forensic sciences.

1.2 Forensics, photography and evidences of crime-scene.

1.3 Pattern evidence- face, iris & retinal imaging, identification of lip prints, ear prints, gait pattern, bloodstain patterns, footprints, footwear impressions.

Extra Reading /Key words: automated fingerprint identification system.

UNIT II **12 HRS**

Forensic evidence and its Significance

2.1 Biological evidence – nature, types and importance.

2.2 Significance of hair evidence; transfer, persistence and recovery of hair evidence; comparison of human and animal hair samples.

2.3 Types and identification of microbial organisms of forensic significance; cellular antigens. ABO blood groups. Extracellular proteins and intracellular enzymes.

Extra Reading /Key words: metallic seal impressions.

UNIT III **12 HRS**

Forensic Hematology

3.1 Bloodstain Pattern Analysis - Bloodstain characteristics. Impact bloodstain patterns. Cast-off bloodstain patterns.

3.2 Projected bloodstain patterns. Contact bloodstain patterns. Documentation of bloodstain pattern evidence.

3.3 Crime scene reconstruction with the aid of bloodstain pattern analysis, Sexual assault investigations.

Extra Reading /Key words: Tetra-Methylbenzidine test.

UNIT IV **12 HRS**

Digital Forensics

4.1 Fingerprint Developing Methods - chemistry of latent fingerprint residue, methods of development of latent fingerprints using conventional methods, Light sources for developing finger printing.

4.2 Powdering (black and grey, fluorescent and magnetic), fuming method, vacuum metal deposition (VMD) method, chemical method.

4.3 Photography of fingerprints, digital transmission. Report writing & court room testimony.

Extra Reading /Key words: *Drug –dye complexometry.*

UNIT V **12 HRS**

Molecular Forensics

5.1 DNA Profiling - History of DNA Typing, molecular biology of DNA, variations, polymorphism, DNA Extraction-Organic and Inorganic extraction, Comparison of Extraction methods

5.2 Commercial kits DNA typing systems- RFLP analysis, PCR amplifications, sequence polymorphism.

5.3 Analysis of SNP, YSTR, Mitochondrial DNA, Ancient DNA typing, Evaluation of results.

Extra Reading /Key words: *Ion Microprobe Mass Analyser.*

Note: Texts given in the Extra reading /Key words must be tested only through assignment and Seminars.

PRESCRIBED TEXT BOOKS

- Houck, M.M., & Siegel, J.A., (2006). Fundamentals of Forensic Science. Academic Press, London, 2006.
- Sharma, B.R., (2003). Forensic Science in Criminal Investigation & Trials. Universal Publishing Co., New Delhi.
- Barry, A.J., Fisher., (2003). Techniques of Crime Scene Investigation, 7th Ed, CRC Press, New York.

SUGGESTED REFERENCE BOOKS

- Richard Saferstein., (2007). Criminalistics: An Introduction of Forensic Science. Prentice Hall Inc, USA.
- Houck, M.M., & Siegel, J.A., (2006). Fundamentals of Forensic Science. Academic Press, London.
- Bridges, B.C., (2000). Criminal Investigation, Practical Fingerprinting, Thumb Impression, Handwriting expert Testimony, Opinion Evidence. Univ. Book Agency, Allahabad.
- James Cowger., (1993). Friction Ridge Skin- Comparison & Identification of Fingerprints. CRC Press, New Yark.

Note: Learners are advised to use latest edition of books.

WEBSITE REFERENCES

- https://www.forensicscolleges.com/blog/resources
- ttps://forensicresources.org/view-resources/websites/
- https://www.ojp.gov/ncjrs/virtual-library/abstracts/forensic-resources-web
- https://guides.library.utoronto.ca/ForensicScienceUTML/FSCResources
- https://www.forensicscienceresources.com/
- https://sciencespot.net/Pages/classforsci.html

COURSE OUTCOMES (CO)

The learners will be able to

CO No.	Course Outcomes	Cognitive Level
CO-1	Understand the basic concept, meaning, significance and development of forensic science.	**K1**
CO-2	Understand the basics of different biological evidence used in the crime investigation	**K2**
CO-3	Integrate the blood stain pattern analysis with the documentation	**K3**
CO-4	Demonstrate knowledge and understanding on the methods of developing fingerprints from the crime scene. Apply the DNA finger printing analytical methods in identifying evidence during investigation.	**K4**
CO-5	Evaluate the crime scene investigations, reconstruction of scene of crime, basic principles of photography and its relevance.	**K5**

(K1=Remember, K2=Understand, K3=Apply, K4=Analyze, K5=Evaluate)

PO – Programme Outcomes, PSO – Programme Specific Outcomes, CO- Course Outcomes

PO – CO MAPPING

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9
CO 1	3	1	-	-	-	1	2	1	2
CO 2	2	1	-	-	-	2	1	2	1
CO 3	3	2	2	2	2	2	3	2	3
CO 4	2	2	1	1	2	3	3	3	3
CO 5	2	2	1	3	2	3	3	2	2

PSO – CO MAPPING

CO/PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	1	1	1
CO2	3	2	1	2	1
CO3	3	3	3	2	1
CO4	3	3	2	2	1
CO5	3	3	3	3	3

(For The Candidates Admitted From 2022 Onwards)
II B.Sc. BIOINFORMATICS - SEMESTER - III

Course Title	MAJOR ELECTIVE – BIOLOGICAL TECHNIQUES
Total Hours	60
Hours/Week	4 Hrs/ Wk
Semester	III
Code	U22BT3MET02
Course Type	Theory
Credits	3
Marks	100

CONSPECTUS

To provide a strong foundation in the principle and working mechanism of various biological techniques and instrumentation.

COURSE OBJECTIVES:

1. Understand the solution preparation methods and the various units of measurement.
2. Explain the phenomenon of spectroscopy and the applications of analytical spectroscopic techniques in research.
3. Acquire knowledge on the radiation and imaging-based techniques and their field of applications.
4. Explicate the working principle of centrifugation, chromatography and electrophoretic techniques in the separation of macromolecules with its respective types and applications.
5. Familiarize on the microarray techniques.

UNIT I **12 HRS**

Solution chemistry

Types of Solutions – Homogeneous and Heterogeneous, saturated and unsaturated Units of measurement – Molarity, Molality, Normality, Mass Percentage, volume percentage, Mass by volume percentage, mole fraction, concentration in parts per million.

Buffer preparation – Phosphate, TE, TAE, Preparation of stock and working reagents/solutions, pH meter - principle, instrumentation and application.

Extra Reading /Key words: Buffers and indicators

UNIT II **12 HRS**

Spectroscopy

Definition of spectrum. Electromagnetic radiation, principles, Spectroscopy - types of spectra, absorbance, emission and fluorescence.

Types of spectroscopy – principle, instrumentation and applications of UV- visible spectroscopy, atomic absorption spectroscopy, NMR, FTIR, Raman Spectroscopy.

Mass Spectrometry- principle, instrumentation and applications of Flame Photometry and Fluorimetry, GC-MS, LC-MS, MALDI-TOF

Extra Reading /Key words: X-ray Crystallography

UNIT III: **12 HRS**

Structure elucidation methods

Nuclear Magnetic Resonance Spectroscopy – Introduction – Principles - NMR Theory and Experiment – Classical Description of NMR.

NMR Parameters - coupling constants in 1H, 13C and 31P NMR spectra - The Nuclear Overhauser Effect - Application of NMR spectroscopy for structure elucidation of simple biomolecules

X-ray Spectroscopy – Production and properties of X-rays. The Bragg's Law –Diffraction Methods –Powder Method – Particle size Calculation – X-ray scattering by electrons. X-ray Data Collection, Structure Solution, Refinement of the Structure.

Extra Reading /Key words: Crystallographic databases

UNIT IV: 12 HRS

Separation Techniques

Chromatography –Principle, methodology and applications of paper, thin layer, column (gel filtration, ion-exchange, affinity), gas and HPLC

Centrifugation - Principle, types and applications of preparative and analytical ultracentrifuges.

Electrophoresis - Principles, types and their applications for proteins, nucleic acids, including gradient gel and pulse field gel electrophoresis, agarose gel electrophoresis, PAGE, 2D-PAGE, capillary electrophoresis and immune electrophoresis.

Extra Reading /Key words: UPLCMS

UNIT V 12 HRS

Microarray

Microarray - Principle of microarray, Types, Application of microarray.

Techniques of microarray - Micro array design - Data representation - Data cleaning methods - Data Normalization methods, Analysis of Microarray data - K-Means Clustering.

Microarray in Bioinformatics: Microarray database**,** software for microarray data analysis.

Extra Reading /Key words: *Microchip in separation of DNA fragments, hPAGE*

Note: Texts given in the Extra reading /Key words must be tested only through assignment and Seminars.

PRESCRIBED TEXT BOOKS

- Upadhyay, A., Upadhyay, K. and Nath, N, (2002), Biophysical Chemistry, Himalayan Publication House, New Delhi.
- Wilson K., Walker. (2000), Practical Biochemistry– Principles and Techniques, fifth edition, Cambridge University Press, Cambridge.

SUGGESTED REFERENCE BOOKS

1. Keith Wilson and Jhon Walker, (2010) Principles and Techniques of Biochemistry and Molecular Biology- seventh Edition. Cambridge University Press, Cambridge
2. Walker, John M. Rapley, Ralph (Eds.), (2008), Molecular Biomethods Handbook, 2nd ed., Humana Press.
3. Prescott LM., Harley JP., Klein DA., (2006). Microbiology sixth edition. McGraw –Hill, New York.
4. Plummer D., (1987). Introduction to Practical Biochemistry third edition. McGraw –Hill, New York.

WEBSITE REFERENCES

- https://www.toppr.com/guides/chemistry/is-matter-around-us-pure/centrifugation/
- https://unacademy.com/content/jee/study-material/chemistry/electrophoresis/
- https://www.khanacademy.org/science/class-11-chemistry-india/xfbb6cb8fc2bd00c8:in-in-organic-chemistry-some-basic-principles-and-techniques/xfbb6cb8fc2bd00c8:in-in-methods-of-purification-of-organic-compounds/a/principles-of-chromatography
- https://www.nuclear-power.com/nuclear-engineering/radiation-detection/scintillation-counter-scintillation-detector/
- https://www.britannica.com/science/mass-spectrometry

COURSE OUTCOMES

CO No.	Course Outcomes	Cognitive Level
CO-1	Understand the underlying working principle of various laboratory instruments with their specific applications.	K1
CO-2	Describe the principle and methodology of analytical instruments.	K2
CO-3	Integrate the use of centrifugation, electrophoresis and chromatography in the relevant field of application.	K3
CO-4	Analyze the practical necessity for the relevant usage of the instruments.	K4
CO-5	Integrate spectroscopic techniques in their research projects and utilize them to discover the structure of novel compounds.	K5

(K1=Remember, K2=Understand, K3=Apply, K4=Analyze, K5=Evaluate)

PO – CO MAPPING

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9
CO 1	2	3	-	-	-	-	1	2	2
CO 2	3	2	3	-	1	1	2	3	3
CO 3	3	3	3	3	3	3	3	3	3
CO 4	2	3	3	3	3	3	3	3	3
CO5	2	2	2	3	3	-	3	3	3

PSO – CO MAPPING

CO/PO	PSO1	PSO2	PSO3
CO1	2	1	1
CO2	2	3	3
CO3	3	3	3
CO4	3	3	3
CO5	3	2	3

(For The Candidates Admitted From 2022 - 2023 Onwards)

SEMESTER - III

Course Title	NON MAJOR ELECTIVE 1 – BIOTECHNOLOGY IN AGRICULTURE
Total Hours	30
Hours/Week	2
Semester	III
Code	U22BT3NMT01
Course Type	Theory
Credits	2
Marks	100

CONSPECTUS

To make the learners understand various tools and techniques used in agriculture biotechnology, applying plant tissue culture methods in crop improvement for the increase in yield, iron, protein and amino acids.

COURSE OBJECTIVES

1. To recognize the basic techniques and types of agriculture methods
2. To understand the importance of horticulture and post harvesting. Understand the molecular mechanism of ripening of fruits in postharvest methods.
3. To apply the Plant tissue culture techniques and its application in crop improvement
4. To appraise the applications of biotechnology on conventional methods for crop improvement.
5. To prioritize the nutritional security of food crops and the evaluating the toxicity of food crops.

UNIT I

Agricultural Methods **6 HRS**

Diiferent methods of agriculture and importance of Agriculture.

Irrigation-water managements, methods of irrigation, micro-irrigation, cropping systems.

Plant protection, Seed Production of important crops, Seed bank.

Extra Reading (Key words): Pollen and Anther culture

UNIT II

Horticulture **6 HRS**

Scope and classification of horticultural crops. Growth habit and pruning methods. Plant growth regulators and their uses in horticulture.

Pre- and Post-harvest factors affecting shelf life of Horticultural crops. Postharvest molecular biology- ripening (role of ethylene, climacteric vs. non-climatic fruits), fruit softening.

Biotechnology for recycling Horticultural waste as manures and livestock feed.

Extra Reading /Key words: GIS and GPS Agriculture.

UNIT III

Tissue Culture **6 HRS**

Tissue culture in crop improvement.

Micropropagation for virus-free plants.

Somaclonal variation, Somatic hybridization, Haploids in plant breeding.

Extra Reading (Key words): i-Farm Technology.

UNIT IV

Crop Improvement **6 HRS**

Conventional methods for crop improvement (Pedigree breeding, Heterosis breeding, Mutation breeding).

GMO products- Golden Rice, Bt Cotton, BT brinjal, Flavr-Savr" tomato, Pest resistant plant, Vaccine production in GM crop.

Genetic engineering plants for delayed ripening and better shelf life.

Extra Reading /Key words: Agri-food informatics.

UNIT V **6 HRS**

Food safety

International aspects of the quality and safety of Foods derived from modern Biotechnology

Biosensors for food quality Assessment, Malnutrition, causes, prevention and control.

Food safety and food faddism. Safety testing for toxicity, Native toxins and toxins produce during storage, health hazards.

Extra Reading /Key words: RNAi-based Crop Traits.

Note: Texts given in the Extra reading /Key words must be tested only through assignment and Seminars.

PRESCRIBED TEXT BOOKS

1. Hand book of horticulture - by ICAR, New Delhi
2. Plant Biotechnology by Chawla., (2002). Oxford IBH, ND.

SUGGESTED REFERENCE BOOKS

1. Postharvest by Wills, Mcglasson, (2007). CABI.
2. Vaclavik., (2003). Essentials of Food Science, Plenum,NY.
3. Philips, C. L. G. C., & Wetter, L.R., (1995). Plant cell tissue and organ culture: fundamental methods, National Research council, Canada, PRL, Saskatoon.
4. Valpuestav (2002) Fruit & Vegetable Biotechnology. Woodhead Publishing Series in Food Science, Technology and Nutrition

Note: Learners are advised to use latest edition of books.

WEBSITE REFERENCES

- https://www.usda.gov/topics/biotechnology/biotechnology-frequently-asked-questions-faqs
- https://www.ctahr.hawaii.edu/oc/freepubs/pdf/bio-3.pdf
- http://absp2.cornell.edu/resources/briefs/documents/warp_briefs_eng_scr.pdf
- https://www.fda.gov/food/consumers/agricultural-biotechnology
- https://www.isaaa.org/resources/publications/agricultural_biotechnology/download/agricultural_biotechnology.pdf
- https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8751662/

COURSE OUTCOMES

CO No.	Course Outcomes	Cognitive Level (K1-K6)
CO-1	Recognize the basic types and scope of agricultural methods and its importance in cropping.	**K1**
CO-2	Comprehend the methods of horticulture with relation to post harvesting of fruits and vegetables.	**K2**
CO-3	Apply the techniques of biotechnological application on crop development and quality food crop tissue culture	**K3**
CO-4	Critique the conventional methods of crop improvement using biotechnological molecular tools and evaluating the recycle of waste to become bio-entrepreneur.	**K4**
CO-5	Appraise the nutritional security of food crops and the evaluating the toxicity of food crops.	**K5**

(K1=Remember, K2=Understand, K3=Apply, K4=Analyze, K5=Evaluate)

PO – Programme Outcomes, PSO – Programme Specific Outcomes, CO- Course Outcomes

PO – CO MAPPING

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9
CO 1	3	2	2	1	-	1	2	2	1
CO 2	3	2	2	-	-	2	2	3	2
CO 3	2	3	3	1	2	3	3	3	3
CO 4	1	3	3	2	3	3	3	3	3
CO 5	1	1	2	3	2	1	1	2	1

PSO – CO MAPPING

CO/PO	PSO1	PSO2	PSO3
CO1	3	2	1
CO2	2	2	3
CO3	1	3	3
CO4	1	3	3
CO5	3	2	2

(For The Candidates Admitted From 2022 Onwards)
II B.Sc. BIOTECHNOLOGY – IV Semester

Course Title	Major Core 09– Bioinformatics & Computational Analysis (Theory Cum Lab)
Total Hours	75
Hours/Week	5 Hrs./Wk.
Code	U22BT4MCT09
Course Type	Theory Cum Lab
Credits	4
Marks	100

CONSPECTUS

This course will explore the rapidly developing field of bioinformatics, gaining an understanding of the computational complexities associated with the analysis of large biological data sets. This course will explore the ways to use some of the common bioinformatics tools effectively.

COURSE OBJECTIVES

1. Demonstrate the available databases of proteins to visualize structural details and outline the basics of bioinformatics and the set of databases utilized for data retrieval, analysis and manipulation.
2. Perform gene and protein sequence alignments to find similar sequences and compute the significant relationship between two or more biological sequences using bioinformatics tools.
3. Describe phylogenetic tree preparation, based on sequences similarities and genome sequencing, gene analysis and annotation methods.
4. Study the different types of protein structures and its associated structure prediction tools in bioinformatics.
5. Perform practical to predict the required data

UNIT- I: 15 HRS

Bioinformatics and its application.

1.1 Bioinformatics – Definition, scope, Goal, Application, Limitations. Bioinformatics softwares – Web based tools and command line tools.

1.2 Databases – Types of databases- Relational database, Object oriented databases. Biological databases – Primary databases, Secondary databases, Specialized databases. Nucleotide database- Genbank, DDBJ, EMBL. Protein database – Uniprot - Swissprot, TrEMBL, PIR. Protein structure database- PDB.

1.3 Human genome project – Background, Goals, Main conclusion of Human genome project, Human genome variation – SNPs and HapMap Project.

Extra Reading/Key words: *Genomic Medicine*

UNIT – II : 15 HRS

Sequence alignment

2.1 Sequence alignment – Definition, Types. Pairwise sequence alignment – Local alignment, Global alignment. Sequence similarity search tool - BLAST, FASTA.

2.3 Alignment algorithm – Dot matrix, Dynamic programming – Needle man wunch algorithm, Smith waterman algorithm. Scoring Matrices – PAM, Blosum.

2.3 Multiple sequence alignment – Scoring Function, Progressive alignment, Iterative alignment. Tools used for multiple sequence alignment.

Extra Reading/Key words:*Tools and software packages used in homology modeling.*

UNIT- III : 15 HRS

Phylogenetic analysis

3.1 Phylogenetic tree – Definition, terminology, Properties. Types of Trees; Stages of Phylogenetic analysis.

3.2 Tree construction methods – distance based methods – UPGMA, neighbour joining; Character based method - Maximum Parsimony, Maximum Likelihood.

3.3 Phylogenetic tree evaluation – bootstraping ,Jacknifing. Phylogenetic programs – Phylip, MEGA.

Extra Reading/Key words: *Significance of ancestral nodes in evolution. Newly developed phylogenetic databases.*

UNIT- IV: 15 HRS

Structure Prediction

4.1 Protein Structure – primary structure, secondary Structure, tertiary structure; Protein structure visualization tools – RasMol - Swiss PDB Viewer - PYMOL

4.2 Secondary Structure Prediction – RNA secondary structure prediction, protein secondary structure prediction - Chou-Fasman, Garnier-Orguthorpe – Robson (GOR) methods.
4.3 Protein Tertiary Structure -Predicting 3D structure – comparative (homology) modeling, threading (fold recognition) and ab initio methods. CASP.
Extra Reading/Key words:*Tools and software packages used in homology modeling.*

UNIT – V: 15 HRS

Practical

1. Nucleotide database – Genbank, EBI, DDBJ
2. Protein Database : Uniprot
3. Protein structure database – PDB
4. Pairwise sequence alignment – BLAST
5. Multiple sequence alignmet – Clustal Omega
6. Pairwise sequence alignment – EMBOSS needle, Emboss water
7. Phylogenetic analysis – Simple Phylogeny.
8. Structure Visualization tool – Rasmol.
9. Secondary structure prediction – Jpred
10. Homology Modelling – Swiss Model workspace

A record will be submitted and evaluated during the practical examination.

Note: Texts given in the Extra reading /Key words must be tested only through assignment and Seminars.

PRESCRIBED TEXT BOOKS

1. Attwood. T.K and Parry Smith D.J, (2007), Introduction to Bioinformatics, 1st Edition, Pearson Education Ltd, NewDelhi.
2. Jin Xiong, Essential Bioinformatics, Cambridge University Press, 2006, ISBN 9780511806087

BOOKS FOR REFERENCE

1. BabajanBanaganapalli, Khalid Rehman Hakeem, Noor Ahmad Shaik, RamuElango, (2019).Essentials of Bioinformatics, Volume II. In Silico Life Sciences: Medicine.Springer International Publishing
2. Jonathan Pevsner,(2015). Bioinformatics and Functional Genomics.Wiley-Blackwell; 3rd edition
3. Arthur M. Lesk , (2004), Introduction to Bioinformatics, Oxford University Press, London.
4. Baxevanis& BFF Ouellette, (2001), Bioinformatics: A practical guide to the analysis of genes and proteins, AD - Wiley Interscience New York.
5. Cantor. C.R &Schimmel. P.R, (1980) Biophysical Chemistry Part - I, W.H.Freeman& Co., San Fransisco.
6. Des Higgins& Willie Taylor (2000). Bioinformatics: Sequence, Structure and databanks Oxford University Press.
7. Gibson.G. and Muse. S.V, (2002), A primer of Genome Science. Sinauer Associates, Inc.Publishers, Sunderland.
8. Primrose. S.B and Twyman. R.M, (2003), Principles of Genome analysis and Genomics,3rd Edition. Blackwell Publishers, Japan.
9. Stephen Misener& Stephen A. Krawetz, (2000), Bioinformatics : Methods and Protocols Humana Press, New Jersey.

WEB REFERENCES

- https://omicstutorials.com/interpreting-dot-plot-bioinformatics-with-an-example/
- https://www.cs.utoronto.ca/~brudno/bcb410/lec2notes.pdf
- https://www.khanacademy.org/science/ap-biology/natural-selection/phylogeny/a/phylogenetic-trees

Note: Learners are advised to use latest edition of books.

