



**PSGR
Krishnammal College for Women**



**PSGR KRISHNAMMAL COLLEGE FOR WOMEN
COIMBATORE-641004
(College of Excellence)
Autonomous and Affiliated to Bharathiar University
(Accredited with 'A+' Grade by NAAC with CGPA 3.71 (IV Cycle)
(Ranked 7th in NIRF 2024)**

**DEPARTMENT OF BIOTECHNOLOGY
CHOICE BASED CREDIT SYSTEM (CBCS) & LEARNING OUTCOMES- BASED
CURRICULAR FRAMEWORK (LOCF)
B.Sc. BIOTECHNOLOGY**

SEMESTER I - VI

2023 – 2026 BATCH

B.Sc BIOTECHNOLOGY

PROGRAMME LEARNING OUTCOME (PLO):

After completion of this programme, the student will be able to

PLO1: Achieve successful technical and professional career which will turn the student into an effective researcher or as an entrepreneur.

PLO2: Acquire sound knowledge in basic sciences and applied sciences and thereby applying the principles in dealing problems in a scientific way.

PLO3: Acquire knowledge in the fields of molecular biology, genome biology, gene engineering, protein engineering, immuno technology, tissue engineering and bioinformatics.

PLO4: Have a life-long learning to follow novel developments in the field which will inspire high ethical values and technical standards.

PLO5: Be equipped to transfer this knowledge to the consumer by applying biotechnological principles in producing a research oriented product.

PROGRAMME SPECIFIC OUTCOME:

At the end of the programme the student will

PSO1: Ability to understand the structure and function of cells.

PSO2: Skill to make biosafe cloning host cells, design new proteins, develops new diagnostic tools, drug discovery through virtual analysis.

PSO3: Acquire skills to higher levels of learning and/or for the development of new products.

PSO4: Initiate new start ups in areas of biotechnology.

PSO5:Comprehend current trends to meet the future challenges in biotech industry.

DEPARTMENT OF BIOTECHNOLOGY-UG
CHOICE BASED CREDIT SYSTEM & OUTCOME BASED EDUCATION
BACHELOR OF SCIENCE (B.Sc.) BIOTECHNOLOGY – 2023-2026 BATCH
SYLLABUS & SCHEME OF EXAMINATION

Applicable to students admitted during the academic year 2023-2026 onwards (I Sem)

SEM	Part	Subject Code	Title of the Paper		Instruction hours/week	Contact hours	Tutorial hours/ semester	Duration of Examination	Examination Marks			Credits
									CA	ESE	TOTAL	
I	I	TAM2301/ HIN2301/ FRE2301	Language Tamil I / Hindi I / French Paper I	Language	6	88	2	3	25	75	100	3
	II	ENG2301	English Paper I	English	6	88	2	3	25	75	100	3
	III A	BT23C01	Core Paper I– Cell and Molecular Developmental Biology	CC	5	73	2	3	25	75	100	4
		BT23CP1	Core Practical I– Lab in Cell and Molecular Developmental Biology and Microbiology	CC	3	45	-	-	-	-	-	-
	III A	BT23A01/ CE23A01/ PS23A01	Allied I–Paper I Biochemistry/ Allied Chemistry For Biologist Paper I/Allied Physics Paper–I	GE	5	73	2	3	20	55	75	4
	IIIA	BT23AP1/ CE23AP1/ PS23AP1	Allied Practical I Lab in Biochemistry and Bioinstrumentation / Allied Chemistry Practical for Biologist / Allied Physics Practical	GE	3	45	-	-	-	-	-	-
	IV	NME23B1/ NME23A1/	Basic Tamil I /Advanced Tamil I/	AEC	2	28	2	-	100	-	100	2
		NME23ES / NME23WS	Introduction to Entrepreneurship / Women Studies		2	30	-	-	100	-	100	

#Allied theory papers with practicals will be evaluated for 25/75 and converted into 20/55 whereas Allied practical's will be evaluated for 25/50 and converted into 15/35

CC–Core Course

GE– Generic Elective

AEC–Ability Enhancing Course

CA– Continuous Assessment

ESE -End Semester Examination

QUESTION PAPER PATTERN

CA Pattern

Section A	:	$3 \times 2 = 6$
Section B	:	$3 \times 5 = 15$ (either or – same CLO Level)
Section C	:	$3 \times 8 = 24$ (either or – same CLO Level)
Total		45

ESE Pattern

Section A	:	$5 \times 2 = 10$
Section B	:	$5 \times 5 = 25$ (either or – same CLO Level)
Section C	:	$5 \times 8 = 40$ (either or – same CLO Level)
Total		75

I Year UG / PG

CIA Test	:	5 Conducted for 45 marks after 50 days
Model Exam	:	7 Conducted for 75 marks after 85 days (Q.P. Pattern (2,5,8) Each Unit 15 Marks)
Semester/Assignment/ Quiz	:	5
Class Participation	:	5
Attendance	:	3

25 + ESE 75 Marks

CIA Question Paper Pattern: 1 x 45 = 45 Marks

One question from each unit with each question comprising of