COURSE OUTCOMES (CO):

The learners will be able to

CO No.	Course Outcomes	Cognitive Level (K1-K6)
CO-1	Understand and summarize the history and basic concepts in bioinformatics.	K1
CO-2	Acquire knowledge of the various biological fields that leverage bioinformatics as a tool, and to use raw sequence data to illustrate molecular evolution insight.	K2
CO-3	Appreciate the need of organising and analysing large datasets generated by system and genomics technology; simulate and model large-scale biological systems.	K3

CO-4	Comprehend and criticize the evolutionary computation and theoretical concepts deployed in bioinformatics.	K4
CO-5	Enable them to critically assess bioinformatics research and preparing them for a future research career in the field by providing them with a solid foundation in the theory underlying the methodologies and tools used in the field.	K5

(PSO – Programme Specific Outcomes; CO – Course Outcome; R- Remember; U- Understand; Ap – Apply; An – Analyse; E- Evaluate; C – Create)

PO – CO MAPPING

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

PSO – CO MAPPING

PSO	PSO1	PSO2	PSO3
CO1	2	2	3
CO2	3	2	3
CO3	2	3	2
CO4	3	3	3
CO5	2	2	3

(For The Candidates Admitted From 2022 Onwards)
II B.Sc. BIOTECHNOLOGY – IV Semester

Course Title	Major Core 10– Cheminformatics
Total Hours	60
Hours/Week	4 Hrs./Wk.
Code	U22BT4MCT10
Course Type	Theory
Credits	4
Marks	100

CONSPECTUS

This course introduces students to various chemical databases, chemical data sources, search tools, and data analysis techniques. It will make the learners to understand, how to extract knowledge from reaction information. Students will familiarize with basic models of chemical reactivity and to know simple approaches to quantify chemical reactivity

COURSE OBJECTIVES

1. Apply the concept of cheminformatics on the interference of chemistry and nomenclaturing.
2. Evaluate the elements of graph theory, types of matrix and 2D molecular description.
3. Implement computation of molecular descriptors and chemical similarity by analyzing chemical databases.
4. Utilise a variety of search techniques on chemical structures.
5. Establish and interpret SAR relationships among compounds.

UNIT – I: 12 HRS

Cheminformatics Introduction

1.1 Introduction, Scope of cheminformatics, History of cheminformatics. Representation of chemical compounds – Chemical nomenclature – Development of chemical nomenclature.

1.2 Representation of chemical elements, Representation of the empirical formulas of inorganic compounds, organic compounds, Systemic nomenclature of Inorganic and organic compounds. Line notations – Wiswesser line notation, ROSDAL, Smiles coding, Sybyl line notation

1.3 Modelling of small molecules and Structure Elucidation, Drawing Tools and Structure Visualizations.

Extra Reading/Key words: *Algorithmic molecular design.*

UNIT – II: 12 HRS

Representation of Chemical compounds

2.1 Basics of Graph theory**,** molecular graphs – Vertex and edge weighted molecular graphs**.** Matrix representations – adjacency matrix, Distance matrix.

2.2 Connection table, Input and output of chemical structures, Standard structure exchange formats – Structure of a Molfile, Structure of an SDFfile.

2.3 Special notation of chemical structure – Markush structures, Fragment coding, Fingerprints, Hashcodes. Representation of 3D strutures – Automatic 3D structure generation. 3D structure codes – PDB, STAR, CIF. Softwares.

Extra Reading/Key words: *Pharmacophore Modelling*

UNIT – III: 12 HRS

Chemical databases-

3.1 – Struture database – INSPEC, GMELIN, Belisteien database- The cross fire revolution, retrieval performance of Cross fire, Abstracts, Reactions and echopharm extensions to the Belisteien file.

3.2 Literature Databases – Chemical abstract file, SCISEARCH, Medline. Spectroscopic databases – SpecInfo. Crystallographic databases – ICSD, CSD, PDB.

3.3 Structure database – CAS registry, NCI database. Chemical reaction database – CASREACT, ChemInform RX. Patent database – INPADOC, WPINDEX, MARPAT

Extra Reading/Key words: *NIH Clinical Collection*

UNIT – IV: 12 HRS

Structure Descriptors

4.1 Descriptors – Definition, classification of structure descriptors – data type and molecular representation. Structure keys and 1D fingerprints.

4.2 Descriptors calculated from 2D structure – simple count, physicochemical properties, topological indices, 2D fingerprints. Descriptors based on 3D representation - 3D fragment screens, phramacophore keys.

4.3 QSAR Equation- simple and multiple Linear Regression- Designing a QSAR "Experiment"- Principal Components Regression- molecular Field Analysis and partial least Squares.

Extra Reading/Key words: *Chemogenomics*

UNIT – V: **12 HRS**

Applications of Cheminformatics

5.1 Prediction of properties of compounds - QSPR, Estimation of aqueous solubility, Prediction of toxicity of the compounds.

5.2 Structure spectra – Molecular descriptors, C NMR Spectra, H NMR Spectra, Infrared Spectra, Mass Spectra, Computer assisted structure elucidation

5.3 Drug Design, Application of cheminformatics in drug design, Ligand based drug design- Pharmacophore Design, Molecular similarity and molecular descriptors. ADMET prediction.

Extra Reading/Key words: *Didactic Drug Design Targets*

Note: Texts given in the Extra reading /Key wordsmust be tested only through assignment and Seminars.

TEXTBOOK

1. Johann Gasteiger and Thomas Engel. 2003. Chemoinformatics -A Textbook. Germany: Wiley-VCH,
2. Andrew R. Leach, Valerie J. Gillet. 2007. An Introduction to Chemoinformatics.UK: Springer,

BOOKS FOR REFERENCE

1. Branden C and Tooze J, (1991). Introduction to Protein Structure, Garland Publishing Inc., New York.
2. P.S.Kalsi (1990) Sterochemistry – Conformation & Mechanism by, New Age International Ltd., 1990.
3. Eric M. Gordon , James F.Kerwin (1998), Combinatorial Chemistry and Molecular Diversity in Drug Discovery
4.Cantor CR &Schimmel PR, 1980. Biophysical Chemistry Part - I, W.H. Freeman & Co., in San Fransisco,

Note: Learners are advised to use latest edition of books.

Web references

- https://chem.libretexts.org/Courses/Intercollegiate_Courses/Cheminformatics/05%3A_5._Quantitative_Structure_Property_Relationships/5.03%3A_Molecular_Descriptors
- https://pharmafactz.com/medicinal-chemistry-introduction-to-quantitative-structure-activity-relationships-qsar/
- https://efaidnbmnnnibpcajpcglclefindmkaj/https://annamalaiuniversity.ac.in/studport/download/engg/pharm/resources/MPHARM_P'Col_1Y_2S_203T_Principles%20of%20Drug%20Disc.pdf

COURSE OUTCOMES (CO):

The learners will be able to

CO No.	Course Outcomes	Cognitive Level (K1-K6)
CO-1	Comprehend the cheminformatics application's tools, frameworks and libraries.	K1
CO-2	Investigate and implement computation of molecular descriptors and chemical similarity.	K2
CO-3	Outline the overview methods in model building process and calculating the toxic effects of the compounds.	K3
CO-4	Apply QSAR principles in High-Throughput Screening to generate new leads.	K4
CO-5	Design the biological targets and properties of the small molecule.	K5

PSO – Programme Specific Outcomes; CO – Course Outcome; R- Remember; U- Understand; Ap – Apply; An – Analyse; E- Evaluate; C – Create

PO – CO MAPPING

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	2	-	1	2	1	3	2	2
CO2	3	3	2	-	2	2	3	3	3
CO3	3	3	2	1	2	2	3	2	3
CO4	3	3	2	2	2	3	3	3	3
CO5	3	2	3	1	-	-	2	2	3

PSO-CO MAPPING

PSO	PSO1	PSO2	PSO3
CO1	2	3	3
CO2	3	2	3
CO3	2	3	3
CO4	3	3	3
CO5	2	3	3

(For The Candidates Admitted From 2022 Onwards)

II B.Sc – IV Semester

Course Title	MAJOR ELECTIVE – FORENSIC SCIENCES
Total Hours	60
Hours/Week	4
Semester	III
Code	U22BT4MET03
Course Type	Theory
Credits	3
Marks	100

CONSPECTUS

To make the learners to present the theory of forensic science, its development and progress over time. The students will also be familiarized with the sample collection, evaluation and forensic organizations. The course aims to elaborate the different techniques used in forensic investigations with the principals involved.

COURSE OBJECTIVES

1. Apprehend the basic concepts and scope of forensic science in crime investigations.
2. Comprehend the method of collection and analysis of biological samples in investigations.
3. Evaluate the blood stain pattern analysis and its types.
4. Analyze the methods used in developing fingerprint in assessing the samples, evaluating and profiling of DNA sample.

UNIT I **12 HRS**

Forensics

1.1 Introduction- definition, nature and purpose of forensic science; functions of the forensic science laboratories, laws and principle of forensic sciences.

1.2 Forensics, photography and evidences of crime-scene.

1.3 Pattern evidence- face, iris & retinal imaging, identification of lip prints, ear prints, gait pattern, bloodstain patterns, footprints, footwear impressions.

Extra Reading /Key words: automated fingerprint identification system.

UNIT II **12 HRS**

Forensic evidence and its Significance

2.1 Biological evidence – nature, types and importance.

2.2 Significance of hair evidence; transfer, persistence and recovery of hair evidence; comparison of human and animal hair samples.

2.3 Types and identification of microbial organisms of forensic significance; cellular antigens. ABO blood groups. Extracellular proteins and intracellular enzymes.

Extra Reading /Key words: metallic seal impressions.

UNIT III **12 HRS**

Forensic Hematology

3.1 Bloodstain Pattern Analysis - Bloodstain characteristics. Impact bloodstain patterns. Cast-off bloodstain patterns.

3.2 Projected bloodstain patterns. Contact bloodstain patterns. Documentation of bloodstain pattern evidence.

3.3 Crime scene reconstruction with the aid of bloodstain pattern analysis, Sexual assault investigations.

Extra Reading /Key words: Tetra-Methylbenzidine test.

UNIT IV **12 HRS**

Digital Forensics

4.1 Fingerprint Developing Methods - chemistry of latent fingerprint residue, methods of development of latent fingerprints using conventional methods, Light sources for developing finger printing.

4.2 Powdering (black and grey, fluorescent and magnetic), fuming method, vacuum metal deposition (VMD) method, chemical method.

4.3 Photography of fingerprints, digital transmission. Report writing & court room testimony.

Extra Reading /Key words: *Drug –dye complexometry.*

UNIT V **12 HRS**

Molecular Forensics

5.1 DNA Profiling - History of DNA Typing, molecular biology of DNA, variations, polymorphism, DNA Extraction-Organic and Inorganic extraction, Comparison of Extraction methods

5.2 Commercial kits DNA typing systems- RFLP analysis, PCR amplifications, sequence polymorphism.

5.3 Analysis of SNP, YSTR, Mitochondrial DNA, Ancient DNA typing, Evaluation of results.

Extra Reading /Key words: *Ion Microprobe Mass Analyser.*

Note: Texts given in the Extra reading /Key words must be tested only through assignment and Seminars.

PRESCRIBED TEXT BOOKS

- Houck, M.M., & Siegel, J.A., (2006).“Fundamentals of Forensic Science”, Academic Press, London, 2006.
- Sharma, B.R., (2003). “Forensic Science in Criminal Investigation & Trials”, Universal Publishing Co., New Delhi.
- Barry, A.J., Fisher., (2003). “Techniques of Crime Scene Investigation”, 7th Ed, CRC Press, New York.

SUGGESTED REFERENCE BOOKS

- Richard Saferstein., (2007). “Criminalistics: An Introduction of Forensic Science”, Prentice Hall Inc, USA.
- Houck, M.M., & Siegel, J.A., (2006). “Fundamentals of Forensic Science”, Academic Press, London.
- Bridges, B.C., (2000). “Criminal Investigation, Practical Fingerprinting, Thumb Impression, Handwriting expert Testimony, Opinion Evidence”, Univ. Book Agency, Allahabad.
- James Cowger., (1993). “Friction Ridge Skin- Comparison & Identification of Fingerprints”, CRC Press, New York.

Note: Learners are advised to use latest edition of books.

WEBSITE REFERENCES

- https://www.forensicscolleges.com/blog/resources
- ttps://forensicresources.org/view-resources/websites/
- https://www.ojp.gov/ncjrs/virtual-library/abstracts/forensic-resources-web
- https://guides.library.utoronto.ca/ForensicScienceUTML/FSCResources
- https://www.forensicscienceresources.com/
- https://sciencespot.net/Pages/classforsci.html

COURSE OUTCOMES (CO)

CO No.	Course Outcomes	Cognitive Level (K1-K6)
CO-1	Understand the basic concept, meaning, significance and development of Forensic science.	**K1**
CO-2	Understand the basics of different biological evidence used in the crime investigation	**K2**
CO-3	Integrate the blood stain pattern analysis with the documentation	**K3**
CO-4	Demonstrate knowledge and understanding on the methods of developing fingerprints from the crime scene. Apply the DNA finger printing analytical methods in identifying evidence during investigation.	**K4**
CO-5	Evaluate the crime scene investigations, reconstruction of scene of crime, basic principles of photography and its relevance.	**K5**

(K1=Remember, K2=Understand, K3=Apply, K4=Analyze, K5=Evaluate)

PO – Programme Outcomes, PSO – Programme Specific Outcomes, CO- Course Outcomes

PO – CO MAPPING

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9
CO 1	3	1	-	-	-	1	2	1	2
CO 2	2	1	-	-	-	2	1	2	1
CO 3	3	2	2	2	2	2	3	2	3
CO 4	2	2	1	1	2	3	3	3	3
CO 5	2	2	1	3	2	3	3	2	2

PSO – CO MAPPING

CO/PO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	1	1	1
CO2	3	2	1	2	1
CO3	3	3	3	2	1
CO4	3	3	2	2	1
CO5	3	3	3	3	3

(For The Candidates Admitted From 2022 Onwards)

B.Sc BIOINFORMATICS (INTEGRATED) – IV Semester

Course Title	Allied 6: Biostatistics for bioinformatics with SPSS
Total Hours	60
Hours/Week	4
Semester	IV
Code	U22BT4ALT04
Course Type	Theory cum lab
Credits	2
Marks	100

CONSPECTUS

This paper enables the student to describe the fundamental concepts, procedures, applications of statistics; the main principles of probability, statistical theory and the mathematical foundation which can be applied to other fields such as Actuarial Science and Computer Science.

COURSE OBJECTIVES

6. Demonstrate a solid understanding of hypothesis testing and choose, apply appropriate statistical methods for analyzing one or two variables.
7. Derive the theoretical mathematics of statistical inferences and perform linear regression model fitting and diagnosis.
8. Execute the statistical analysis by using SPSS software for data management and data analysis and learn to perform basic software analysis.
9. Apply statistics analysis in scientific reports based on statistical analysis for scientific collaboration with public health related scientists in epidemiology, health management and policy environmental health sciences, nutrition, health behaviour and health education
10. Practically explore the scientific report based statistical analysis.

UNIT I **12 HRS**

Basics of Statistics

1.1. Basics of Statistics - Nature of biological and clinical experiments – collection of experimental data Variables in biology; Population and sampling, sampling distribution

1.2. Difference between parametric and non - parametric statistics; Data Collection, Classification, Tabulation.

1.3. Statistical Package for Social Sciences (SPSS) - Introduction to SPSS for windows - data entry on SPSS - Variable naming- Analysis of data - Formulation of frequency tables. Applications of SPSS.

Extra Reading/Key words: *Statistics in Bioinformatics.*

UNIT II: **12 HRS**

Measurement of Central Tendency

2.1. Measures of central tendency of a set of observations - Purpose of statistical investigations - arithmetic mean - mean of grouped data - median – mode - range, mean deviation, variants and standard deviation. Skewness and kurtosis.

2.2. Diagrammatic representation - Bar and pie chart - histogram - frequency polygon,

2.3. Frequency Curve – Logarithmic curves –Scatter plot and line graphs.

Extra Reading (Key words): *Creating a data for the analysis of central tendency*

UNIT III: **12 HRS**

Correlation and Regression

3.1. Correlation - Types; methods - Graphic, mathematical- Karl Pearson's correlation co-efficient, Rank correlation co-efficient.

3.2. Regression - Simple linear regression- regression equation and regression line.

3.3. Test for correlation and regression coefficients

Extra Reading/Key words: *Statistics module, rating scales*

UNIT IV: **12 HRS**

Basics of Probability

4.1. Basic Concepts of Probability - Sample space and events - Probability distribution - Binomial, Poisson, Normal, Test of significance - hypothesis testing- Type I error, Type II error, level of significance.

4.2. Student 't' test - One sample 't' test, Independent sample and Paired 't' test.

4.3. Simple problems involving the estimation of probabilities - Normal Distribution and Binomial distribution – Z-score, P-value and E-value.

Extra Reading/Key words: *Probability in Bioinformatics, Matlab, Minitab*

UNIT V: **12 HRS**

Analysis of variance

Chi – square; Application of chi – square test. Chi – square test for Goodness fit; Test for Independence of Attributes.

F' test – Analysis of Variance (ANOVA) – Oneway ANOVA – Two way analysis of variance. Introduction to Multrovariate statistics.

Extra Reading/Key words*: Dataport, Datamining*

Note: Testing for this paper will be done in the lab by external examiner. Students will work out problems using SPSS package.

PRESCRIBED TEXT BOOKS

1. Rajathi and P. Chandran (2011). SPSS for you.
2 Jerold. H. Zar. (2010). Biostatistical analysis (Fifth Edition). Prentice Hall.

SUGGESTED REFERENCES

1. Millie R.L., Ciaran A., Fullerton D.A., and Maltby., (2002) SPSS for Social Scientists.(Version 9, 10, 11). Consultant Editior - Jo. Campling, Publiushers Palcrave Macmillan, (UK, USA) Printed in China
2. Robert L. Miler John Maltby & co., (2002). SPSS for Social Scientists. Palcrave Macmillan, New York.
3. Einspruch E.L. (2004) Next steps in SPSS Sage Publications, International Education and Professional Publishers, Thousand Oaks, London, New Delhi.
4. Snedecor, G.W & William, G. (1975). Statistical Methods. Havard University, Oxford & IBH Publications Co., Calcuta. Bombay, New Delhi.
5. Sokal, R and James F.R. (1973). Introduction to Biostatistics, W.H. Freeman & company, Toppan company, Ltd., Tokyo, Japan.

Note: Learners are advised to use latest edition of books.

WEBSITE REFERENCES

1. https://www.researchgate.net/publication/352992776_biostatisitcs_and_research_methodology_unit-1_subject_code_bp801t_b_pharm_iv_th_year_-viii_th_semester_session_2020_-21
2. https://www.hsph.harvard.edu/wp-content/uploads/sites/565/2019/09/HST190_Lecture_1.pdf
3. https://www.cartercenter.org/resources/pdfs/health/ephti/library/lecture-notes/env-health-science-students/ln-biostat-hss-final.pdf

COURSE OUTCOMES

The learners will be able to:

CO No.	Course Outcomes	Cognitive Level (K1-K6)
CO-1	Define the principal concepts about biostatistics and recognize the definition of statistics, its subject and its relation with the other sciences.	**K1**
CO-2	Restate the principal concepts about biostatistics, collect data relating to variable/variables which will be examined and calculate descriptive statistics from these data.	**K2**
CO-3	Analyze the data relating to variable/variables of convenient sample by using sampling theory.	**K3**
CO-4	Identify the distribution form of relating to the variable/variables and recognize the normal distribution, to interpret the data via normal distribution.	**K4**
CO-5	Evaluating the link between a single or a series of exposures, where the outcome is continuous but the exposures are either numerical, categorical, or a combination of both, can be determined using correlation or by applying linear regression analysis.	**K5**

(K1=Remember, K2=Understand, K3=Apply, K4=Analyze, K5=Evaluate)

PO –Programme Outcomes, PSO – Programme Specific Outcomes, CO-Course Outcomes

PO – CO MAPPING

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9
CO 1	1	2	-	1	1	-	2	3	2
CO 2	1	1	1	2	2	1	3	3	2
CO 3	2	2	1	1	1	-	3	3	2
CO 4	2	3	2	1	3	1	2	2	3
CO5	1	2	-	1	1	-	2	2	1

PSO – CO MAPPING

CO/PO	PSO1	PSO2	PSO3
CO1	2	2	1
CO2	3	2	2
CO3	1	3	2
CO4	3	2	2
CO5	2	2	3

(For The Candidates Admitted From 2022 Onwards)

II B.Sc – IV Semester

Course Title	**NME – FUNCTIONAL FOOD AND NEUTRACEUTICALS (Theory cum lab)**
Code	**U22BT4NMT02**
Course Type	**Theory**
Semester	**IV**
Total Hours	**30**
Hours/Week	**2**
Credits	**2**
Marks	**100**

CONSPECTUS

This subject provides a comprehensive knowledge on the applied aspects of functional foods and nutraceuticals and the relation of nutraceutical in health and medicine.

COURSE OBJECTIVES

1. Understand the classification, scope & future prospects in functional foods and nutraceuticals.
2. Identify the sources of nutrition and medicinal values in common functional foods.
3. Acquires knowledge
4. Determines Science with other Sciences: Medicine, Human physiology, genetics, food technology, chemistry and nutrition.
5. Validate in the formulation, processing, manufacture and packaging requirements of nutraceuticals

UNIT I **6 HRS**

Functional Foods: Definition, Relation of functional foods & Nutraceutical to foods & drugs. Vegetables, cereals, milk and dairy products as functional foods.

Extra reading/Keywords: *Functional foods as free radicals and antioxidants.*

UNIT II **6 HRS**

Nutritive and Non-nutritive food components with potential health effects. Functional foods from wheat, rice and Dietary fibers their health effects. Soy proteins and soy isoflavones in human health; Role of nuts in cardiovascular disease prevention.

Extra reading/Keywords: *Nutraceuticals in the management of neurodegenerative diseases.*

UNIT III **6 HRS**

Plants as bioreactors as a tool for production of Nutraceuticals. 'Tailor-made' carbohydrates and lipids of plant and non-plant origin.

Extra reading/Keywords: *Labeling for Nutraceuticals products.*

UNIT IV **6 HRS**

- Enzymatic browning in foods.
- Qualitative analysis of starch in a given sample.
- Assessment of quality using standard tests for the following:
- Milk and dairy products
- Tea and coffee powder

UNIT V **6 HRS**

- Preparation of Functional food/Nutraceuticals product
- Rich in minerals
- Rich in carotenoids and vitamin A
- Rich in antioxidants
- Preparation of traditional health products – e.g. Gulkand, Betel leaf juice, Bilwa jam.
- Survey report on any one Functional food/Nutraceuticals product.

Note: Texts given in the Extra reading/Key words must be tested only through assignment and seminars.

PRESCRIBED TEXT BOOKS

1. Syrpas, M., Kitrytė, V., & Venskutonis, P. R. (2022). Functional foods: An introduction to functional food products and nutraceuticals. de Gruyter.
2. Vattem, D. A., & Maitin, V. (2015). Functional foods, nutraceuticals and natural products: Concepts and applications. DEStech Publications.
3. Swaminathan M., Essentials of Food and Nutrition, 2nd Ed, 1985, Ganesh and Co.

SUGGESTED REFERENCE BOOKS

1. Krause's Food, Nutrition and Diet Therapy, 10th Edition by Mahan, L.K. & EcottStump, S. (2000), W.B. Saunders Ltd.
2. Modern Nutrition in Health & Disease, 9th Edition by Shils, M.E., Olson, J.A., Shike, N. and Ross, A.C. (Ed) (1999):, Williams & Wilkins.
3. Modern Nutrition in Health & Disease, 9th Edition by Shils, M.E., Olson, J.A., Shike, N. and Ross, A.C. (Ed) (1999):, Williams & Wilkins.
4. Dietary Supplements and Functional Foods -Geoffrey P. Webb.

Note: Learners are advised to use latest edition of books.

WEBSITE REFERENCES

- https://www.orientjchem.org/vol39no4/enzymatic-activity-of-polyphenol-oxidase-a-laboratory-experiment-in-flexible-learning/
- Gulkand Recipe - How to Make Gulkand at Home - Indian Rose Petal Preserve Recipe (blendwithspices.com)
- chem.boun.edu.tr/wp-content/uploads/2014/04/Chem-415-Experiment-1.pdf
- http://ecoursesonline.iasri.res.in/mod/page/view.php?id=6180

COURSE OUTCOMES

CO No.	Course Outcomes	Cognitive Level (K1-K6)
CO-1	Understand the importance of functional foods and nutraceuticals.	**K1**
CO-2	Recognize the nutritional value in functional foods.	**K2**
CO-3	Categorize the nutritional and non-nutritional foods and their significance in diet and health.	**K3**
CO-4	Assess the quality of natural daily consumed food products.	**K4**
CO-5	Prepare healthy recipes of functional foods.	**K5**

(K1=Remember, K2=Understand, K3=Apply, K4=Analyze, K5=Evaluate)

PO–Programme Outcomes, PSO–Programme Specific Outcomes, CO-Course Outcomes

PO – CO MAPPING

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9
CO1	2	2	1	-	-	2	-	2	-
CO2	1	1	-	-	-	2	-	3	-
CO3	1	1	-	-	-	2	-	2	-
CO4	1	1	1	-	-	2	-	2	2
CO5	1	1	1	-	-	2	-	2	2

PSO – CO MAPPING

CO/PO	PSO1	PSO2	PSO3
CO1	1	-	-
CO2	1	-	-
CO3	1	2	2
CO4	1	2	2
CO5	1	2	2

(For the candidates admitted from 2021 onwards)

HOLY CROSS COLLEGE (AUTONOMOUS)

Affiliated to Bharathidasan University

Nationally Accredited (4th Cycle) with A++ Grade (CGPA3.75/4) by NAAC

College with Potential for Excellence, Tiruchirappalli–620002

PG AND RESEARCH DEPARTMENT OF BIOTECHNOLOGY & BIOINFORMATICS

Programme: M.Sc. Biotechnology

PO No.	Programme Outcomes *Upon completion of the M.Sc. Degree Programme, the graduate will be able to*
PO-1	To upgrade their existing knowledge on scientific discoveries, laboratory techniques on biotechnology.
PO-2	Able to contribute and fulfill the needs of biotechnology industries with specific skills and provide solutions to develop product, process or technology.
PO-3	Familiarize with professional and ethical biotechnological practices for advancementsin societal, environmental and medical upliftment.
PO-4	Acquire self-confidence to become entrepreneur, manager and Research scientist with strong ethical values. Understand the potentials, and impact of biotechnological innovationsonenvironmentandtheirimplementationforfindingsustainablesolutionto issues pertaining to environment, health sector and agriculture.
PO-5	Apply knowledge in the scientific development and able to compete their level to government scientist and reputed national institutions.

	Programme Specific Outcomes *Upon completion of the courses the student would be able to*
PSO-1	Apply the tools and techniques learnt for designing and performing new experiments. Understand the operation mechanism of various bio instruments employed in industrial companies and research labs.
PSO-2	Decide and apply suitable tools and techniques in biotechnological manipulation especially gene manipulation and bioinformatics.
PSO-3	Understand the fundamental concepts in core courses such as basic science, cell biology, plant and animal biotechnology, r-DNA technology, microbiology, molecular biology and basic bioinformatics tools.
PSO-4	Gain and apply knowledge to plan, analyze and find innovative solutions for existing biotechnological problems.
PSO-5	Able to enhance their skill in planning and designing projects and receive funds from government, Graduates will be able to acquire competence to work in research laboratories and R &D labs.

(For The Candidates Admitted from 2021 Onwards)
HOLY CROSS COLLEGE (AUTONOMOUS), TIRUCHIRAPALLI – 2
COURSE CONTENT AND SCHEME OF EXAMINATIONS
PG AND RESEARCH DEPARTMENT OF BIOTECHNOLOGY AND BIOINFORMATICS PG COURSE PATTERN M.Sc. BIOTECHNOLOGY

Semester	Course	Title of the Paper	Code	Hrs/ Week	Credit	Marks
I	Major core-1	Molecular Cell Biology	P21BT1MCT01	5	5	100
	Major core-2	Advanced Analytical Techniques in Biotechnology laboratory	P21BT1MCT02	4	4	100
	Major core-3	Genetic Engineering	P21BT1MCT03	4	4	100
	Major core-4	Animal & Plant Biotechnology	P21BT1MCT04	4	4	100
	Major core-5	Practical –I (Molecular Cell Biology and Advanced Analytical Techniques in Biotechnology laboratory)	P21BT1MCP05	4	3	100
	Major core-6	Practical –II (Genetic Engineering and Animal & Plant Biotechnology)	P21BT1MCP06	4	3	100
	Major Elective	Agricultural Biotechnology/ Environmental Biotechnology	P21BT1MET01/ P21BT1MET02	4	4	100
		Internship (Extra Credit)	P22EX1INT01		2	100
		Value Education /Catechism/ Bible Studies)		1		
			TOTAL	**30**	**29**	**800**
II	Major core-7	Genomics & Transcriptomics	P21BT2MCT07	4	4	100
	Major core-8	Proteomics & Metabolomics	P21BT2MCT08	4	4	100
	Major core-9	Neuroscience & Stem Cell technology	P21BT2MCT09	4	4	100
	Major core-10	Practical III – (Genomics & Transcriptomics and Proteomics & Metabolomics)	P21BT2MCP10	4	3	100
	Major core-11	Practical IV – (Neuroscience & Stem Cell technology)	P21BT2MCP11	4	3	100
	Non-Major Elective	-	-	5	3	100
	Major Elective	Forensic Science Technology (Theory cum Lab)/ Medical Informatics	P21BT2MET03/ P21BT2MET04	4	4	100
	Extra Credit - 1	Reviewing Manuscript	P21BT2SST01	-	2	100
	Extra Credit	Online Course	P22OC2ECT01	-	1	100
		Value /Catechism/Bible Studies)		1		
	Extra Credit	Summer Internship	P22EX2INT02	-	02	100
			TOTAL	**30**	**30**	**1000**

III	Major core-12	Bioprocess technology & Industrial Biotechnology	P21BT3MCT12	4	4	100
	Major core-13	Nanotechnology &Toxicology	P21BT3MCT13	4	4	100
	Major core-14	CADD & Systems Biology	P21BT3MCT14	5	5	100
	Major core-15	Practical V (Bioprocess technology & Industrial Biotechnology)	P21BT3MCP15	4	3	100
	Major core-16	Practical VI (Nanotechnology &Toxicology and CADD & Systems Biology)	P21BT3MCP16	4	3	100
	Non-major Elective	-	-	5	3	100
	Major Elective	Food Process technology& Pharmaceutical Biotechnology/ Statistics & Programming for Biologists	P21BT3MET05/ P21BT3MET06	4	4	100
	Extra Credit -2	**Self Study:** Project and Proposal Writing	P21BT3SST02		2	100
	Extra Credit	Online Course	P22EX2ONC01	-	1	100
	Extra Credit	Summer Internship (50hrs)	P22EX3INT03	-	2	100
			TOTAL	**30**	**31**	**900**
IV	Extra Creditn-3	Self-study: Quality control in Biotechnology	P21BT4SST03		2	100
	Extra Credit-4	Self-study: Intellectual property rights	P21BT4SST04		2	100
	Extra Credit	Summer Internship	P22EX4INT04	-	2	100
	Project	Project and dissertation	P21BT4DIS01	30	12	100
				30	**18**	**400**
			TOTAL	**120**	**108**	**3100**

List of Non Major Elective Courses offered

Semester	Course	Title of the Paper	Code	Hrs/ Week	Credits	Marks
II	Non-Major Elective	Floristry business	P21BT2NMT01	5	3	100
III	Non-Major Elective	Functional foods and Nutraceuticals	P21BT3NMT02	5	3	100

(For the candidates admitted from 2021 onwards)
I M.Sc. BIOTECHNOLOGY – Semester I

Course Title	MAJOR CORE 1 – MOLECULAR CELL BIOLOGY
Total Hours	75
Hours/Week	5 Hrs /Wk
Code	P21BT1MCT01
Course Type	Theory
Credits	5
Marks	100

GENERAL OBJECTIVE

To make the learners to develop an exhaustive acquaintance with the structural, functional and molecular aspects of the cellular and sub cellular mechanisms and their research applications.

COURSE OBJECTIVES

To enable the learners

CO No.	Course Objectives
CO-1	Elucidate and demonstrate the structure and cellular functions associated with macromolecules in a cell.
CO-2	Comprehend the process of cell communication and signaling and associate the interaction of molecules in the process of signaling.
CO-3	Outline and examine the structural function of a chromosome and mechanism of DNA replication.
CO-4	Deconstruct and relate to the concept of processing of RNA and protein synthesis.
CO-5	Critically assess and predict the mechanism of gene regulation and the genetic base of tumorigenesis.

UNIT I: 15 HRS

History of a cell: Definition, history, application of a cell. Prokaryotic and Eukaryotic cell- structure and function. Cell theory, Properties of cell.

Structural organization and function of intracellular organelles: Cell wall, nucleus, mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, plastids, vacuoles, chloroplast, structure and function of cytoskeleton and its role in motility. Mitosis and meiosis, their regulation, steps in cell cycle, and control of cell cycle.

Extra Reading (Key words):*Red hot mitochondria.*

UNIT II: 15 HRS

Cytoskeleton and cell motility: Microtubules, actin and filament based motile system, membrane organization and transport across membrane.

Cellular interaction and cell signaling – Microvilli, intracellular communication and gap junction, Cell signalling and regulation**:** Hormones and their receptors, cell surface receptors, signalling through G-protein coupled receptors, receptor tyrosine kinase, signal transduction pathways, second messengers, bacterial and plant two component signalling systems, bacterial chemotaxis. Cascades of induction, interactions, paracrine factors, signal transduction cascade – RTK pathway, JAK-STAT pathway, Hedgehog family, Wnt family, TGF-β superfamily. Cell adhesion and roles of different adhesion molecules, extracellular matrix, neurotransmission.

Extra Reading (Key words):*Piezo1 Protein in cell signaling*

UNIT III: 15 HRS

Chromosome- structure and functions. DNA modification in specialized chromosomes. Chromatin, heterochromatin and euchromatin. Nucleic acids- structure, their stability, polymorphisms, sugar puckering, base stacking, cot curves, C-value paradox - prokaryotic and eukaryotic DNA and its replication. Mitochondrial and Chloroplast DNA.

DNA Replication-Types and mechanism of DNA replication. Unit of replication, fidelity of replication, extrachromosomal replicons. Denaturation - Renaturation kinetics. DNA damage, DNA Modifications.

DNA repair mechanisms. DNA mutations – types and detection of mutations -. RNA binding proteins, Ribonucleoproteins, RNA-protein recognition and interactions.

Extra Reading (Key words): *Gene free chromosomal region*

UNIT IV: 15 HRS

Transcription and processing of RNA :- Prokaryotic and eukaryotic - Regulatory signal elements: promoter, motifs. Transcription factors and machinery, formation of initiation complex, transcription activators and repressors, RNA polymerases, capping, elongation and termination, RNA processing, RNA editing, splicing, polyadenylation, structure and function of different types of RNA, RNA transport. RNA types and functions- Non-coding RNAs: structure and function - si RNA and miRNAs. Catalytic RNA. Genetic code, Properties and Wobble hypothesis. Overlapping genes.

Protein synthesis and processing: Ribosome, formation of initiation complex, initiation factors and their regulation, elongation and elongation factors, termination, genetic code, aminoacylation of tRNA, tRNA-identity, aminoacyl tRNA synthetase, translational proof-reading, translational inhibitors, post- translational modification and inhibitors of protein synthesis. Protein localization-synthesis of secretory and membrane proteins - Protein sorting - Vesicular traffic in secretion.

Extra Reading (Key words): *Cell-free protein synthesis in protein therapeutics*

UNIT V: 15 HRS

Regulation of Gene Expression-Types, Operon concept - Lac, Trp and Ara operons - Gene regulation in eukaryotes – myosin and hemoglobin synthesis- Down-stream regulation - SNAPs and SNAREs -TAG protein destruction - DNA re-arrangement. Insertional elements and Transposons - Plant, Bacterial and Animal, Structure- organization and transposition. Homologous recombination and non-homologous recombination of genes - Holiday junction - Rec A and other recombinases.

Tumorigenesis – Theories regarding tumor formation. Biological clock and Mutation theory. Site-specific and Oligonucleotide directed mutagenesis. Oncogenes and Tumour Suppressor Gene. Genetic pathways for PCD Anti- and pro-apoptotic proteins.

Extra Reading (Key words): *Stem cell vaccine to protect cancer*

Note: Texts given in the Extra reading /Key words must be tested only through assignment and Seminars.

PRESCRIBED TEXT BOOKS

1. Freifelder D (2003), *Essentials of Molecular Biology*, Edition IV, Jones and Bartlett Publications Inc.
2. De Robertis DP (2001), *Cell and Molecular Biology*, Edition VIII, Lippincott Williams and Williams.

SUGGESTED REFERENCE BOOKS

1. Karp G (2013), *Cell Biology*, Edition VII, International Student Version, Wiley publication.
2. Lodish H, Berk A, Kaiser CA, Krieger M, Bretscher A, Ploegh H, Amon A, Scott MP (2012), *Molecular Cell Biology*, Edition VII, W.H. Freeman and Company, New York.
3. Paul A (2011) *Textbook of Cell and Molecular Biology*. Books & Allied Ltd Publishers. ISBN-10: 8187134747.
4. Clark DP, (2009) *Molecular Biology. (Understanding the genetic revolution*), Elsevier Academic Press.
5. Cooper GM, Hausman RE (2007), *The Cell - A Molecular Approach*, Sinauer Associates, Inc.
6. Lewin B (2007), *Genes IX*, Jones and Bartlett Publishers
7. Watson JD, Baker TA, Bell SP, Gann A, Levine M, Losick R, Cummings B (2004). *Molecular Biology of the Gene*, Edition V.
8. Lodish, Harvey, Arnold, Matsudaira, Paul, Kaiser, Chris A, Krieger, Monty Scott, Matthew P., Zipursky, Lawrence , Darnell, James (2004), *Molecular Cell Biology*, W.H. Freeman and Company.
9. Alberts B, Johnson A, Lewis J, Raff M, Roberts K, Walter P, **(**2002), *Molecular Biology of the Cell*, IV edition, Garland Publishing , New York.
10. Karp G (2002) *Cell and Molecular Biology*, Edition III, John Wiley and sons.
11. Darnell J, Lodish H, Baltimore D (2000), *Molecular Cell Biology*, Edition IV, W.H. Freeman and Company, New York.
12. Primrose SB (2001), *Molecular Biotechnology* – Panima Publications, New Delhi.

Note: Learners are advised to use latest edition of books.

COURSE OUTCOMES (CO):

The learners will be able to

CO No.	Course Outcomes	PSOs Addressed	Cognitive Level
CO-1	Predict the structural and functional details of various cell organelles and their properties.	PSO 3	U
CO-2	Construct a model depicting the cell cycle and its regulatory mechanism.	PSO 1, 3	Ap
CO-3	Illustrate the major components and pathways of cell signaling.	PSO 1,4	Ap
CO-4	Differentiate the structure, function and numerical alterations of chromosomes in prokaryotes and eukaryotes.	PSO 3	An
CO-5	Reason out the mechanism of construction, damage and repair of DNA and interactions.	PSO 2, 4	U
CO-6	Examine in detail the factors affecting the regulation of RNA and protein synthesis and their properties.	PSO 3,5	An
CO-7	Present an elaborate account on operons, insertional elements and transposons involved in recombination and interpret the mechanism of tumour formation.	PSO 3, 5	C

PO – Programme Outcomes; CO – Course Outcome; R- Remember; U- Understand; Ap – Apply; An – Analyse; E- Evaluate; C – Create

(For the candidates admitted from 2021 onwards)
I M.Sc. BIOTECHNOLOGY – Semester I

Course Title	MAJOR CORE 2 – ADVANCED ANALYTICAL TECHNIQUES IN BIOTECHNOLOGY LABORATORY
Total Hours	60
Hours/Week	4 Hrs /Wk
Code	P21BT1MCT02
Course Type	Theory
Credits	4
Marks	100

GENERAL OBJECTIVE

To make the learners become familiar with fundamental principles of biomedical instrumentation and learns about different biological signals, their acquisition, measurements and related constraints used in biomedical engineering research labs and hospitals.

COURSE OBJECTIVES

To enable the learners

CO No.	Course Objectives
CO-1	Elucidate and demonstrate the tranducers and principles of biomedical instruments.
CO-2	Comprehend the process of medical imagining techniques such as diagnostic radiology and PET scanner.
CO-3	Outline working principle and applications of microscopic techniques in cellular function.
CO-4	Deconstruct the principle and working mechanism of analytical and spectroscopic techniques.
CO-5	Critically evaluate the applications of electrophoretic techniques in biotechnology.

UNIT I: 12 HRS

Transducers: Photoelectric transducers – Flow transducers – Piezoelectric transducers and their applications, Biological receptors and receptor characteristics.

Cell resting potential and action potentials - Single neuron recording, patch-clamp recording, Origin of bio potentials Electrocardiogram (ECG), Electroencephalogram (EEG), Electromyogram (EMG), Electrooculogram (EOG), Electroretinogram (ERG), Recording Electrodes – Electrode-tissue interface, polarization, skin contact impedance.

Extra Reading (Key word): *Electrode Jellies*

UNIT II: 12 HRS

Medical imaging techniques: Basics of diagnostic radiology – Production - Nature and properties of X rays - X-ray machine, SPECT Scanner – PET Scanner - MRI, fMRI, computerized axial tomography scan - Biosensors – types and applications. Bio-electronics.

Analytical instruments in Biomedical Engineering: oximeter, spectrophotmeter, colorimeter, blood gas analyzer, blood cell counter.

Radiolabelling techniques - Properties of different types of radioisotopes used in biology, molecular imaging of radioactive material - safety guidelines - P3 laboratory - BARC approval -waste disposal management. Radioactivity detectors - GM Counters, Liquid and solid scintillation counters, Radiation dosimeters. Autoradiography.

Extra Reading (Key words): *FLISA*

UNIT III: 12 HRS

Laboratory instrumentation: Principle, working, applications of laminar clean air flow, autoclave, incubators, weighing balances, water bath and hot air oven.

Microscopic techniques - Principles, structural components, applications and working of microscope – Compound, Dark Field, Fluorescent, Phase contrast, Inverted. Electron microscope - Scanning Electron Microscopy, Transmission Electron Microscopy- Biological sample preparation for SEM and TEM, Scanning tunneling and high voltage electron microscopes. CLSM and AFM- their uses and image processing methods.

Extra Reading (Key words): *Cryo-Electron Microscopy*

UNIT IV: 12 HRS

Spectroscopic techniques - UV and visible, fluorescence, gamma ray and infrared spectroscopy, Atomic absorption spectroscopy, Nuclear Magnetic Resonance (NMR), Electron Spin Resonance (ESR), Surface

plasma resonance, Mass Spectroscopy, Circular Dichroism spectroscopy and X-ray crystallography technique. Lasers, Spectrofluorimetry, turbidometry and nephelometry.

Analytical Techniques- Principle, working and applications of redox and pH meter. Colorimetry- Principles, instrumentation and applications of Micro Colorimetry (DSC and ITC).

Extra Reading (Key words): *Raman spectroscopy in antibiotic discoveries*

UNIT V: 12 HRS

Centrifugation –concepts of relative centrifugal force and sedimentation coefficient. Factors affecting Sedimentation velocity, Standard Sedimentation Coefficient, Centrifugation of associating systems. Principle and applications of Preparative Centrifuge –Differential and Gradient centrifugation; Analytical centrifuges-Ultra centrifuge.

Chromatography - Principle and applications of Paper, Thin layer, Column, HPLC, Gas-liquid, Ion-exchange, Affinity and Gel permeation, GC-MS, MALDI TOF, LC-MS.

Electrophoretic techniques- Principles and applications of electrophoresis – AGE, PAGE, SDS-PAGE, DGGE, cellulose acetate, continuous flow and capillary electrophoresis, DNA sequencing gels, RNA electrophoresis, Isoelectric focusing, PFG, 2D gel electrophoresis and 2D-DIGE. Immunoelectrophoresis.

Extra Reading (Key words): *Microchip in separation of DNA fragments, hPAGE*

Note: Texts given in the Extra reading /Key wordsmust be tested only through assignment and Seminars.

PRESCRIBED TEXT BOOKS

1. Khandpur RS (2004), *Handbook of Biomedical Instrumentation*", Tata McGraw, New Delhi.
2. Geddes LA, Baker LE (1989), *Principle of Applied Bio medical Instrumentation,* Edition III, Wiley Interscience Publication.
3. John W (2003), *Medical instrumentation*, John Wiley and sons, New York.
4. Leslie C, Weibell FJ, Pfeiffer EA (2004), *Bio medical Instrumentation and Measurements,* PHI, Edition II.

SUGGESTED REFERENCE BOOKS

1. Wills TJ (1993), "*Biomedical digital signal processing*", Prentice Hall of India Pvt.Ltd. New Delhi.
2. Geddes LA, Joh LEB (1989), *Principles of Applied Biomedical Instrumentation*, Wiley & Sons.
3. Merrill RA (1990), *Principles of Biomedical Instrumentation and Measurement*, Publishing Company.
4. Mitra SK (2013), *"Digital signal processing",* Tata McGraw Hill Limited.
5. Oppenheim, Schafer, "*Digital signal processing*", Prentice hall of India.
6. Reddy DC (2005), *"Biomedical Signal Processing-Principles & Techniques",* Tata McGraw Hill.

Note: Learners are advised to use latest edition of books.

COURSE OUTCOMES (CO):

The learners will be able to

CO No.	Course Outcomes	PSOs Addressed	Cognitive Level
CO-1	Identify the underlying working principle of various biomedical instruments with their specific applications.	PSO 1	U
CO-2	Interpret the role of diagnostic tool in medical imaging techniques.	PSO 2	R
CO-3	Integrate the use of microscopic principle for analyzing the anatomy of a cell.	PSO 2	U
CO-5	Integrate spectroscopic techniques in their research projects and utilize them to discover the structure of novel compounds.	PSO 4	An
CO-6	Compare the principles and applications of various electrophoretic techniques and invent new applications for electrophoresis.	PSO 4	U

PO – Programme Outcomes; CO – Course Outcome; R- Remember; U- Understand; Ap – Apply; An – Analyse; E- Evaluate; C – Create

(For the candidates admitted from 2021 onwards)

I M.Sc. BIOTECHNOLOGY – Semester I

Course Title	MAJOR CORE 3 – GENETIC ENGINEERING
Total Hours	60
Hours/Week	4 Hrs/ Wk
Code	P21BT1MCT03
Course Type	Theory
Credits	4
Marks	100

GENERAL OBJECTIVE

The make the learners to understand the mechanism of cloning, manipulating, gene transfer techniques and DNA finger printing and related techniques on gene sequencing, diagnose the genetic defects and produce the curative molecule for the same.

COURSE OBJECTIVES

To enable the learners

CO No.	Course Objectives
CO-1	Experiment with the basic tools and techniques of gene cloning in new innovative strategies and identify new vectors and make an attempt to design novel artificial vectors.
CO-2	Examine the appropriate selection and screening technique for a specific recombined DNA.
CO-3	Demonstrate the specific techniques for chemically synthesizing a gene and sequencing
CO-4	Describe the applications of genetic engineering in various field and therapeutics.
CO-5	Demonstrate the role of animal models to study pathogenicity, cancer, diabetes, cardio diseases, pulmonary infections, drug targeting and vaccine development

UNIT I: 12 HRS

Scope Of Gene Manipulation: Milestones in Genetic Engineering, Biosafety issues – Genetic engineering guidelines. Isolation and synthesis of desired gene.

Molecular tools – restriction enzymes - discovery, host controlled restriction-modification - DNA ligase, DNA polymerases, reverse transcriptase, terminal transferases, T_4 polynucleotide kinases, methylases, DNases, ribonucleases, alkaline phosphatases, S1 nuclease and other enzymes, Linkers, adapters and homopolymer tails, terminal dinucleotides. Role of *CRISPER & CAS9* in genome editing

Vector and Gene Expression: Vectors and its types- Promoter, MCS, Ori, and marker genes-lac Z. Construction of pBR 322, pBR325, pUC 18 and 19 vectors and expression vectors - Animal viruses as vectors – Types, Gene Cloning vectors (Plasmids, bacteriophages, cosmids, phagemids, Artificial chromosomes) - construction and its use in gene cloning, c-DNA and genomic DNA libraries- Construction of genomic libraries (Using λ gt 10 and 11 vector). In vitro packaging of λ phage and amplification of libraries.

Extra Reading (Key words): *Cold active enzymes.*

UNIT II: 12 HRS

Gene Transfer and expression: Chemical mediated gene transfer**,** Expression of cloned gene, factors influencing cloned gene expression -expression strategies for heterologous genes – expression in bacteria, yeast, insect cell lines and mammalian cells.

Alternative strategies of Gene cloning- Cloning of differentially expressed genes. Site directed Mutagenesis. Code use in different organism- codon usage database – codon optimization to increase the expression of recombinant protein.

Selection and screening of transformants - insertional inactivation, α- complementation, immunological screening, molecular probes, dot blot, zoo blot, Southern hybridization, colony hybridization and Molecular Beacons. Use of Reporter genes. DNA and RNA labelling by radioactive and non-radioactive methods.

Extra Reading (Key words): *Alpha viruses, Flaviviral vectors, Next-Generation Genome Engineering in Vegetable Crops*

UNIT III: 12 HRS

Chemical Synthesis of Genes and PCR: Phosphodiester, phosphotriester and Phosphite ester methods, principles and strategies. Oligonucleotide synthesis and application, synthesis of complete gene. PCR, methodology, essential features of PCR, primers, Taq polymerases, reverse transcriptase-PCR, types of PCR-Nested, inverse, RAPD-PCR, RT-PCR (real time PCR), Applications of PCR. - RACE PCR, Gene tagging in gene analysis and its application. Strategies of gene delivery, gene replacement/ augmentation, gene correction,

gene editing and silencing.

DNA sequencing methods: methods – conventional and next generation sequencing methods. Capillary gel electrophoresis for DNA sequencing. Mapping of DNA and map construction, chromosomal walking, jumping.

Extra Reading (Key words):*NER gene expression and marker genes.*

UNIT IV: 12 HRS

Applications of genetic engineering – Production of recombinant proteins (Insulin, Somatostatin and Somatotropin), vaccine and pharmaceutical compounds: Nucleic acid sequence as diagnostic tool, plants and animal cell as a bioreactor, applications in forensic medicine. Medical Genetics, Gene Therapy, Human Genome Project, Plant Genetic Engineering. Applications of Genetic Engineering in Biopharmaceutical industries

Molecular pharming – transgenic animals as models of human diseases, protein engineering, metabolic engineering. Expression of dsRNA in animals and plants and its applications. Prospects of RNAi in medicine and agriculture.

Extra Reading (Key words):*Duck weed and sea grapes in r DNA technology*

UNIT V: 12 HRS

Knock out gene animal models: Importance and Challenges of Animal Biomedical Research. Animal Models for infectious diseases studies - Pathogenicity, Cancer, Diabetes, cardio diseases, pulmonary infections, Drug Targeting and Vaccine Approaches. Ethical concerns on the use of animals in biological research. Gene knock-out technology and animal models for genetic disorders.

Extra Reading/Key words: *CRISPR*

Note: Texts given in the Extra reading /Key wordsmust be tested only through assignment and Seminars.

PRESCRIBED TEXT BOOKS

1. Primrose SB, Twyman RW (2006), *Principles of Gene Manipulation and Genomics*, Edition VII, Wiley Blackwell.
2. Glick BR, Jack PJ, (2003), *Molecular Biotechnology– Principles and Applications of Recombinant DNA*, Edition III, American Society for Microbiology.
3. Brown TA, (2001), *Gene Cloning and DNA Analysis - An Introduction*, Edition IV, Wiley Blackwell Scientific Publications.

SUGGESTED REFERENCE BOOKS

1. Nicholl DST (2008). *Introduction to Genetic Engineering* Cambridge, Edition III University press.UK.
2. Old RW, Primrose SB (1996), *Principles of gene manipulation - An introduction to genetic engineering*, Edition V, Blackwell Scientific Publications, UK.
3. Ernst-L Winnacker (2003) *From Genes to Clones: Introduction to Gene Technology*. WILEY-VCH Verlag GmbH, Weinheim, Germany Reprinted by Panima Publishing Corporation, New Delhi.
4. Lewis B (2004), *Genes VIII* , Edition III Oxford University & Cell Press, NY.
5. Williamson R (1981), *Genetic Engineering,* Edition I, Academic Press. USA
6. Primrose SB, Twyman RM (2006), *Principles of gene manipulation and genomics* Edition VII, John Wiley & Sons publishers.
7. Glick BR, Pasternak JJ, (2010). *Molecular Biotechnology.* ASM Press.
8. Brown T (2010*). Gene Cloning and DNA Analysis: An Introduction*. John Wiley & Sons
9. Primrose SB, Twyman R (2009). *Principles of Gene Manipulation and Genomics*. John Wiley & Sons.
10. Watson JD, Caudy AA, Myers RM, Witkowski JA (2007*), Recombinant DNA: Genes and Genomics: A short course*, Edition III, W.H.Freeman and Co Ltd.
11. Primrose SB, (2001), *Molecular Biotechnology* – Panima Publications, New Delhi.
12. Kreuzer H, Massey A (1996). *Recombinant DNA and Biotechnology: A guide for students*. ASM Press

Note: Learners are advised to use latest edition of books.

COURSE OUTCOMES (CO):

The learners will be able to

CO No.	Course Outcomes	PSOs Addressed	Cognitive Level
CO-1	Experiment with new molecular tools employed in genetic engineering.	PSO 1	R, U
CO-2	Differentiate various types of cloning and expression vectors and integrate them in research.	PSO 2	R
CO-3	Implement gene transfer techniques for producing transformants and select appropriate screening strategies.	PSO 2	U
CO-4	Integrate appropriate DNA profiling tools and techniques in their research projects.	PSO 3	R
CO-5	Design an experiment to produce recombinant proteins, vaccines and pharmaceutical compounds.	PSO 4	An
CO-6	Construct novel engineered proteins used in medicine and agriculture using transgenic animal models.	PSO 4	U
CO 7	Able to demonstrate various animal models for different diseases	PSO 4	U

PO – Programme Outcomes; CO – Course Outcome; R- Remember; U- Understand; Ap – Apply; An – Analyse; E- Evaluate; C – Create

(For the candidates admitted from 2021 onwards)

I M.Sc. BIOTECHNOLOGY – Semester I

Course Title	MAJOR CORE 4 – ANIMAL AND PLANT BIOTECHNOLOGY
Total Hours	60
Hours/Week	4 Hrs./Wk.
Code	P21BT1MCT04
Course Type	Theory
Credits	4
Marks	100

GENERAL OBJECTIVE

To make the learners to understand the theoretical and practical aspects of animal and plant biotechnology. Also the student learns animal and plant recombinant DNA technologies and protein engineering.

COURSE OBJECTIVES

To enable the learners

CO No.	Course Objectives
CO-1	Gain knowledge about culture media, tissue culture method and somatic hybridization, somatic embryogenesis and somoclonal variation techniques.
CO-2	Outline and examine the genetic transformation and techniques about gene delivery.
CO-3	Comprehend the mechanism of protein engineering.
CO-4	Applications and potential benefits of biotechnology in enhancing human lives.
CO-5	Critically assess and predict the mechanism immunization for human lives.

UNIT I: 12 HRS

Somatic Hybridization

Protoplast Culture and Somatic Hybridization Protoplast isolation- its culture and usage, Somatic hybridization and its applications.

Somatic embryogenesis- Principle, protocol and importance. Artificial seeds – production, applications and limitations. Anther culture and production of androgenic haploids.

Somaclonal variations; - sources of somaclonal variatins, selection of soma clones, progeny testing of soma clones, applications of somaclonal variations to crop improvement, Embryo rescue

Extra Reading (Key words):*Pollen and Anther culture*

UNIT II: 12 HRS

Gene transfer techniques: Agrobacterium-plant interaction; Virulence; Ti and Ri plasmids; Opines and theirsignificance; T-DNA transfer, Genetic Transformation Agrobacterium-mediate gene delivery, Direct gene transfer - PEG-mediated, electroporation, particle bombardment and alternative methods; Screenable and selectable markers, Characterization of transgenics, Gene targeting.

Extra Reading/Key words: *Plant pollination*

UNIT III: 12 HRS

Biotechnological approaches to obtain blood products: Tissue plasminogen activator and erythropoietin, Vaccine technology: Subunit vaccines, drawbacks of existing vaccines, criteria for successful vaccine, peptide vaccine, minicells as vaccines, impact of genetic engineering on vaccine production, viral vector vaccines and AIDS vaccine chiral technology.

Extra Reading/Key words: *SARS CoV 2* virus *& vaccine*

UNIT IV 12 HRS

Applications of animal biotechnology in Medicine: Introduction to fermentation Technology, Bioreactors for large scale production of animal cells Production of hormones and special secondary metabolites-insulin, growth hormone and interferon, Principles of gene therapy, types of gene therapy, vectors in gene therapy, molecular engineering, human genetic engineering, Social ethical issues.

Extra Reading/Key words: *Endocrine gland and its hormones*

UNIT V: 12 HRS

Immunodiagnostics and vaccine technology: Outline to immunodiagnostics-Monoclonal antibodies, hybridoma technology, Starter to vaccines, differentiate Killed and Attenuated vaccines; Modern methods of vaccine generation, Stem cell technology, Cell banking.

Extra Reading/Key words: *Innate and Acquired Immunity*

Note: Texts given in the Extra reading /Key words must be tested only through assignment and Seminars.

PRESCRIBED TEXT BOOKS

1. Freshney RI (2000), *Culture of Animal cells : Manual of Basic technique*, Edition IV. John Wiley Publications.
2. Ranga. MM (2004), *Animal Biotechnology*, Edition II. Agrobios (India), Jodhpur.
3. Mishra SP (2009). *Plant Tissue Culture*. Ane Books Pvt Ltd.
4. Smith R (2000). *Plant Tissue Culture: Techniques and Experiments.* Edition II, Academic Press.
5. Chawla HS (2000), *Introduction to Plant Biotechnology*, Taylor and Francis Inc Science Publishers, U.S.

SUGGESTED REFERENCE BOOKS

1. Verma A, Singh A (2013). *Animal Biotechnology: Models in Discovery and Translation*, Academic Press.
2. Jose, Robert (2005), *Principles of cloning*, Academic press.
3. Primrose SB (2001), *Molecular Biotechnology* – Panima Publications, New Delhi.
4. Winnacker, EL, (1987) *From Genes to Clones*, Publishers Wiley-VCH Verlag GmbH.
5. Watson JD, Caudy AA, Myers RM, Witkowski JA (2006), *Recombinant DNA: Genes and Genomics: A short course*, Edition III, W.H. Freeman and Co Ltd.
6. Primrose SB, Twyman RW (2006), *Principles of Gene Manipulation and Genomics*, Edition VII, Wiley Blackwell.
7. Sell S, (2003) (Ed) *Stem Cells Handbook*, Humana Press, NY.
8. Glick BR , Jack JP (2003), *Molecular Biotechnology– Principles and applications of Recombinant DNA*, Edition III, American Society for Microbiology.
9. Babiuk LA, Phillips JP, Moo-young M (1989), *Animal Biotechnology* Pergamm press , Oxford. 10. Altman A, Hasegawa PM (2012). P*lant Biotechnology and Agriculture: Prospects for the 21st Century*, Academic Press.
10. Altman A,Hasegawa. PM (2011). *Plant Biotechnology and Agriculture: Prospects for the 21st Century*. Academic Press.
11. Stewart, Jr. NC (2008). *Plant Biotechnology and Genetics: Principles, Techniques and Applications.* John Wiley & Sons
12. Slater A, Scott N, Fowler M (2008) *Plant Biotechnology- The genetic manipulation of plants*, Oxford University Press, Oxford.

COURSE OUTCOMES (CO):

The learners will be able to

CO No.	Course Outcomes	PSOs Addressed	Cognitive Level
CO-1	Perform meristem culture and somatic embryogenesis to develop new verities.	PSO 2	Ap
CO-2	Describe the mechanism of gene transfer technique and its application.	PSO 3	An
CO-3	Reason out the mechanism of vaccine and its beneficiary role in human health care.	PSO 4	U
CO-4	Analytically understand the pros and cons of generating genetically modified organisms and the associated ethical issues.	PSO 2	Ap
CO-5	Apply their knowledge in immunodiagnostics and the vaccination.	PSO 5	Ap

PSO – Programme Specific Outcome; CO – Course Outcome; R- Remember; U- Understand; Ap – Apply; An – Analyse; E- Evaluate; C – Create

(For the candidates admitted from 2021 onwards)

I M.Sc. BIOTECHNOLOGY – Semester I

Course Title	MAJOR CORE 5 – PRACTICAL I- MOLECULAR CELL BIOLOGY, ADVANCED ANALYTICAL TECHNIQUES IN BIOTECHNOLOGY LABORATORY
Total Hours	60
Hours/Week	4 Hrs/ Wk
Code	P21BT1MCP05
Course Type	Practical
Credits	3
Marks	100

GENERAL OBJECTIVE

This practical focuses on the working principles of Molecular and cellular Biology, Biomedical and Bioinstrumentation techniques.

A. Molecular Cell Biology

1. Sub cellular fractionation and marker enzymes.
2. Histochemical techniques
3. Identification of different phases of mitosis – Onion root tip
4. Identification of different phases of Meiosis in grasshopper testis / flower buds.
5. Isolation, separation and quality checking of Genomic DNA

a. Human (buccal cells)
b. Bacterium (*E. coli*)
c. Plant(Cauliflower)

6. Quantitation of DNA.
7. Confirmation by AGE - Quality checking of DNA by UV spectrophotometer.
8. UV mutagenesis-DNA repair mechanism-Demonstration.
9. Site Directed Mutagenesis-Demonstration

B. Principles of Biomedical and Bioinstrumentation

1. Microscopy: Bright field, phase contrast & Fluorescence Microscopy.
2. Micrometry, Histology, Histochemistry of Carbohydrates, Proteins, lipids and Nucleic acids (DNA).
3. Isolation of Cellular organelles- Differential Centrifugation
4. Isolation of RNA and quantitation of RNA
5. Paper chromatography - Circular and ascending
6. Separation of sugars and amino acids by TLC.
7. Separation of plant pigments by column chromatography.
8. Absorption spectra of proteins/aminoacid
9. HPLC Analysis -Demonstration
10. GC-MS/MS- Demonstration and interpretation of Results.
11. X-Ray Crystallography-Demonstration and interpretation of Results
12. IR- Demonstration and interpretation of Results
13. AAS- Demonstration and interpretation of Results

(For the candidates admitted from 2021 onwards)

I M.Sc. BIOTECHNOLOGY – Semester I

Course Title	MAJOR CORE 6 – PRACTICAL II - GENETIC ENGINEERING, ANIMAL AND PLANT BIOTECHNOLOGY
Total Hours	60
Hours/Week	4 Hrs /Wk
Code	P21BT1MCP06
Course Type	Theory
Credits	3
Marks	100

GENERAL OBJECTIVES

This practical focuses on the working principles of Gene Manipulation, Animal and plant biotechnology techniques.

A. Genetic Engineering

1. Electrophoresis of restriction digested plasmid DNA,
2. Restriction mapping and determination of molecular weight of digested DNA fragment
3. Purification of digested DNA by gel elution
4. Ligation of DNA
5. Preparation of competent cells and transformation by $CaCl_2$ method and Selection of Transformed colony by X-Gal method
6. DNA amplification by PCR
7. Detecting the DNA profile by RFLP, RAPD
8. Phage Titration (λ).
9. RT-PCR to study transgene expression

B. Animal Biotechnology

1. Maintaining Aseptic Animal Cell Culture Laboratory
2. Preparation of cell culture media, sera and reagents
3. Preparation of single cell suspension from chicken liver (Primary cell culture)
4. Isolate human monocytes from peripheral blood mononuclear cell
5. Isolation and staining of liver parenchyma cells
6. Counting of viable cells using Trypan Blue, AO/ EtBr staining.
7. MTT Assay for cell viability.
8. LDH Assay for cytotoxicity
9. Isolation of protein and determination of its molecular weight through SDS – PAGE.
10. Identification and confirmation of specific protein through Western Blotting
11. Drug/Toxicity testing using cell lines
12. Cell fusion with PEG

C. Plant Biotechnology

1. Bioinoculants : Isolation and mass production of: Rhizobium
2. Isolation of plant chloroplasts
3. Agrobacterium culture, selection of transformants
4. Estimation of phosphate by Fiskay-Subbarao method
5. Suspension culture and production of secondary metabolites.
6. Preparation of plant tissue culture medium- Murashige and Skoog's.
7. Callus induction, propagation, regeneration.
8. Hardening
9. Micro propagation – Nodal and apical meristems.
10. Preparation of synthetic seeds.

(For the candidates admitted from 2021 onwards)

I M.Sc. BIOTECHNOLOGY – Semester I

Course Title	MAJOR ELECTIVE 1 – AGRICULTURAL BIOTECHNOLOGY
Total Hours	60
Hours/Week	4 Hrs./Wk.
Code	P21BT1MET01
Course Type	Theory
Credits	4
Marks	100

GENERAL OBJECTIVE

To make the learners to expose the basic scientific evidence and technical aspects of agricultural biotechnology. It clarifies major scientific, ecological and sociological aspects of biotechnology in agriculture and food production.

COURSE OBJECTIVES

To enable the learners

CO No.	Course Objectives
CO-1	Learn basics of plant physiological functions, processes and its importance in crop production
CO-2	Develops the knowledge of improved productivity in modern agriculture.
CO-3	Understand the fundamental aspects of agricultural microbiology and applications
CO-4	Describe the role organic farming in soil fertility.
CO-5	Transform the knowledge of agriculture into agribusiness and agro-based industries.

UNIT I: 12 HRS

Physiology and cell biology of plants: Crop physiology and its importance in agriculture. Overview of plant cell: bio membrane, organelles and the cytoskeleton.

Absorption of Water, Mineral Nutrition and BNF: Active and passive absorption of water. Diffusion and osmosis. Water potential and its importance. Stomatal Physiology, transpiration and water use efficiency. Mengele'sclassification of mineral nutrients in plants. Nutrient uptake mechanisms. Functional roles and deficiency symptoms of macro and micro nutrients.

Extra Reading/Key words: *Nomenclature of plant*

UNIT II: 12 HRS

Photosynthesis and Lipid Metabolism Photosynthesis: Light and dark reactions - C3, C4 and CAM; Respiration: Glycolysis, TCA cycle and electron transport chain; Fat Metabolism. Fatty acid synthesis and breakdown.

Plant Growth Regulators and Growth Analysis: Auxins, cytokines, gibberellins, Abscisic acid and ethylene-physiological roles and agricultural uses. Physiological aspects of growth and development of major crops - growth analysis and role of physiological growth parameters in crop productivity.

Extra Reading/Key words: *Isolation of compounds from plant materials*

UNIT III: 12 HRS

Biological Nitrogen Fixation: Symbiotic, associative and asymbiotic microbes involved in nitrogen fixation.Azolla, blue green algae and mycorrhiza. Rhizosphere and phyllo sphere. Microbes in human welfare: silage production, bio fertilizers, bio pesticides, biofuel production and biodegradation of agro-waste.

Extra Reading/Key words:.

UNIT IV: 12 HRS

Organic matter and soil fertility: Soil organic matter - soil fertility management - soil quality management - water management, pest management, soil biology and nutrition - Inorganic nutrition in soil. Field indicators of biological and nutritional problems. Indian organic farming: Progress of organic farming in India, regulations, project and initiatives.

Organic manures and fertilizers: Concentrated organic manures, effect of organic manures on soil properties, farms utilizing animal manures.

Types of organic fertilizers: Animal manure, biosolids, commercial organic fertilizers, phosphate rich organic manures, Inorganic fertilizers, problems of inorganic fertilizers. Irrigation - tillage, rotations, fallows.

Extra Reading (Key words):*manure a source of cellulose, Halogenated organic pollutant*

UNIT V **12 HRS**

Agribusiness

Transformation of agriculture into agribusiness, various stakeholders and components of agribusiness systems. Importance of agribusiness in the Indian economy and New Agricultural Policy.

Agro-based industries: Distinctive features, importance and needs of agro-based industries. Classification of industries and types of agro based industries. Institutional arrangement, procedures to set up agro-based industries. Constraints in establishing agro-based industries.

Extra Reading/Key words: *IPR*

Note: Texts given in the Extra reading /Key words must be tested only through assignment and Seminars.

Going for Industrial Visit/Training to an Agricultural University/ Research Institute and report submission is mandatory for students and the same will be evaluated through Viva. The assignments marks includes this marks

PRESCRIBED TEXT BOOKS

1. Salisbury FB (2006). *Plant physiology*. Edition IV. Sinauer Associates, Inc., USA.
2. Reddy SS, Ram PR (2018). *Agricultural Finance and Management*. Oxford & IBH Publishing Company Private Ltd., India.
3. Madigan MT, Bender KS, Buckley DH, Sattley WM, Stahl DA (2017). *Brock Biology of Microorganisms*.Edition XV. Pearson. UK.
4. Barnard FL, Foltz JC, Yeager EA (2016). *Agribusiness Management*. Edition V, Routledge. UK
5. Taiz L, Zeiger E, Moller IM, Murphy A (2018). *Plant Physiology and Development*, International Edition VI. Sinauer; Oxford University Press; USA.

SUGGESTED REFERENCE BOOKS

1. Mohr H, Schopfer P (1995). *Plant physiology*, Springer-Verlag, Germany.
2. Buchanan BB (2015). *Biochemistry and Molecular Biology of Plants*. Edition II. WileyBlackwell, USA.
3. Barry P, Ellinger P (2011). *Financial Management in Agriculture*. Edition VII, Pearson. UK.
4. Kay R, Edwards W, Duffy P (2015). *Farm Management*. Edition VIII, McGraw-Hill Education, USA.
5. Bagyaraj DJ, Rangaswami G (2007). *Agricultural Microbiology*, Edition II. PHI Learning Private Limited. India.
6. Aneja KR (2017). *Fundamental Agricultural Microbiology*. New Age International Publishers, India.
7. Rao NS (2017). *Soil Microbiology*. Edition V, Published by Medtec. University Book Store. New Delhi, India

Note: Learners are advised to use latest edition of books

COURSE OUTCOMES (CO):

The learners will able to

CO No.	Course Outcomes	PSOs Addressed	Cognitive Level
CO-1	Outline diverse physiological process and summarize the mechanisms of uptake, transport and translocation of water and nutrients in plants	PSO 2	U
CO-2	Explain carbon cycles in plants, lipid metabolism and growth regulators in plant growth	PSO 3	An
CO-3	Utilize microbes as models to study genetics	PSO 4	U
CO-4	Apply organic farming to improve soil fertility and high quality crops.	PSO 2	Ap
CO-5	Acquire knowledge on transforming agriculture into agribusiness.	PSO 5	C

PSO – Programme Specific Outcome; CO – Course Outcome; R- Remember; U- Understand; Ap – Apply; An – Analyse; E- Evaluate; C – Create

(For the candidates admitted from 2021 onwards)

I M.Sc. BIOTECHNOLOGY – Semester I

Course Title	MAJOR ELECTIVE 1 – ENVIRONMENTAL BIOTECHNOLOGY
Total Hours	60
Hours/Week	4 Hrs./Wk.
Code	P21BT1MET02
Course Type	Theory
Credits	4
Marks	100

GENERAL OBJECTIVES:

To make the learners to understand the scientific and engineering principles of microbiological treatment technologies to clean up contaminated environments. The course was designed to discuss the application of microbial environment, its management, microorganisms in extreme environments, microbiological treatment of waste water, bioremediation and biodegradation of xenobiotics.

COURSE OBJECTIVE

To enable the learners

CO No.	Course Objectives
CO-1	Apprehend the basic concepts and scope of biotechnology on environmental issues.
CO-2	Comprehend the method of degradation of pollutants such as bioremediation, bioleaching, bioaugmentation and removal of heavy metals from the environment.
CO-3	Outline the mechanism of waste water treatment process and design of implementing microbial population.
CO-4	Illustrate the implementation methods of biotechnology in air pollution and waste water treatment.
CO-5	Application of biotechnological tools in making a renewable bioproducts from the environmental waste and monitoring the environmental pollutants.

UNIT I: **12 HRS**

Introduction to Environmental Biotechnology

Global environmental changes: Global warming, Greenhouse effect. Sources, impact of Environmental Pollutions - Water, Thermal, Industrial, oil, Metal, Toxic/Hazardous wastes and Radiation-Environmental issues. Bio tools for environmental monitoring – Role of biotechnology in environmental protection.

Extra Reading /Key words: *Rhizosphere Engineering*

UNIT II: **12 HRS**

Biodegradation and Bioremediation

Aerobic and Anaerobic degradation of aliphatic and aromatic compounds – Biodegradation of herbicides and pesticides. Bioremediation technologies – Biostimulation, Bioaugmentation, Bioventing, biosparging and Phytoremediation – Bioleaching, bioprecipitation, bioaccumulation

and biosorption of heavy metals. oil degradation – biodecolourization – Reed bed technology Rhizosphere engineering - Biofiltration and Bioindicators. Seaweeds for removal of heavy metal pollutants.

Extra Reading /Key words: *Biopulping*

UNIT III: **12 HRS**

Wastewater treatment

Decomposition of organic compounds in natural ecosystems – Co-metabolic degradation of organo-pollutants. Nitrogen removal – Ammonification, nitrification, denitrification. Overview of aerobic and anaerobic treatment processes – Process design of aerobic and anaerobic system – Activated sludge process – Trickling filter – Rotating biological contactors – Fluidized bed reactor – Up flow anaerobic sludge blanket reactor (UASB) – Membrane bioreactors – Algal photosynthesis in wastewater treatment.

Extra Reading /Key words: *Watershed development in ground water recharge*

UNIT IV: **12 HRS**

Biotechnology for Air Pollution and Waste Management

Air pollution control and treatment strategies – Biotechnology for treating air pollutants – Biofilters and Bioscrubbers – Biotechnology for the management of agricultural, plastic, dairy, paper and pulp, textile, leather, hospital and pharmaceutical industrial wastes.

Extra Reading /Key words: *Landfilling*

UNIT V: **12 HRS**

Bioproducts from Renewable Sources and Environmental Monitoring

Overview of renewable sources – Production of bio compost and vermicomposting – Production of bio fertilizers and bio pesticides – Production of biomethane, bioethanol, biohydrogen, biodiesel Production of bioplastics and biopolymers. Bioindicators –Biomarkers –Biosensors –Biomonitoring –Polluted environment – Short and long term monitoring of remediated sites, GIS and Remote sensing.

Extra Reading /Key words: *Map Projections in Gioinformatics*

Note: Texts given in the Extra reading /Key wordsmust be tested only through assignment and Seminars.

PRESCRIBED TEXTBOOKS

- Evans (2000), *Environmental Biotechnology Theory and Applications*
- Evans GE (2003) *Environmental Biotechnology.*
- Mahesh S (2003), *Biotechnology, Recombinant DNA Technology, Environmental Biotechnology*.
- Bhattacharyya , Banerjee R (2008), *Environmental Biotechnology*, Oxford University Press, USA.

SUGGESTED REFERENCE BOOKS

- Chakrabarty KD, Omen GS (1989). *Biotechnology and Biodegradation, Advances In Applied Biotechnology Series*, Vol.1, Gulf Publications Co., London, 1989.34
- Evans, GG, Furlong J (2011), *Environmental Biotechnology*: *Theory and Application*, Edition II, John Wiley & Sons.
- Henze M, Harremoes P, Jansen JC, Arvin E (2013), "*Wastewater Treatment: Biological and Chemical Processes*", Edition II, Springer, 2013.
- Jordening HJ, Winter J (2005), "*Environmental Biotechnology: Concepts and Application*", Wiley-VCH Verlag GmbH & Co.
- Wong JWC, Tyagi RD, Pandey A (2016), *"Current Developments in Biotechnology and Bioengineering Solid waste*" Elsevier.
- Zarook S, Ajay S (2005), *Biotechnology for Odor and Air Pollution Control*, Springer.
- Evans GE, Evans GG, Furlong JC (2011). *Environmental Biotechnology: Theory and Application*. John Wiley & Sons.
- Thakur IS (2006). *Environmental Biotechnology: Basic Concepts and Applications.* I. K. International Pvt Ltd

Note: Learners are advised to use latest edition of books

COURSE OUTCOMES (CO):

The learners will be able to

CO No.	Course Outcomes	PSOs Addressed	Cognitive Level
CO-1	Aware of social environmental pollution and resolve the problems by biotechnological methods in environmental protection.	PSO 1	U
CO-2	Identify scientific solutions and participation can be served for the environmental protection by bioremediation, phytoremediation methods	PSO 3	E
CO-3	Carry out an experiment with nitrification in a continuous lab-scale bioreactor for ammonia removal and outline the principles of methods for quantification of organic carbon in wastewater and	PSO 4	C
CO-4	Explain the microbial processes and growth requirements undelaying the activated sludge process, removal of air pollutants and biotechnological applications in managing pollutants in various field.	PSO 3	Ap
CO-5	Evaluate and monitor the environmental contaminants by the advance techniques like biosensor, biomarkers, GIS and remote sensing.	PSO 4	E

PO – Programme Specific Outcome; CO – Course Outcome; R- Remember; U- Understand; Ap – Apply; An – Analyse

(For the candidates admitted from 2021 onwards)

I M.Sc. BIOTECHNOLOGY – Semester II

Course Title	MAJOR CORE 7 – GENOMICS & TRANSCRIPTOMICS
Total Hours	60
Hours/Week	4 Hrs./Wk.
Code	P21BT2MCT07
Course Type	Theory
Credits	4
Marks	100

GENERAL OBJECTIVE:

To make the learners to study about the genes& genomics, NGS the basic aspects of RNAi biology, use of siRNA and microRNAs for gene silencing, RNAi vectors and generation of transgenic animals and plants expressing dsRNA and Pharmacogenomics. The course aims to provide students with an advanced integrated knowledge and understanding of core topics.

COURSE OBJECTIVES:

To enable the learners

CO No.	Course Objectives
CO1	Assess and appraise the genes & genomes patterns.
CO2	Exemplify the mechanism and workflow of Next generation sequencing along with platforms of NGS.
CO3	Discuss the discovery, mechanism and applications of RNAi.
CO4	Illustrate Genome Wide Gene Expression Analysis.
CO5	Deliberate the role of transcriptomics in functional genomics and RNA informatics.

UNIT I: 12 HRS

Genes and Genomes

Gene- Eukaryotic and prokaryotic gene structure, genome databases, Coding regions (genes) and Non-coding regions (Intergenic sequences). Gene and related sequences – NTS, ETS and ITS, 3' UTR, 5' UTR, Pseudogenes.

Repeat sequences- a) Interspersed repeats: LINES, SINES, LTR elements; SINES types: ALU elements, MIR, MIR3; b) Tandem repeats: Transposons; c) Microsatellites.

Gene Mapping-Genetic mapping, Physical mapping - (Contig maps, Restriction maps, DNA sequence maps, FISH).

Genomics-Sanger sequencing-principle, methodology and applications. History of genome sequencing, Human Genome sequencing project.

Analysis of gene expression- qPCR, northern blot, southern blot; Transcriptome profiling;–Copy number variation, sequence repeats, SNV, haplotype, and their relevance in diseases.

Extra Reading/Key Words: *Agrigenomics and epigenomics*

UNIT II: 12 HRS

Next Generation Sequencing (NGS) Technology

Whole genome - de novo sequencing or resequencing; exome sequencing; RNA sequencing; small RNA sequencing.

NGS workflow- DNA/RNA isolation and quantitation. Fragmentation (different methods – Physical / Enzymatic/ Chemical). Library preparation-blunt end and adapter ligation, amplification, index addition. single end and paired end reads. Exome/ gene panel capture. Ribosomal RNA depletion (RNA-Seq) and small RNA enrichment. 16S rRNA based sequencing for metgenomics.

Platforms for NGS sequencing

Clonal amplification- Bead-based or Emulsion-based PCR amplification, array-based or bridge amplification. Sequencing technologies-(Clone-by-clone sequencing, Shot-gun sequencing, sequencing by hybridization and sequencing by synthesis), Emerging sequencing platforms PacBio (SMRT technology), Oxford Nanopore systems.

Extra Reading/Key Words*: Analysis of epigenomic datasets; Epigenomic variation of plant improvement genes.*

UNIT III: **12 HRS**

Functional genomics

Discovery of RNA interference (RNAi)- PTGS, RNAi and related phenomena. Categories of small non-coding RNAs- dsRNAs, siRNAs, shRNAs, piRNAs and miRNAs, Detection of small RNAs.

Large-scale genetic analysis using RNAi: Genome-wide RNAi screens in *C. elegans*, and other systems, High-throughput small RNA profiling, RNAi microarrays.

miRNAs and siRNAs

miRNAs and siRNAs: Pathways, expression and functions of microRNAs, High-throughput analysis of miRNA gene expression. siRNA vectors, siRNA delivery in vitro and in vivo.

Extra Reading/Key Words: *Data released by 1000 genome project and application of 1000 genome project*

UNIT IV: **12 HRS**

Genome Wide Gene Expression Analysis: cDNA-Microarrays - Technique of Micro array, Micro array design, Data representation, Data cleaning methods, Data Normalization methods, Analysis of Microarray data using, K-Means Clustering, Hierarchical Clustering, Self Organizing Maps (SOM), Principle Component Analysis (PCA), CLICK algorithm. Gene coexpression and co-regulation, Application of Micro array. Statistical test for differential expression in cDNA microarray experiments.

Missing value estimation methods Serial analysis of gene expression (SAGE), SAGE data analysis, role of SAGE in gene discovery, Tissue Specific Transcriptomics and Expression Pattern Analysis. SAGE Bioinforamtics. Virtual-SAGE.

Extra Reading/Key Words: *Personalized medicine and Microarray Bioinformatics*

UNIT V: **12 HRS**

RNA informatics-Computational tools for miRNA discovery, siRNA and miRNA design. Expression of dsRNA in animals and plants, and its applications. RNAi vectors and generation of transgenic animals and plants, Analysis of expression of dsRNA and gene silencing.

Transcriptomics in functional genomics, Transcriptomics and Disorders, Transcriptomics in drug design, Transcriptomics in Human cancer hazard assessment, Transcriptomics and Phylogenetics applications, Impact of transcriptomics on Pharmaceutical Research.

Microarray databases (GEO, Array express etc.), data-file formats, Tools for Transcriptomics and Transcriptome Analysis, Bioconductor.

Extra Reading/Key Words: *Medical genomics and Genetic Counselling*

Note: Texts given in the Extra reading/Key words must be tested only through assignment and Seminars.

PRESCRIBED TEXT BOOKS

1. Chakravarthy R (2006), *"Pharmacogenomics: An Introduction",* ICFAI University Press, India.
2. Cohen N (2010), "*Pharmacogenomics and Personalized Medicine (Methods in Pharmacology and Toxicology*)", Humana Press, USA,
3. Chakraborty C, Bhattacharyya A (2004), *"Pharmacogenomics: An Approach to New Drug Development",* Biotech Books, India.

SUGGESTED REFERENCE BOOKS

1. Hannon GJ, *RNAi: A Guide to Gene Silencing*. CSHL Press
2. Carmichael GG, *RNA Silencing: Methods and Protocols* Ed. CSHL Press
3. Jones LB. *Genes IX*. Barlett Publishers.
4. Strachan T, Read A. *Human Molecular Genetics,* Garland Science
5. Fitzgerald PJ. *An introduction to Human Molecular Genetics: Mechanism of Inherited Diseases* Science Press
6. Thompson, Thompson, *Genetics in Medicine*
7. Harper P, *Landmarks in Medical Genetics* (Ed.) Oxford University Press

Note : Learners are advised to use latest edition of books

COURSE OUTCOMES (CO):
The learners will able to

CO No.	Course Outcomes	PSOs Addressed	Cognitive Level
CO-1	Analyze the genes & genomes patterns to annotate for a specific requirement.	PSO 2	U
CO-2	Apply the platforms, mechanism and workflow of Next generation sequencing in scientific applications.	PSO 3	R
CO-3	Describe the mechanism and role of RNAi in living systems.	PSO 4	An
CO-4	Apply the cDNA and SAGE on Genome Wide Gene Expression Analysis.	PSO 4	U
CO-5	Illustrate the role of transcriptomics in functional genomics and RNA informatics.	PSO 5	An

PO – Programme Outcomes; CO – Course Outcome; R- Remember; U- Understand; Ap – Apply; An – Analyse; E- Evaluate; C – Create

(For the candidates admitted from 2021 onwards)

I M.Sc. BIOTECHNOLOGY – Semester II

Course Title	MAJOR CORE 8– PROTEOMICS & METABOLOMICS
Total Hours	60
Hours/Week	4 Hrs./Wk.
Code	P21BT2MCT08
Course Type	Theory
Credits	4
Marks	100

GENERAL OBJECTIVE:

To make the learners to study the basic principles of proteomics and metabolomics and their application in the new systems biology 'omics' approach. The course aims to provide students with both the methodologies used in proteomics and metabolomics, as well as their applications in both research and medical diagnostic settings.

COURSE OBJECTIVES:

To enable the learners

CO No.	Course Objectives
CO1	Describe proteomics and metabolomics, including their uniqueness among emerging 'omics fields.
CO2	Understand the basis of proteomic and metabolomic techniques and their limitations
CO3	Identify the types of information that proteomic and metabolomic techniques.
CO4	Describe of the online databases can be used as tools in the data analysis
CO5	Gain a comprehensive understanding of how the proteomic and metabolomic methods

UNIT I: 12 HRS

Introduction to Proteomics

In vitro protein synthesis and in vivo protein expression and purification from bacteria, yeast, Baculovirus and human; Structure-function relationship, gene ontology definition and application; details and techniques to study post-translational modifications in vivo and in vitro.

Protein expression analysis: 2D-PAGE, Protein microarray, Mass spectrometry, western blotting

Mass spectrometry– ionization methods (MALDI, electrospray), mass analysers, fragmentation modes (CID, HCD and ETD), intact protein analysis, protease digestion, peptide mass fingerprinting, tandem mass spectrometry.

Basics of chromatography and fractionation strategies- Liquid chromatography-based (SCX/bRPLC). Protein sequence and spectral databases/ libraries, de-novo sequencing, search algorithms- SEQUEST, Xtandem, MS-Amanda; Proteomic data repositories

Extra Reading (Key words): *Selected Reaction Monitoring-MS (SRM-MS) and MultipleReaction Monitoring-MS (MRM-MS)*

Unit II: 12 HRS

Functional proteomics

Interactomics-Protein-protein interaction, mammalian two-hybrid systems, Tandem affinity purification, co-immunoprecipitation, surface plasmon resonance, FRET, BRET, Protein-protein interaction network, Protein arrays-Abundance-based microarrays-Capture microarrays, Reverse-Phase Protein (RPP) microarrays, Tissue microarray (TMA); Function-based microarrays-Chemically linked microarray, Peptide fusion tags, Protein microarrays by using cell-free expression system; Nucleic Acid Programmable Protein Array (NAPPA), Protein in situ array (PISA) Multiple spotting technique (MIST), protein chips, antibody arrays, Peptidomics and application, Phage peptide display, combinatorial antibody library peptide aptamers-methodologies and application.

Extra Reading (Key words): *Clinical Proteomic Technology Assessment for Cancer (CPTAC 1)*

Unit III: 12 HRS

Molecular interactions: Protein-Protein interactions, Protein-DNA interactions. Methods to predict molecular interactions- Y2H method, TAP/ GFP tags, Phage-Display method, Phylogenetic footprinting, Gene fusion method, Protein profiling, Protein chips, Molecular-Docking. Database, Server and tools for analysis of protein-protein interaction and Docking. Tools of analyzing Proteomics data (ExPASy server) and GCG utilities and EMBOSS. Proteome-wide interaction maps, Proteomics workflows. Protein Engineering.

Quantitative and Targeted Proteomics: Introduction to quantitative proteomics- Differential proteomics, post-translational modifications, Targeted proteomics- Parallel reaction monitoring, Multiple reaction monitoring,

Targeted proteomics software- Skyline

Extra Reading (Key words): *SNP & alternate splicing proteins analysis*

Unit IV: 12 HRS

Introduction to metabolomics-metabolites, and metabolism-Types of metabolism-primary and secondary, Structural diversity of metabolites-physical and chemical properties, metabolites in the biological system, metabolons, Metabolites isolation from the biological system.

Metabolomics-an overview, basic sample preparation strategies- extraction, derivatization, Workflow for lipidomics. Targeted Vs Untargeted metabolomics; development of targeted assays for small molecules

Mass spectrometry based metabolomics Introduction to mass spectrometry and modes of data acquisition, data repositories. Mass analyzer-triple quadrupole and ion trap, raw data formats, data analysis platforms- Skyline and MultiQuant Software, global metabolomics analysis platforms - XCMS, MS2 compound, MetaboAnalyst, IMet-Q.

Extra Reading (Key words): *CSF Metabolomics*

Unit V: 12 HRS

Metabolome databases – KEGG, BioCyc, Metlin, Human Metabolome Databases, targeted metabolomics and proteomics - Multiple reaction monitoring (MRM/SRM) and Parallel reaction monitoring (PRM), SRMAtlas; database for Metabolomics experiments – MetaboLights.

Computational Methods to Interpret and Integrate Metabolomic Data, Metabolomics data processing workflow, Chemical ontologies and pipelines.

Metabolic profiling and fingerprinting, Metabolic pathway analysis and metabolic networks, Single Cell Metabolomics, Metabotype Concept.

Applications of Metabolomics: Metabolic Pathway as a target for Drug-screening, Metabolomics approach for hazard identification in human health assessment of environmental chemicals, Clinical implications of Metabolomics. Plant metabolomics. Metabolic pathways and inborn errors of metabolism

Extra Reading (Key words): *Metabolomics Biomarkers*

Note: Texts given in the Extra reading /Key wordsmust be tested only through assignment and Seminars.

PRESCRIBED TEXT BOOKS

1. Liebler DC, *Introduction to Proteomics -Tools for the New Biology*, Humana Press.
2. Sjuzdak G, *Mass Spectrometry for Biotechnology,* Academic Press.
3. Veetsra T, Yates J, *Proteomics for Biological Discovery,* Wiley.
4. Weckwerth W, *Metabolomics- Methods and Protocols,* Humana Press.

SUGGESTED REFERENCE BOOKS

1. Bourmaud A, Gallien S, Domon B (2016), *Parallel reaction monitoring using quadrupole-orbitrap mass spectrometer: Principle and applications.*
2. Comai, Lucio, Katz, Jonathan, Mallick, Parag (2017), *Proteomics Methods and Protocols*, Springer Edition.
3. Posch, Anton (2015), *Proteomic Profiling: Methods and Protocols*, Springer Edition.
4. Twyman R (2013), *Principles of Proteomics*, Edition II.
5. Pennington SR, Dunn MJ (2002), *Proteomics –From peptide sequence to Function.*
6. Campbell AM, Heyer LJ (2002), *"Genomics, Proteomics & Bioinformatics*.
7. Hamden M, Righetti PG (2005), *Proteomics Today.*
8. Sussulini, Alessandra (Ed.) (2017), *Metabolomics: From Fundamentals to Clinical Applications.*
9. Prasain J (2016), *Metabolomics: Fundamentals and Application.*

Note : Learners are advised to use latest edition of books

COURSE OUTCOMES (CO):

The learners will be able to

CO No.	Course Outcomes	PSOs Addressed	Cognitive Level
CO-1	Apply proteomics and metabolomics, with special emphasis in scientific research.	PSO 1	An
CO-2	Describe the basis of proteomic and metabolomic techniques and their limitations to be able to create scientific arguments as to whether or not they can be applied to a specific problem.	PSO 2	U
CO-3	Identify the types of information that proteomic and metabolomic techniques provide, and their impact when combined with complementary methods	PSO 2	E
CO-4	Apply the online databases as tools in the comprehensive analysis of the results gained from metabolomic and proteomic methods discussed.	PSO 4	An
CO-5	Demonstrate how the proteomic and metabolomic methods can be used in both the study and diagnosis of disease states in order to apply them to their own research endeavors.	PSO 4	An

PO – Programme Outcomes; CO – Course Outcome; R- Remember; U- Understand; Ap – Apply; An – Analyse; E- Evaluate; C – Create

(For the candidates admitted from 2021 onwards)

I M.Sc. BIOTECHNOLOGY – Semester II

Course Title	MAJOR CORE 9 – NEUROSCIENCE AND STEM CELL TECHNOLOGY
Total Hours	60
Hours/Week	4 Hrs /Wk
Code	P21BT2MCT09
Course Type	Theory
Credits	4
Marks	100

GENERAL OBJECTIVE

The make the learners to understand the concepts of neuro biology and stem cell with a specific focus on their characterization, function and role in diseases and therapeutics. The course will expose students to the advancements ranging from adult stem cells to embryonic and induced pluripotent stem leading to the discussion on various bioengineering approaches to stem cell research.

COURSE OBJECTIVES

To enable the learners

CO No.	Course Objectives
CO-1	Elucidate the structural and functional properties of neurons.
CO-2	Comprehend the physiological characteristics of neurons
CO-3	Outline and examine the neurochemical association in neurological diseases.
CO-4	Illustrate the type of stem cell and its characteristics
CO-5	Critically evaluate the application of stem cell in cell engineering and therapeutics

UNIT I: 12 HRS

Neuroanatomy

The Neuroanatomy - brain, spinal cord and neurons and glia, CSF pathways, Blood supply and sinovenous drainage of brain and spinal cord, anatomy of peripheral nerves, neuromuscular junction and muscles; histology of cerebrum, cerebellum, nerves and neuromuscular junction. Functional anatomy of lobes of cerebrum and white matter tracts of brain and spinal cord.

Extra Reading (Key words): *Synaptic nervous system (SANS), parasynaptic nervous system*

UNIT II: 12 HRS

Neurophysiology: Resting and action potentials; Mechanism of action potential conduction; Voltage dependent channels; nodes of Ranvier; Chemical and electrical synaptic transmission; information representation and coding by neurons.

Behaviour Science: Basic mechanisms associated with motivation; control of feeding, sleep, hearing and memory; Disorders associated with the nervous system.

Neuropharmacology: Synaptic transmission, neurotransmitters and their release; fast and slow neurotransmission; characteristics of neurites; hormones and their effect on neuronal function.

Neurochemistry: Neurotransmitters associated dopaminergic, serotoninergic, adrenergic and cholinergic systems, opioids, excitatory and inhibitory aminoacids; their role in pathogenesis of parkinsonism, depression, migraine, dementia, epilepsy. Carbohydrate, aminoacid and lipid metabolism and the neural expression of disorders of their metabolism, electrolytes and their effect on encephalopathies and muscle membrane function.

Extra Reading (Key words): *Neurophysiology of pain and neurochemistry of autism*

UNIT III: 12 HRS

Scope and Properties of Stem Cell: Scope, embryonic and adult stem cells, properties, umbilical cord stem cells, Properties of stem cells – totipotency – pluripotency –multipotency. identification, stem cells culture, techniques and their applications in modern clinical sciences.

Embryonic stem cell: *In vitro* fertilization – human embryonic stem cells – blastocyst – inner cell mass – growing ES cells in lab – laboratory tests to identify ES cells – stimulation of ES cells for differentiation – properties of ES cells – human ES cells – Monkey and Mouse ES cells.

Adult Stem cells: Somatic stem cells – test for identification of adult stem cells – adult stem cell differentiation – trans differentiation – plasticity – different types of adult stem cells

Stem cell bank-Aseptic techniques for cell culture room. Preparation of cell culture media, cell viability assays, Cytotoxicity assays. Signal transduction pathways in normal and diseased conditions. Novel sources of multipotent stem cells. Ethical issues associated with Stem Cells and Engineering.

Extra Reading (Key words): *Nanotechnology to Detect Bone-Healing Stem Cells*

UNIT IV: 12 HRS

Overview of Stem cell Biology: Stem Cells-sources of stem cells – Fate mapping of Stem Cells. Cell cycle control, Checkpoints, Senescence of Dividing Somatic cells.

Primordial Germ cells and Germ cell development. Epigenetics and Reprogramming in Stem Cell Biology. Molecular mechanisms of self- renewal, Pluri/multipotency and lineage differentiation.

Stem cell niche in Drosophila germ line. Hematopoietic stem cells: Repopulating Patterns of Primitive Hematopoietic Stem cells, Molecular Diversification and Developmental Interrelationships, Lymphopoiesis and Hemangioblast.

Extra Reading /Key words: *Cell Cycle Kinetics of Stem Cells in Vivo Hierarchy in the organization of Stem Cell Populations. Adult" Stem Cells: Tissue Specific or Not? Adult Stem Cell Plasticity: Criticisms and Pitfalls Identification, Isolation, and Characterization of stem cells. Human stem cell cloning and stem cell therapy*

UNIT V: 12 HRS

Stem Cell Engineering and Application in Therapeutics: Target identification, Manipulating differentiation pathways. Stem cell therapy Vs cell protection, stem cell based drug discovery. Genetically engineered stem cells, stem cells and Animal cloning, Therapeutic applications – heart disease, parkinson disease, Neurological disorder- Alzheimers disease, spinal cord injuries, diabetes, burns.

Tssue engineering application – production of complete organ - kidney – eyes - heart – brain.

Matching the stem cell with trans plant recipient - HLA typing.

Extra Reading (Key words): *stem cell banking*

Note: Texts given in the Extra reading /Key wordsmust be tested only through assignment and Seminars.

PRESCRIBED TEXT BOOKS

1. Sell S, *Stem cells Hand Book*, Human press
2. Snow EN, *Stem cell Research*'
3. Vinken, Bruyn, *Handbook of Neurology*.

SUGGESTED REFERENCE BOOKS

1. Mathews GG (2000). *Neurobiology*, Edition II, Blackwell Science, UK.
2. Kandal, Schwartz, *Principles of Neuroscience*, Edition IV.
3. Chiappa, *Clnical neurophysiology: Aminoff. 6.Evoked potentials*.
4. Bradley, Fenichel GM, Daroff RB, Jankovic J (2003), *Neurology in Clinical Practice*. Edition IV
5. Asbury (2002), *Diseases of the Nervous System: Clinical Neuroscience and Therapeutic Principles (diseases of the nervous system.*
6. Adams, Victor. *Principles of Neurology*, Edition IX
7. Ropper AH, Samuels MA, *Epilepsy: A Comprehensive Textbook,* Edition II.
8. Engel Jr. J, Pedley TA (2005), *Clinical guide to epileptic syndromes and treatment. Panayiotopod Niedermeyer.* Edition V.
9. Lark D, Pazdernik N (2010). *Stem Cell Biology,* Edition I, Elsevier.
10. Prentice DA, *Stem cell and Cloning*.

Note : Learners are advised to use latest edition of books.

COURSE OUTCOMES (CO):

The learners will be able to

CO No.	Course Outcomes	PSOs Addressed	Cognitive Level
CO-1	Analyze the anatomical structure and organization of nervous systems.	PSO 1	An
CO-2	Understand the function of nervous system and their behavior science.	PSO 2	U
CO-3	Intergradation of neurotransmitters in association with neurological disorders.	PSO 2	E
CO-4	Demonstrate an understanding for the concept of stem cells, and how they relate to tissue development,	PSO 3	R
CO-5	Outline the applications of stem cell in therapeutics	PSO 4	An

PO – Programme Outcomes; CO – Course Outcome; R- Remember; U- Understand; Ap – Apply; An – Analyse; E- Evaluate; C – Create

(For the candidates admitted from 2021 onwards)

I M.Sc. BIOTECHNOLOGY – Semester II

Course Title	MAJOR CORE 10 – PRACTICAL III- GENOMICS AND TRANSCRIPTOMICS & PROTEOMICS AND METABOLOMICS
Total Hours	60
Hours/Week	4 Hrs Wk
Code	P21BT2MCP10
Course Type	Theory
Credits	3
Marks	100

GENERAL OBJECTIVE

The course aims to provide students with both the methodologies and tools used in Genomics& TranscriptomicsandProteomics & Metabolomics, to apply in both research and medical diagnostic settings.

A. Genomics & Transcriptomics

1. Isolation of total RNA from samples
2. Analysis of the quality and integrity of the RNA for genomic applications by Bioanalyzer (Demo)
3. Synthesis of cDNA from total RNA
4. Evaluation of the synthesized cDNA by using RT-PCR applications
5. Evaluation of Gene Expression by Real-Time Quantitative PCR –SYBR green-based and Taqman based assays(Demo)
6. Primary Sequence databases: Genbank, DDBJ, UniprotKb
7. Basic Local alignment search tool (BLAST)
8. Proteomic Identification Database: PRIDE
9. Plant Databases: TAIR, Rice Genome Annotation Project Database

B. Proteomics & Metabolomics

1. Analysis of relative protein expression by western blotting
2. Separation of proteins by 2D gel electrophoresis-Demo
3. Separation of metabolites with GC/MS and data analysis – (demo)
4. Analysis of Proteomics data
5. PhosphoproteomeDatabase:Phosphositeplus
6. Protein Databases: NCBI-Protein, HPRD, Human protein Atlas
7. Pathway Analysis tool: EcoCyc
8. Pathway databases:NetPath, Reactome, KEGG, Plant cyc
9. Metabolome databases-Biocyc, HMDB, Metabolights

(For the candidates admitted from 2021 onwards)

I M.Sc. BIOTECHNOLOGY – Semester II

Course Title	MAJOR CORE 11 – PRACTICAL IV – NEUROSCIENCE AND STEM CELL TECHNOLOGY
Total Hours	60
Hours/Week	4 Hrs Wk
Code	P21BT2MCP11
Course Type	Theory
Credits	3
Marks	100

GENERAL OBJECTIVE

The course will intend to teach the current aspects in understanding the concepts of neuro biology and stem cell with a specific focus on their characterization, function and role in diseases and therapeutics.

Neuroscience

1. Study of gross anatomy and pre-dissected human brain.
2. Study of Human Spinal cord and PNS anatomy using virtual anatomy software
3. Histochemical demonstration of the following in brain tissue: a. Lipid, b. Proteins, c. Carbohydrates
4. Electrophysiological studies of the brain in humans/animals using EEG.
5. Determination of iodine number of fat in brain tissues.
6. Detection of neurochemicals using Silica gel Thin Layer Chromatography.
7. Quantitative determination of Neurotransmitter - Dopamine-β-Hydroxylase (DBH) Activity in the brain.
8. Isolation of DNA from brain tissues and quality checking of Genomic DNA.
9. Separation of DNA using agarose gel electrophoresis.

Stem Cell Engineering (Lab Demonstration)

1. Isolation and Culture of Hematopoietic and Mesenchymal Stem cells
2. Stem cell counting and viability checking.
3. Cell proliferation assay
4. Embryo culture and in-vitro fertilization techniques (Demonstration)
5. Culturing of stem cells on 3D scaffolds
6. Stem cell analysis using microscopy techniques
7. Case studies of stem cell therapy for various diseases.

(For the candidates admitted from 2021 onwards)

I M.Sc – Semester II

Course Title	NON MAJOR ELECTIVE – FLORISTRY BUSINESS
Total Hours	75
Hours/Week	5 Hrs./Wk.
Code	P21BT2NMT01
Course Type	Theory
Credits	3
Marks	100

GENERAL OBJECTIVE

To make learners to understand the basics of growing and fertilizing flowering plants. Students will also learn design techniques and arrangements. To focus on the Floriculture, its marketing and depended economy and its impact on society.

COURSE OBJECTIVES

To enable the learners

CO No.	Course Objectives
CO-1	To understand the emerging trends and scope of floriculture.
CO-2	Comprehend the cultivation methods of flowering plants and their nutritional requirement.
CO-3	Demonstrate the pest management for floricultural crops, their quality and productivity.
CO-4	Outline the biotechnological approaches to improve the hybrids.
CO-5	Apply the harvesting methods, packaging and improving their e marketing approaches.

UNIT I: 15 HRS

Avenues and scope: Scope of floriculture, emerging trends in floriculture biotechnology, Floriculture in the era of WTO, National and International status of Floriculture Industry/ business. Design of home, industry and institutional gardens.

Extra reading/Keywords: *Bedding plants*

UNIT II: 15 HRS

Cultivation of floriculture crops: Anthurium, Bird of Paradise, Chrysanthemum, Lily, Marigold, Orchids, Rose, Tulip. Nutritional aspects of floriculture crops- Biotechnological role in floriculture. Preparation and maintenance of bonsai & lawn

Extra reading/Keywords: *Ornamental propagation*

UNIT III: 15 HRS

Package of practices for management of pest and disease for floricultural crops, Role of Green house in improving the quality and productivity of floricultural plants. Eco-friendly cultivation of floricultural crops, Compatibility for Inter cropping of floricultural crops with other agricultural crops.

Extra reading/Keywords: *Free style garden*

UNIT IV: 15 HRS

Morden Floriculture Technology: Modern Floriculture Industries, Genetic Improvement programmes through biotechnological approaches, Production of F1 hybrids, rapid propagation methods. Role of tissue culture in Floriculture Industry.

Extra reading/Keywords: *Microgreens*

UNIT V: 15 HRS

Floriculture Industries (National and International status). Harvesting, Packing, Marketing, Revenues, Avenues for employments in Floriculture Industries, Socio economical aspects of Floriculture Industry. Challenges and advantage of e- business in floriculture.

Extra reading/Keywords: *Landscape garden design*

Note: Texts given in the Extra reading /Key wordsmust be tested only through assignment and Seminars.

PRESCRIBED TEXT BOOKS

1. Prakash J, Bhandary KR, *Floriculture Technology, Trades and Trends,* Oxford and IBH publication

SUGGESTED REFERENCE BOOKS

1. Edward A, *The Principles of Floriculture,* White Forgotten Book publication
2. Laurie A, Victor H, *Floriculture Fundamentals and Practices,* Edition II New McGRAW-HILL Book company.

COURSE OUTCOMES (CO):

The learners will be able to

CO No.	Course Outcomes	PSOs Addressed	Cognitive Level
CO-1	Discriminate the basics of floriculture, scope and importance in floriculture cultivation.	PSO 5	R
CO-2	Investigate and apply the cultivation methods for high demand flowering plants.	PSO 2	A
CO-3	Evaluate and imply the natural eco - friendly cultivation methods in boosting the yield.	PSO 2	E
CO-4	Discriminate the biotechnological approaches in improving the propagation methods.	PSO 3	R
CO-5	Outline the challenges and applications of e- marketing in floriculture.	PSO 2	An

PSO – Programme Specific Outcomes; CO – Course Outcome; R- Remember; U- Understand; Ap – Apply; An – Analyse; E- Evaluate; C – Create

(For the candidates admitted from 2021 onwards)

I M.Sc. BIOTECHNOLOGY – Semester II

Course Title	MAJOR ELECTIVE 2 – FORENSIC SCIENCE TECHNOLOGY
Total Hours	60
Hours/Week	4 Hrs./Wk.
Code	P21BT2MET03
Course Type	Theory Cum Lab
Credits	4
Marks	100

GENERAL OBJECTIVE

To make the learners to understand the competence in problem-solving, legal analysis and application, quantitative reasoning, investigation and scientific laboratory procedures can be applied to immediate employment or advanced study.

COURSE OBJECTIVES

To enable the learners

CO No.	Course Objectives
CO-1	Develop specific knowledge about forensic science, finger printing and their examinations
CO-2	Apply the laboratory skills in examining different types of evidences found at the crime scene
CO-3	Identify and classify different types of specimens at the crime location
CO-4	Learn potential benefits of microbial and digital forensic science

UNIT I: 12 HRS

Introduction to forensic science: Historical aspects of forensic science, Definitions and concepts of forensic science, Need of Forensic Science, Basic Principles of Forensic Science, Different branches of Forensic Science. Frye case and Dauber standard. Crime – Introduction Natures, causes and consequences of crime, Procedures involved in the detection of crime. Classification and cataloguing of fingerprint record. Automated Fingerprint Identification System. Significance of poroscopy and edgeoscopy.

Extra Reading (Key words): *INTERPOL*

UNIT II: 12 HRS

Qualitative and quantitative methods of analysis: Destructive and Non-Destructive Methods, Separatorary techniques, Hyphenated techniques. Schematic analysis of Chemical, Biological and Physical samples, Preliminary and Confirmatory methods of analysis, Colour spot tests in Forensic Biological, Chemical and Physical analysis, Microcrystalline test, Dope Test. Applications of chromatography in forensic studies.

Extra Reading/Key words: *Comparison microscope*

UNIT III: 12 HRS

Introduction to finger printing and specimen: latent prints. Latent fingerprints detection by physical and chemical techniques. Mechanism of detection of fingerprints by different developing reagents. Application of light sources in fingerprint detection. Forensic significance of semen, blood, hair saliva, sweat, milk and urine. Forensic applications of Compound, Fluorescence, Polarized, Stereo-zoom, Scanning Electron and Transmission Electron Microscope. Application of immunoassays in forensic work.

Extra Reading/Key words: *Purification of forensic specimens*

UNIT IV: 12 HRS

Microbial forensic science: Types and identification of microbial organisms of forensic significance. Basics of forensic entomology. Insects of forensic importance. Collection of entomological evidence during death investigations.

Digital forensic science: Definition and types of computer crimes. Distinction between computer crimes and conventional crimes. Tools for detection of deception –non-verbal detection, statement analysis, voice stress analyzer, hypnosis, Polygraphy, Narco analysis and brain electrical oscillation signatures.

Extra Reading/Key words: *Narcotic drugs,CDFD*

UNIT V : (Practical) 12 HRS

1. Latent finger Print development by chemical methods.
2. Forensic Drug Testing- Analysis of Drugs by Thin Layer Chromatography
3. Forensic analysis of oils and fats
4. Analysis of Corrosive chemicals: Hydrochloric acid, sulphuric acid, and nitric acid
5. Microscopic analysis and comparison of human hair and animal hair
6. Extraction of DNA from body fluids
7. DNA Fingerprinting

Note: Texts given in the Extra reading /Key words must be tested only through assignment and Seminars.

A record will be submitted and evaluated during the practical examination internally

PRESCRIBED TEXT BOOKS

1. Willdard HH (1974), *Instrumental Methods of Analysis.*
2. Settle FA (1997), *Handbook of Instrumental Techniques for Analytical Chemistry*, Prentice Hall.

SUGGESTED REFERENCE BOOKS

1. Bhasin MK, Nath S (2002), *Role of Forensic Science in the New Millenium*, University of Delhi, Delhi.
2. James SS, Nordby JJ (2005), *Forensic Science: An introduction to scientific and Investigative Techniques*, Edition II, CRC Press, Boca Raton
3. Moonesens AA (1979), *Scientific Evidence in Criminal Cases*.
4. Lundquist, Curry (1963), *Methods of Forensic Science*.

Note : Learners are advised to use latest edition of books.

COURSE OUTCOMES (CO):

The learners will be able to

CO No.	Course Outcomes	PSOs Addressed	Cognitive Level
CO-1	Explain the basics of forensic studies and finger printing technology	PSO 2	U
CO-2	Apply the laboratory skills to participate in the career needs of Forensic community	PSO 3	Ap
CO-3	Differentiate different specimens of the crime scene	PSO 4	An
CO-4	Explain benefits of microbial forensics and digital forensics	PSO 2	E

PSO – Programme Specific Outcome; CO – Course Outcome; R- Remember; U- Understand; Ap – Apply; An – Analyse; E- Evaluate; C – Create

(For the candidates admitted from 2021 onwards)

I M.Sc. BIOTECHNOLOGY – Semester II

Course Title	MAJOR ELECTIVE 2 – MEDICAL INFORMATICS
Total Hours	60
Hours/Week	4
Code	P21BT2MET04
Course Type	Theory
Credits	4
Marks	100

GENERAL OBJECTIVE

Medical documentation and electronic patient records. Image capturing, analysis and processing techniques. Medical terminology and standards. Modelling, simulation, and visualisation as tools for diagnosis and therapy. Medical knowledge representation and decision support. User interfaces in health care. Telemedicine

COURSE OBJECTIVES

To enable the learners:

CO No.	Course Objectives
CO-1	Understand the basic concept of medical informatics and account for the challenges in deploying and using advanced data analysis and information systems in health care practice.
CO-2	Analyze how practices within health care can be supported by computerized tools.
CO-3	Describe how the requirements of different stakeholders within health care (e.g. physicians, nurses) can be studied and fulfilled to overcome their problems virtually.
CO-4	Learn potential benefits of medical informatics and to determine the problems in health care practice are appropriate to address, including ethical and safety positions, by using computerized methods for visualization and analysis
CO-5	Apply the informatics tools and technology and describe the challenges in designing advanced data analysis and information systems for health care practice

UNIT I: 12 HRS

Introduction to medical informatics

Introduction to medical informatics, Computer based medical informatics retrieval, Database and information system in health care, Big Data in hospitals; Basic medical imaging: acquisition, diagnostic display, enhancement and analysis- Computed tomography

Health informatics- Medical Informatics, Clinical informatics, Nursing informatics, Public health informatics.

Extra Reading/Key words: *Biomonitoring drugs*

UNIT II: 12 HRS

Medical data storage and automation

Representation of health care Data-Relational-Hierarchical and network Approach, Data modelling for patient database development.

Introduction to biomedical statistics, Computer processing of biosignals, Advanced medical imaging: CAD and advanced diagnostic image processing Networking and teleradiology

Extra Reading/Key words: *PACS Architecture*

Unit III: 12 HRS

Computerized patient records

Clinical studies – Evidence based medicine. Automated clinical laboratories- Automated methods in hematology, cytology and histology, Computer assisted medical imaging,

Medical standard organization JCI, Computer based patient records- Tracking history by computer, CPR in Radiology, Computerized prescription for Patients.

Extra Reading/Key words: *Nuclear medicine*

UNIT IV: 12 HRS

Cybersecurity in health care

Informatics in Patient Care Settings, The EMR and the HER- HHS meaningful use criteria - Next generation nursing systems - Health data storage and exchange – Telemedicine- Clinical imaging - Automated staffing and workload systems - Quality assurance. Social, ethical and legal Issues,

Introduction to computer processing of medical image, Clinical software development. Medical startups, Intellectual property Right Protection.

Extra Reading/Key words: *CPG Resources*

UNIT V: **12 HRS**

Recent advances in medical informatics

Virtual reality applications in medicine, Computer assisted surgical techniques- Virtual endoscopy, Computer assisted surgery, Computer assisted medical education. Virtual hospital- e-health services, Telemedicine. Technologies to Decrease Medication Errors- Automated Inpatient Medication Dispensing Devices , Pharmacy Dispensing Robots, Electronic Medication Administration Record (eMAR, Smart Intravenous (IV) Infusion Pums, Bar coding and RFID

Extra Reading/Key words: *National Institute for Health and Clinical Excellence*

PRESCRIBED TEXT BOOKS

1. Shortliffe EH, Cimino JJ, Chiang MF (2021), *Biomedical Informatics- Computer Applications in Health Care and Biomedicine*, Edition V.
2. Tan J (2008), *Medical Informatics: Concepts, Methodologies, Tools, and Applications* (4 Volumes).

SUGGESTED REFERENCE BOOKS

1. Cleveland AD, Cleveland DB (2009), H*ealth Informatics for Medical Librarians*
2. Hersh WR, Hoyt RE (2018), *Health Informatics - Practical Guide*, Edition VII

COURSE OUTCOMES

The learners will be able to:

CO No.	Course Outcomes	PSOs Addressed	Cognitive Level
CO-1	Explain the structure of medical Informatics and functional capabilities of hospital informatics.	**PSO 1**	**U**
CO-2	Analyze the needs of software and computers in medical imaging and automation clinical practices.	**PSO 2**	**An**
CO-3	Apply the tools and software to fulfill the needs of medical standards.	**PSO 4**	**Ap**
CO-4	Explain the importance of health care informatics	**PSO 3**	**R**
CO-5	Apply the recent trends, virtual hospitability and various ICT applications in medical informatics.	**PSO 5**	**E**

PSO – Programme Specific Outcome; CO – Course Outcome; R- Remember; U- Understand; Ap – Apply; An – Analyse; E- Evaluate; C – Create

(For the candidates admitted from 2021 onwards)

I I M.Sc. BIOTECHNOLOGY – Semester III

Course Title	MAJOR CORE 12: BIOPROCESS TECHNOLOGY & INDUSTRIAL BIOTECHNOLOGY
Total Hours	60
Hours/Week	4 Hrs/Wk
Code	P21BT3MCT12
Course Type	Theory
Credits	4
Marks	100

GENERAL OBJECTIVE

To develop an exceptional knowledge of the principles and processes of fermentation technology and expand their industrial applications for the production of novel products.

COURSE OBJECTIVES

To enable the learners

CO No.	Course Objectives
CO 1	Attempt to produce a novel industrially important products from microbes industrially important microbes
CO 2	Explain the types of fermenters, their principle and applications
CO 3	Analyze and examine the mechanics involved in designing of bioreactors
CO 4	Explore the different methodologies involved in recovery, purification and commercialization of fermented products
CO 5	Correlate and conclude the economically suitable method for waste management under biosafety levels

UNIT I: 12 HRS

Introduction to Bioprocess technology: Isolation, screening and maintenance of industrially important microbes, microbial growth and death kinetics, Monod's kinetics, strain improvement for increased yield and other desirable characteristics (mutation, selection and recombination), historical development in fermentation process, batch and continuous fermenters, modifying batch and continuous reactors, fed-batch operations, conventional fermentation v/s biotransformation, factors affecting product formation, immobilized cell systems.

Extra Reading /Key words: *Bioreactor, construction of bioreactor, chemostat*

UNIT II: 12 HRS

Media formulation and optimization, sterilization, aeration, agitation and heat transfer in bioprocess, measures to select bioreactor, components of bioreactor (impellers, baffles, stirrer, etc.), types of bioreactors, selection of scaleup - measurement and control of bioprocess parameters (temperature, pressure, plug-flow, oxygen, pH), product recovery costs, waste water usage and recycling, effluent treatment and disposal, large scale animal and plant cell cultivation.

Extra Reading / Key words: *oxygen transfer, volumetric transfer coefficient (K_La)*

UNIT III: 12 HRS

Separation of insoluble products - filtration, centrifugation, sedimentation, flocculation, cell disruption, separation of soluble products – liquid-liquid extraction, evaporation, precipitation, reverse osmosis, ultra and micro-filtration, electrophoresis (spray drying, vacuum drying, freeze drying), Qualitative and quantitative estimation of product using – chromatography (Adsorption, Ion exchange, gel permeation, affinity, HPLC), purification – drying (spray drying, vacuum drying, freeze drying), crystallization, storage and packaging.

Extra Reading/ Keywords: *Flocculation, sedimentation, centrifugation*

UNIT IV: 12 HRS

Industrial uses of microbes - production of primary metabolites (ethanol, citric acid, acetic acid/vinegar), vitamins (vitamin B12), secondary metabolites (penicillin, tetracycline), role of microbes in pickle, colours and flavours production, alcoholic beverages, microbial production of food (SCP), microbes as food and feed for animals, microbes used in the production of vaccines (DNA vaccine and recombinant vaccine), antibiotics (streptomycin and penicillin), enzymes (amylase and protease).

Extra Reading/Key words: *Insulin, lipase, interferons*

UNIT V: 12 HRS

Processing wastes - whey, molasses, starch substrates and bioconversion (other food wastes) into useful products, bacteriocins from lactic acid bacteria, bioremediation (biosorption of heavy metals, xenobiotics,

phytoremediation), pollution and waste control (sewage treatment), microbial mining and ore leaching, guidelines for rDNA research activities - biosafety levels, maximum containment laboratories, infectious waste disposal and management.

Extra Reading/Key words: *superbugs, bioleaching, biosurfactant*

Note: Texts given in the Extra reading /Key words must be tested only through assignment and Seminars.

PRESCRIBED TEXT BOOKS

1. Doran PM (2012). *Bioprocess Engineering PrinciplesM* Academic Press.
2. Patel AH (2005). *Industrial Microbiology*, Macmillan Private Limited.
3. Whitaker, Hall SJ, (2004). *Principles of Fermentation Technology*, Edition II, Butterworth Heinemann, Oxford, ed.
4. Ganguli P, (2001). *Intellectual Property Rights*, Tata Mcgraw Hill.
5. Shuler ML, Kargi F (2001). *Bioprocess Engineering: Basic Concepts*, Edition II.

SUGGESTED REFERENCE BOOKS

1. Cruger WA (2003). *A Textbook of Industrial Microbiology,* Panima Publishing Corporation, New Delhi. Shuler.
2. Kargi MLF (2003). *Bioprocess engineering: Basic Concepts*, Prentice Hall, Engelwood Cliffs.
3. Stanbury PF, Whitaker A (2003). *Principles of Fermentation Technology*, Pergamann Press, Oxford.
4. Prescott SC, Dunn CG (2002). *Industrial Microbiology,* Edition I, Agrobios (India) Ltd.
5. Flickinger MC, Drew SW (1999). *Encyclopedia of Bioprocess Technology - Fermentation Biocatalysis and Bioseparation*, (Volumes I-V), John Wiley and Sons, Inc., New York.

Note: Learners are advised to use latest edition of books

COURSE OUTCOMES

CO No.	Course Outcomes	PSOs Addressed	Cognitive Level
CO-1	Scrutinize the methods of isolation, screening and preservation of industrially important microbial strains	PSO-1	**R**
CO-2	Apply several concepts to enhance the performance of bioreactor and evaluate process to investigate a bioprocess	PSO-2	**U**
CO-3	Produce commercially valued fermentation products by manipulating and enhancing their recovery and purification methods.	PSO-2	**Ap**
CO-4	Categorize the industrial scale production and therapeutic applications of enzymes and deconstruct the design of immobilized enzyme reactors	PSO-5	**Ap**
CO-5	Recognize the proper method for waste disposal from the industry and to avoid accumulation of contaminants to the environment	PSO-3	**E**

PO – Programme Outcomes; CO – Course Outcome; R- Remember; U- Understand; Ap – Apply; An – Analyse; E- Evaluate

(For the candidates admitted from 2021 onwards)

II M.Sc. BIOTECHNOLOGY – Semester III

Course Title	MAJOR CORE 13 – NANOTECHNOLOGY AND TOXICOLOGY
Total Hours	60
Hours/Week	4 Hrs/Wk
Code	P21BT3MCT13
Course Type	Theory
Credits	4
Marks	100

GENERAL OBJECTIVE:

The course is designed to study about the basic techniques, methods and applications involved in nanotechnology and toxicology.

COURSE OBJECTIVES

To enable the learners

CO No.	Course Objectives
CO-1	Obtain knowledge on the basics of nanomaterials and their properties based on its size
CO-2	Design a method for the production and characterization of a nanoparticle.
CO-3	Elucidate the applications of nanotechnology in different fields
CO-4	Study Fundamentals of toxicology and the body's response to drugs, foods, and toxic substances derived from environmental, dietary, occupational and pharmaceutical sources.
CO-5	Acquaint with the concepts of organ toxicology and the roles of the various disciplines in toxicology

UNIT I: 12 HRS

Introduction to Nanotechnology - Importance, History of Nanotechnology; Classification based on the dimensionality; Nanoparticles – nanoclusters, nanotubes, nanowires and nanodots, Semiconductor, nanotubes; Influence of Nano-structuring on mechanical, optical, electronic, magnetic and chemical properties.

Physical synthesis: Inert gas condensation, Plasma arc technique, Ion sputtering, Laser ablation, Laser pyrolysis, ball milling, chemical vapour deposition method and other variants, Electrodeposition, Nanolithography

Chemical and Biological synthesis: Self-assembly, colloids, emulsion polymerization, Vapor (or solution) liquid - solid (VLS or SLS) growth, electrochemical approaches, sonochemical. biological synthesis- use of bacteria, fungi, Actinomycetes for nanoparticle synthesis, mechanism of formation - viruses as components for the formation of nanostructured materials, synthesis process and application, Role of plants in nanoparticle synthesis.

Extra Reading/Key words: *Computational Nanoscience*

UNIT II: 12 HRS

Characterization by Diffraction studies: X-ray Diffraction - Principle of operation and application for band gap measurements, thermal analysis methods, differential scanning calorimetry. Particle size characterization - Zeta potential measurement.

Characterization by Spectroscopic techniques: UV-Visible Spectroscopy, IR Spectroscopy, Raman Spectroscopy, NMR Spectroscopy.

Characterization by Microscopy: Optical microscopy, Electron microscopy - Scanning Electron Microscopy, Transmission Electron Microscopy, Atomic Force Microscopy, Scanning Tunneling Microscopy.

Extra Reading/Key words: *Oswald Ripening, Plasma resonance*

UNIT III: 12 HRS

Application in Electronics - Nanotechnology in electronics and energy storage, solar cells, Microarray technology. Phase Change Memory Devices- FeRAM- MRAM- RRAM and Probe storage- molecular memory and atomic memory.

Applications in Biomedical: Nanosensors in diagnosis, drug delivery, Cancer therapy, tissue engineering and other therapeutic applications; Nanotechnology in defence and aerospace.

Applications in Agri based Industries: Nanotechnology in Agriculture. Potential benefits in nanotechnology in the food industry - Nanotechnology in textiles and cosmetics.

Extra Reading (Key words): *Production of Superflexible Chips and Biodegradable Electrodes*

UNIT IV: **12 HRS**

Basics of Toxicology - Definition, history, scope and sub-divisions of toxicology, Toxicodynamics –Dose vs Toxicity Relationships. Toxicokinetics – ADME, LADMET hypothesis. Genotoxicity and carcinogenicity

Toxins: Classification- toxic agents, natural toxins, animal toxins, plant toxins, food toxins, genetic poisons and chemical toxins. Factors affecting toxicity, Elimination of toxicants-renal, hepatic, DMES, pulmonary systems.

Biochemical toxicology: Mechanisms of toxicity – Delivery, Absorption, Distribution and Excretion of xenobiotic; Reaction of toxicants with target molecules; Cellular disrepair and repair mechanisms.

Extra Reading (Key words): *Toxins as Lead molecule*

UNIT V: **12 HRS**

Protocols in Toxicology Studies - Assessment of toxicokinetics. Assessment of oxidative stress and antioxidant status. Analytical Toxicology: Instrumentation involved in toxicology – Microscopy, Spectrophotometry, Chromatography, radiological techniques, Electrophoresis.

Toxicity in organ systems (Hepatotoxicity, nephrotoxicity, toxicology of the nervous system, neurotoxicity, toxicity of the endocrine system, respiratory system, reproductive system, and blood as a target organ).

Methods for toxicity assessment – Cyto, Geno, hepato, neuro, nephrotoxicity. Applied fields of toxicology: Regulatory, Cosmetic, Wildlife, Medical, Forensic, Veterinary, and Preventive toxicology. Environmental toxicology – Pollutants, Toxicity of pesticides and insecticides, heavy metals, carcinogens.

Extra Reading (Key words): *Pharmacoinformatics*

Note: Texts given in the Extra reading /Key words must be tested only through assignment and Seminars

PRESCRIBED TEXT BOOKS

1. Hodgson (2010). *A Textbook of Modern Toxicology*, Edition IV, John Wiley and Sons.
2. Jain KK (2006). *Nano Biotechnology*, Horizions Biosciences.

SUGGESTED REFERENCE BOOKS

1. Lieberman, Peet (2018). *Mark's Basic Medical Biochemistry: A Clinical Approach*, Edition V, Wolters Kluwer.
2. Parvathi D, Rajagopal K (2017). *A Practical Manual on Synthesis of Nanoparticles and its Applications in Biology*, V. Digital Age Publishers.
3. Gupta PK (2016). *Fundamentals of Toxicology, Essential Concepts and Applications.*
4. Horikoshi S, Serpone N (2013). *Introduction to Nanoparticles*, Wiley WCH Verlag GmbH & Co.
5. Murty BS, Shankar P, Raj, Baldev, Rath BB, Murday, James, (2013). *Textbook of Nanoscience and Nanotechnology*, Springer.

COURSE OUTCOMES (CO):

The learners will be able to

CO No.	Course Outcomes	PSOs Addressed	Cognitive Level
CO-1	Apply the students the essential role of Nanoscience	PSO-1	Ap
CO-2	Understood the classification, principles and Background to nanotechnology	PSO-3	U
CO-3	Evaluate the interaction between biomolecules and nanoparticle surface and its applications	PSO-2	E
CO-4	Analyze effects of toxicants and environmental pollutants toxicants on organ system and drug disposition.	PSO-4	An
CO-5	Understanding site of action, mechanism of action and interaction between toxins and organ system	PSO-3	U

PO – Programme Outcomes; CO – Course Outcome; R- Remember; U- Understand; Ap – Apply; An – Analyse; E- Evaluate; C – Create

(For the candidates admitted from 2021 onwards)

II M.Sc. BIOTECHNOLOGY – Semester III

Course Title	MAJOR CORE 14 – CADD & SYSTEMS BIOLOGY
Total Hours	75
Hours/Week	5 Hrs/Wk
Code	P21BT3MCT14
Course Type	Theory
Credits	5
Marks	100

GENERAL OBJECTIVE

Provides a broad and thorough background in Drug Discovery and Development. To understand the theories used in docking program. To comprehend the basics of analyzing metabolic pathways using bioinformatics tools and also the simulation of cellular environment.

COURSE OBJECTIVES

To enable the learners

CO No.	Course Objectives
CO-1	Demonstrate the various databases used in computer aided drug design.
CO-2	Outline the concepts and methodologies used in systems-level analysis of biomedical systems
CO-3	Understand the basic aspects and applications of Biological networks.
CO-4	Evaluate the methods of computer aided drug design and designate itsimportance on drug discovery process
CO-5	Compute the metabolism and kinetics of the biological pathway using various tools.

UNIT I: 15 HRS

Drug development process overview, the changing landscape of drugs development. Drug discovery phases-preclinical phase studies, pharmacokinetics, admet prediction, admet parameters and their role, admet prediction methods and tools. Computer aided drug design (cadd) - introduction to history, different techniques, applications, success and limitations. Database resources for cadd - therapeutic target information, chemical information.

Extra Reading /Keywords: *Drugs discovered by computer aided drug design*

UNIT II: 15 HRS

Drug target identification **–** Introduction to drug target, properties of an ideal drug target, druggability of drug target. Computational approaches for drug target identification - homology-based approaches, network-based approaches. Computational methods for druggability assessment – sequence based method, structure based methods- identifying cavities and binding pockets, druggability of binding pocket, target specific assessment.

Extra Reading /Keywords: *Drug targets, Pharmapper*

UNIT III: 15 HRS

Structure-based drug designing - target identification; modeling, visualization of macromolecule structure, binding site prediction and analysis, molecular docking - flexible docking, rigid docking, validation of molecular docking, molecular dynamics simulation and its applications. Ligand-based designing - pharmacophore modeling, quantitative structure–activity relationship.

Extra Reading/Kewords: *CoMFA, Gromacs*

UNIT IV: 15 HRS

Introduction to systems biology - systems biology is a living science, properties of models-model behavior, model development. Biological networks – metabolic, signaling and regulatory networks. Network structure identification – bottom up approach, top-down approach. Modeling of gene expression - modules of gene expression, modeling specific processes in eukaryotic gene expression, representation of gene network as directed and undirected graphs.

Extra Reading/ Key Words: *Synthetic biology, neural networks*

UNIT V: 15 HRS

Pathway databases - kegg, reactome, metacyc Enzyme kinetics database, brenda, gene expression databases, biomodels database, est databases- unigene, snp database. Modeling tools - gepasi, e-cell, systems biology workbench, jdesigner, cell designer, cytoscape, e-cell, pybios. Basics of systems biology markup language (sbml), sbml editors.

Extra Reading/Keywords: *ERATO system biology work bench, Computer simulation of cell*

Note: Texts given in the Extra reading /Key words must be tested only through assignment and Seminars

PRESCRIBED TEXT BOOKS

1. Xiong J (2006). *Essential Bioinformatics*, Cambridge University Press.
2. Klipp E, Herwig R, Kowald A, Wierling C, Lehrach H (2005). *Systems Biology in Practice-Concepts, Implementation and Application*, Germany: Wiley-Vch Verlag Gmbh & Co.Kgaa.
3. Leach AR (2001). *Molecular Modeling: Principles and Applications*, Edition II, Pearson Education EMA.
4. Kitano H (2001). *Foundations of Systems Biology*, MIT Press.

SUGGESTED REFERENCE BOOKS

1. Alon U (2006). *An Introduction to Systems Biology: Design Principles of Biological Circuits*. London: Chapman & Hall/Crc, Taylor and Francis Group.
2. Szallasi Z, Stelling J, Periwal V (2006). *Systems Modeling in Cellular Biology*, USA: MIT Press.
3. Larson RS (2005). *Bioinformatics and Drug Discovery*, Humana Press.
4. Kalo W (2005). *Pharmacogenomics*, Edition II, Taylor and Francis, LLC, London.

COURSE OUTCOMES:

The student will be able to

CO No.	Course Outcomes	PSOs Addressed	Cognitive Level
CO-1	Record knowledge in basics of drug development and its process.	PSO 1	R
CO-2	Understand the concept of molecular mechanics and molecular dynamics.	PSO 2	U
CO-3	Understand the need for metabolic web databases in analyzing a biological pathway.	PSO 2	U
CO-4	Integrate the molecular docking tools in their research projects and utilize them to discover new compounds.	PSO 3	Ap

PO – Programme Outcomes; CO – Course Outcome; R- Remember; U- Understand; Ap – Apply; An – Analyse; E- Evaluate

(For the candidates admitted from 2021 onwards)
II M.Sc. BIOTECHNOLOGY – Semester III

Course Title	MAJOR CORE 15: PRACTICAL V - BIOPROCESS TECHNOLOGY & INDUSTRIAL BIOTECHNOLOGY
Total Hours	60
Hours/Week	4 Hrs./Wk.
Code	P21BT3MCP15
Course Type	Practical
Credits	3
Marks	100

GENERAL OBJECTIVE

This course emphases the basic design and principles of bioprocess. Also highlights the modern application of biotechnological process in biotechnological industry.

BIOPROCESS TECHNOLOGY

1. Enumeration of microorganisms from bread
2. Determination of TDT & TDP
3. Determination of Microbial growth curve - effect of pH and temperature on microbial growth curve
4. Analysis of aflatoxin by TLC
5. Qualitative analysis of milk
6. Paper chromatography
7. Thin layer chromatography
8. Protein recovery by ammonium sulphate precipitation
9. Aqueous two phase extraction
10. Estimation of glucose by dinitro salicylic acid (DNS) assay method
11. Immobilization of enzymes
12. Waste water quality indicator – COD and BOD

INDUSTRIAL BIOTECHNOLOGY

1. Isolation of actinomycetes and cellulolytic organisms from soil
2. Isolation of any one industrially important enzyme and antibiotics
3. Production of wine
4. Immobilization of yeast cells
5. Isolation and screening of microorganism producing amylases
6. Production of citric acid
7. Production of bread
8. Estimation of alcohol concentration in wine
9. Preparation of vegetable pickle

(For the candidates admitted from 2021 onwards)

II M.Sc. BIOTECHNOLOGY – Semester III

Course Title	MAJOR CORE 16 – PRACTICAL VI: NANOTECHNOLOGY & TOXICOLOGY AND CADD & SYSTEMS BIOLOGY
Total Hours	60
Hours/Week	4Hrs/Wk
Code	P21BT3MCP16
Course Type	Theory
Credits	3
Marks	100

GENERAL OBJECTIVE:

The course is designed to provide students study with both the methodologies and techniques, involved in nanotechnology and toxicology to apply in both research and applications.

NANOTECHNOLOGY

1. Synthesis of metal oxide nanoparticles and analysis by UV-Vis spectrophotometer and DLS
2. Synthesis of transition metal oxide nanoparticles by hydrothermal technique and to determine particle size using UV-Vis spectrometer.
3. Synthesis of semiconducting nanostructured materials by co-precipitation technique and to calculate the absorption coefficient & optical bandgap using UV-Vis spectrometer
4. Green synthesis of Metallic nanoparticles and characterized the synthesized nanoparticles by UV-visible and IR spectroscopy.
5. Evaluating the stability of nanoparticles
6. Evaluation of Encapsulating and drug-releasing capacity of nanoparticles
7. Antibacterial activity against- *E. coli* and *S. aureus* (Agar-Well Diffusion method).

TOXICOLOGY

1. Determination of Median Effective and Median Lethal Doses of poisoning agents in plants.
2. Collection and Dispatching of Samples for Toxicological Tests.
3. Detection of heavy metal poisoning by the spot test method.
4. Drug screening by ELISA.
5. Detection of insecticide poisoning and its treatment test.
6. Detection of cardiovascular poisoning agents and Carboxyhaemoglobin saturation determination analysis in animals
7. Acid/Base/Neutral drug screen and quantitation by GC and GC-MS – Demonstration.

CADD & SYSTEMS BIOLOGY

1. Structure database - PDB
2. Chemical databases – Pubchem, Drugbank
3. Chemical Structure drawing Software - Chemsketch
4. Docking – Autodock Vina
5. Visualization of Macromolecule Structure – Acclerys discovery studio, Pymol
6. Pharmacophore Mapping - Pharmapper
7. ADMET prediction – Accord Excel
8. Enzyme database - BRENDA
9. Protein network database - String
10. Network Analysis – Cytoscape
11. Pathway modelling tool – Cell designer

(For the candidates admitted from 2021 onwards)

II M.Sc – Semester III

Course Title	NON MAJOR ELECTIVE 2– FUNCTIONAL FOODS AND NUTRACEUTICALS
Total Hours	75
Hours/Week	5
Code	P21BT3NMT02
Course Type	Theory
Credits	3
Marks	100

GENERAL OBJECTIVE

The course gives a detailed knowledge on sources of Functional Foods and Nutraceuticals, the course was framed to understand the role of functional foods, nutraceuticals and dietary supplements in health and disease.

COURSE OBJECTIVES

The learners will be able to

CO No.	Course Objectives
CO-1	To understand the emerging trends history and scope of nutraceutical and functional foods.
CO-2	Comprehend the classification of food sources, mechanism of action and its application.
CO-3	Demonstrate the functional foods of microbial origin and its application in industries.
CO-4	Distinguish between the more common types of nutritional and metabolic disorders. To understand the role of Nutraceuticals and functional food in health and disease.
CO-5	To apply and analyze the international marketing, regulating and safety aspects in health claims.

UNIT I: **15 HRS**

Defining of Nutraceuticals and functional foods, Classifying nutraceutical factor, food and non food source.

Classification of Functional foods and their benefits- traditional foods, designer foods and pharma foods, nutraceuticals.

Components of functional foods, stages involved in development of functional foods, dietary supplements, fortified foods.

Extra Reading/Key words: *Fortified foods*

UNIT II: **15 HRS**

Classification of nutraceutical factor Based on food source, mechanism of action and chemical nature - isoprenoid, phenolic substances, fatty acids, carbohydrates, amino acid based derivatives, isoflavones.

Application of phytochemicals: Polyphenols, Flavonoids, Lycopene- Food source, properties and Health. Application of herbs to functional foods. Oxidative stress and Antioxidants requirement in health effects.

Microbes in food, plants, animals and microbes. Scope of nutraceuticals involved in the industry, Effects on human health and potential applications in risk reduction of diseases.

Extra Reading/Key words: *Phytoesterogens*

UNIT III: **15 HRS**

Functional foods of Microbial origin- Human gastrointestinal tract and its microbiota, functions, probiotic microflora and functions- Lactobacillus and Bifidobacterium.

Concept of probiotics- probiotics and prebiotics with examples, role of probiotics in health and disease. Probiotics- Taxonomy and important features of probiotic micro- organisms.

Health effects of probiotics- Its mechanism of action. Probiotics in various foods: fermented milk products, non-milk products etc. Quality Assurance of probiotics and safety.

Extra Reading/Key words: *Resistant Starch*

UNIT IV: **15 HRS**

Sources and role of Functional foods and Nutraceuticals in health and disease, nutraceuticals from sea foods and sea food by-products, nutraceutical foods from selected Asian fruits and byproducts- apple, Aronia, Avocado, berries, dates, citrus fruits, Vegetables.

Role of nutraceuticals in health and disease management: Nutraceuticals and Functional foods in Gastrointestinal disorder, Cancer, CVD, Diabetic Mellitus; Importance and function of probiotics, prebiotics and synbiotics and their applications,

Functional foods and immune competence: Role and use in obesity and nervous system disorders, non-essential nutrients as dietary supplements, FOSHU foods.

Extra Reading/Key words: *Conjugated linoleic acid*

UNIT V: **15 HRS**

Introduction to Nutraceutical Industry Organizational elements, regulatory aspects in health Claims, regulations and safety issues- International and national. Regulatory Background – Appearance of Permissive Health Claims on Food Products, Pursuit of Qualified Health Claims for Food Products.

Introduction to Consumer Marketing Issues for Nutraceuticals and Functional Foods. NPD trends and challenges with in the functional food industry, Developing foods for aging consumers.

Regulatory aspects- International and national regulatory aspects of functional foods in India, ICMR guidelines for probiotics.

Extra Reading/Key words: *Nutrigenomics*

Note: Texts given in the Extra reading /Key words must be tested only through assignment and Seminars.

COURSE OUTCOMES

The learners will be able to:

CO No.	Course Outcomes	PSOs Addressed	Cognitive Level
CO-1	Outline the mechanism of action of some phytochemicals, its role in treatment in various diseases such as cancer, cardiovascular diseases and so on.	**PSO 3**	**R**
CO-2	Summarizing the work effectively as a group member on a specific problem related to functional foods and nutraceutical products.	**PSO 1**	**U**
CO-3	Implementing the mechanism of action of microbial origin as nutraceuticals like probiotics.	**PSO 3**	**Ap**
CO-4	Appraising the role of functional foods, in health, disease and immune competence.	**PSO 2**	**An**
CO-5	Analyzing the marketing aspects, claims, safety issues and regulatory aspects of functional food industries.	**PSO 4**	**An**

PSO – Programme Specific Outcomes; CO – Course Outcome; R- Remember; U- Understand; Ap – Apply; An – Analyse; E- Evaluate

TEXT BOOKS:

1. Muredzi P, *Food is medicine- An Introduction to Nutraceutical*, Harare Institute of Technology Harare, Zimbabwe.
2. Wildman, Robert (2006). *Handbook of Nutraceuticals and Functional Foods*, CRC.
3. Webb PP (2006). *Dietary Supplements and Functional Foods*, Blackwell.
4. Ikan, Raphael (2005). *Natural Products A Laboratory Guide*, Edition II, Academic Press Elsevier.
5. Wildman RE (2016). *Handbook of Nutraceuticals and Functional Foods*. CRC Press.
6. Gibson GR, Williams MC (2001). *Functional Foods Concept to Product.* CRC Press.
7. Vattem DA, Maitin (2016). *Functional Foods, Nutraceuticals and Natural Products, Concepts and Applications*, DEStech Publications, Inc.
8. Gupta RC (2016). *Nutraceuticals: Efficacy, Safety and Toxicity*, Academic Press.

SUGGESTED REFERENCE BOOKS

1. Shi, John, Shahidi F, Ho C (2007). *Asian Functional Foods*, CRC/Taylor & Francis.
2. Watson, Ross R (2007). *Functional Foods and Nutraceuticals in Cancer Prevention*, Blackwell Publishing.
3. Gibson GR, Willams CM (2000). *Functional Foods Concept to Product*, Woodhead.
4. Hanson, James R (2003). *Natural Products - the Secondary Metabolites*, Royal Society of Chemistry.
5. Simpson BK (2012). *Food Biochemistry and Food processing*, Edition II. Wiley Blackwell.
6. Malavolta, Mocchegiani (2016). *Molecular basis of nutrition and aging*: Academic Press, Elsevier.

(For the candidates admitted from 2021 onwards)

II M.Sc. BIOTECHNOLOGY – Semester III

Course Title	MAJOR ELECTIVE 3 – FOOD PROCESSING TECHNOLOGY & PHARMACEUTICAL BIOTECHNOLOGY
Total Hours	60
Hours/Week	4
Code	P21BT3MET05
Course Type	Theory
Credits	4
Marks	100

GENERAL OBJECTIVE

It is designed to equip students with a basic knowledge of concepts directly relevant to working in the food processing and biopharmaceutical industry and it deals with the techniques and principles involved in food processing and the importance of pharmaceutical biotechnology.

COURSE OBJECTIVES

To enable the learners:

CO No.	Course Objectives
CO-1	Understand the physical, thermal and mechanical properties of food.
CO-2	Tag the various preparation method of food processing.
CO-3	Articulate the processing and packaging of food materials for the production.
CO-4	Deconstruct and relate to the concept of pharmaceutical biotechnology towards the chemotherapeutic agents.
CO-5	Illustrate the importance of food safety, food quality, food laws and regulations in food industry.

UNIT I: 12 HRS

Introduction on physical, thermal and mechanical properties of food. Effects of processing on the sensory characteristics of foods, texture, taste, flavor, aroma and color, effects of processing on nutritional properties Food safety, good manufacturing practice and quality assurance, HACCP, hurdle technology. Process control- Automatic control, sensors, controllers, computer based system's PLC's, types of control systems- dedicated systems, centralized systems, distributed systems, software developments and its neural networks.

Extra Reading / Key words: *Food safety, good manufacturing practice and quality assurance*

UNIT II: 12 HRS

Raw material preparation, cleaning, wet cleaning, dry cleaning, removing contaminants and foreign bodies, sorting shape and size color sorting, weight sorting grading, peeling. Screening, separation by centrifugation, filtration and membrane concentration, size reduction of solid foods and size reduction of liquid foods emulsification and homogenization. Heat processing using hot air, dehydration, baking and roasting, frying and processing by the removal of heat by chilling, chill storage, freezing and freeze drying.

Extra Reading / Key words: *Programmable logic controllers (PLCs)*

UNIT III: 12 HRS

Coating or enrobing- batters, powders and breadcrumbs**,** chocolate and compound coatings, enrobers, dusting or breading and pan coating. Process of packaging and its materials, filling and sealing materials of containers, materials handling, storage and distribution. Quality Control in India- Introduction to Laws relating to Food Processing Industries in India - FPO, MMPO, PFA, AGMARK, Essential Commodities Act, BIS, Food Standardization and regulatory agencies in India: Central Committee for Food Standards, Central and state food departments, State Food Laboratories / Food and Drug Administration, Bureau of Indian Standards, Food Corporation of India

Extra Reading /Key words: *Army Supply Corps and Central Insecticide Board*

UNIT IV: 12 HRS

Biotechnology in the Pharmaceutical Industry (Pre-biotechnology products, impact of biotechnology, post-biotechnology products: biologics and biopharmaceuticals). Discovery and Development History, drug targeting, Molecular Biology and Combinatorial drug discovery, Rational Drug designing. Clinical Trials Phases of Clinical trials of drugs, Preclinical drug evaluation of its biological activity, potency and toxicity- Toxicity test in animals including acute, sub-acute and chronic toxicity, ED50 and LD50 determination, special toxicity test like teratogenecity and mutagenecity. Biosimilar Technology, Introduction to Indian, International Pharmacopoeia and global regulatory guidelines.

Extra Reading /Key words: *Interferon and Interleukins in therapeutics*

UNIT V: **12 HRS**

Chemotherapeutics Agents Structure, Mechanism of Action and Applications of Antibacterial drug: Sulfonamides, Quinolones. Antiviral drug: Amantadine, Azidothymidine. Antifungal drug: Nystatin, Griseofulvin. Mechanism of action of anticancer drugs, Drugs acting on CNS, Insulin, Blood factor VIII. Dispensing Biotechnology Products- Handling, Professional Education, and Product Information**.** Economic Considerations & Approval - introduction, the value of a new medical technology, pharmacoeconomics and its analysis.

Regulatory Issues and Drug Product Approval for Biopharmaceuticals, biosimilar and follow-on biologics, regulatory routes, equivalence, drug approval, characterization, clinical studies, regulatory framework, immunogenicity, challenge and the future of new drug molecules.

Extra Reading /Keywords: *Stem cell in pharmaceutical biotechnology*

Note: Texts given in the Extra reading /Key words must be tested only through assignment and Seminars.

PRESCRIBED TEXT BOOKS

1. Srivastava RP, Kumar S (2017). *Fruit and Vegetable Preservation: Principles & Practices*, International book distributing Co. Lucknow.
2. Daan JA, Crommelin, Sindelar RD, Meibohm B (2013). *Pharmaceutical Biotechnology: Fundamentals and Applications*, Edition IV.
3. Ramaswamy H, Taylor MM, Francis (2013). *Food Processing: Principles and Applications.*
4. Fellows PJ (2005). *Food Processing Technology: Principle & Practice*, Edition II, CRC.

SUGGESTED REFERENCE BOOKSS

1. Lal G, Siddappa GS, Tondon GL (1990). *Preservation of Fruits and Vegetables* CFTRI, ICAR, New Delhi - 12.
2. Potter NN, Hochkiss (1997). *Food Science*, Edition V. CBS.
3. Potty VH, Mulky MJ (1993). *Food Processing*. Oxford & IBH.

Note: Learners are advised to use latest edition of books.

COURSE OUTCOMES

The learners will be able to:

CO No.	Course Outcomes	PSOs Addressed	Cognitive Level
CO-1	Predict the properties of food and its control systemfor the operation of food processing,	**PSO 3**	**U**
CO-2	Learn about the principles and applications of different food chillers and freezers.	**PSO 1, 3**	**Ap**
CO-3	Appraise the construction and working principle of various material handling systems.	**PSO 1,4**	**Ap**
CO-4	Apply the knowledge gained in formulating new types of products and Understand the regulations followed in various food industries.	**PSO 3**	**An**
CO-5	Execute the knowledge on chemotherapeutic agent toward novel drug development process.	**PSO 2, 4**	**E**

PO – Programme Outcomes, CO – Course Outcome, R- Remember, U- Understand, Ap – Apply, An – Analyse, E- Evaluate

(For the candidates admitted from 2021 onwards)

II M.Sc. BIOTECHNOLOGY – Semester IV

Course Title	EXTRA CREDIT – SELF STUDY PAPER – QUALITY CONTROL IN BIOTECHNOLOGY
Total Hours	---
Hours/Week	---
Code	P21BT4SST03
Course Type	SELF STUDY PAPER
Credits	2
Marks	100

GENERAL OBJECTIVE

This course is intended to prepare candidates for the position of "Quality Control Biologist" in the "Life Sciences" Sector/Industry, and it aims to inculcate key competencies in the learner to survive in biotechnology sectors/industries.

COURSE OBJECTIVES

After completion, the student will be able to

CO No.	Course Objectives
CO-1	Concentrate on Quality Assurance and Quality Control issues for efficient operation in the preparation of biotechnology products.
CO-2	Gain a comprehensive understanding of regulatory compliance and good manufacturing practices.
CO-3	Organize information or documentation related to legal or regulatory matters. Inspect areas for compliance with sanitation standards.
CO-4	Articulate the structure and function of the FDA and its responsibilities in regulating and monitoring regulated products such as biopharmaceuticals, biologics, & medical devices.
CO-5	Apprehend Good Documentation Practices, including associated regulations and enforcement

UNIT I:

Introduction to biotechnology & quality assurance

General Introduction and Applications of Biotechnology; Structure of Biotechnology Industry; Importance and underlying principles of QA/AC; Bio-safety, potency and impurity profile issues for biologic/biopharmaceutical products; setting appropriate and meaningful product specifications and expiration dates; managing manufacturing process changes; identifying current pressures on QA/QC groups;

UNIT II:

Quality management system and practices

Quality systems in companies with voluntary standards; Practical applications for ensuring regulatory compliance under FDA guidelines; FDA and other global regulatory expectations for GMP Quality Systems. Pharmaceutical and Biotechnology company use of the graded approach for GMP regulations for manufacturing, testing, and control of clinical supplies and commercial products.

UNIT III:

Drug approval and regulation of biologics

Drug development process – overview, milestones; Investigational new drug application (IND); New drug application (NDA); Over-The-Counter (OTC) Drug Review Process; Patents and exclusivity; Biologics product categories; Biosimilar – Characteristics, Complexity; Biologic License Application (BLA); Office of compliance & biologics quality activities.

UNIT IV:

Regulation of medical device, food & other products

Medical devices – classification; Institutional Review Boards (IRDs), In Vitro Diagnostics (IVDS); Quality System (QS) regulation – Code of Federal Regulations (CFRs); Food – Safety, Defense, Maintenance, Regulation; Legislative acts that Regulate Food & Agriculture; Regulation, regulatory agencies of Genetic Engineering (GE) crops.

UNIT V:

FDA enforcement, documentation, assessment and evaluation of QC / QA

FDA - Monitoring and Enforcement Activities; Approving validation protocols and reports; setting scientifically defensible specifications; GMP documentation requirements; Document preparation for QC/QA norms of different sectors, Quarantine and release practices; and preparing for regulatory inspections

PRESCRIBED TEXT BOOKS

1. Avis KE (1998). *"Biotechnology-Quality Assurance and Validation".*

2. O'Grady J (2021). *"Quality Assurance and Regulatory Affairs for the Biosciences".* Austin Community College.

SUGGESTED REFERENCE BOOKS:

1. Signore AA, Jacobs T (2005). *Good Design Practices for GMP Pharmaceutical Facilities*. Taylor & Francis Group.

2. Doblhoff-Dier O, Bliem R (1999), *Quality control and assurance from the development to the production of biopharmaceuticals,* Trends in Biotechnology, 266-270.

COURSE OUTCOMES

The learners will be able to:

CO No.	Course Outcomes	PSOs Addressed	Cognitive Level
CO-1	Understand the critical importance and underlying principles for the QA/QC of biologics and biopharmaceuticals.	**PSO 2**	**R**
CO-2	Prepare, preserve and ensure stability of biological samples as per good laboratory practices (GLP) and good manufacturing practices (GMP).	**PSO 1**	**U**
CO-3	Develop a clinical-phase appropriate, cost-effective strategy to effectively manage the quality lifecycle through clinical development into commercialization of diverse biologic/biopharmaceutical manufacturing processes and products	**PSO 2**	**Ap**
CO-4	Appraise the FDA regulation for biotechnological products, and regulate GMOs to bring about food safety.	**PSO 3**	**An**

PSO – Programme Specific Outcomes; CO – Course Outcome; R- Remember; U- Understand; Ap – Apply; An – Analyse; E- Evaluate; C – Create

(For the candidates admitted from 2021 onwards)

II M.Sc. BIOTECHNOLOGY – Semester IV

Course Title	EXTRA CREDIT – SELF STUDY PAPER - INTELLECTUAL PROPERTY RIGHTS
Total Hours	-
Hours/Week	-
Code	P21BT4SST04
Course Type	Theory
Credits	2
Marks	100

GENERAL OBJECTIVE

Students get an idea about the advantages and disadvantages of Biotechnological applications, Ethical implications and intellectual property rights.

COURSE OBJECTIVE (CO):

After completion the student will be able to

CO No.	Course Objectives
CO-1	Outline and explain the distinctive forms of IPR.
CO-2	Categorize and explicate the process of patents, copyrights and the infringement
CO-3	Examine the various principles and procedures involved in obtaining trademarks and designs**.**
CO-4	Review the different concepts involved in patenting biotechnological inventions
CO-5	Infer the diverse protection techniques available for computer related inventions and software patents and copyrights**.**

Unit I:

IPR - History and evolution - Distinction forms of IPR - International background of intellectual property. Enforcement of Intellectual Property Rights - Civil remedies, criminal remedies, border security measures. Practical aspect in licensing intellectual property. Intellectual Property Rights in the Cyber world.

Unit II:

Patents - Objectives, rights, assignments, defenses in case of infringement, basic principles of patent law, patent application procedure, drafting of a patent specification

Copyright - Objectives, rights, procedure for application, transfer of copyright, work of employment infringement, defenses for infringement. Understanding copyright law

Unit III:

Trademarks - Objectives, rights, procedure for application, protection of goodwill, infringement, passing off, defenses. Basic principles of trade mark.

Designs - Objectives, rights, procedure for application, assignments, infringements, defenses of design infringement. Basic principles of design rights.

Unit IV:

IPR in Biotechnology –Patenting biotechnology inventions - Objective, concept of novelty, concept of inventive step, microorganisms, issues in patenting biotechnological inventions. Plant varieties protection in India. Protection of traditional knowledge, bio-prospecting and bio-piracy.

Unit V:

IPR in computer related inventions - Protection for software and computer related inventions – Software patents – copyright for computer software - Protecting trademark and copyright in the social media - Copyright issues in the digital environment.

PRESCRIBED TEXT BOOKS

1. Chandra R (2004), *Issues Of Intellectual Property Rights*, Isha Books.
2. Ganguli P (2001), *Intellectual Property Rights*, Tata Mcgraw Hill.

SUGGESTED REFERENCE BOOKS

1. Subbian A, Bhaskaran S (2007), *Intellectual Property Rights: Heritage, Science And Society Int. Treaties*, Deep & Deep Publications.
2. Singh SS (2004), *Law Of Intellectual Property Rights*, Deep & Deep Publications (p) Ltd.
3. Erbisch FH, Maredia KM (2000), *Intellectual Property Rights In Agricultural Biotechnology*, Universities Press.

COURSE OUTCOMES:

CO No.	Course Outcomes	PSOs Addressed	Cognitive Level
CO-1	Classify and explain the distinctive forms of IPR and their enforcement measures.	PSO 1	R
CO-2	Discuss the basic concept of obtaining Patents and Copyrights and their underlying regulations.	PSO 2	R
CO-3	Explain the basic need and procedures involved in the application of trademarks and designs.	PSO 2	U
CO-4	Outline the basic methodology of patenting biotechnological inventions.	PSO 5	R
CO-5	Discuss the role of IPR in protection of software and computer related inventions.	PSO 4	An
CO-6	Appraise the need for IPR in social media and copyright issue in the digital environment.	PSO 4	U

PO – Programme Outcomes; CO – Course Outcome; R- Remember; U- Understand; Ap – Apply; An – Analyse; E- Evaluate; C – Create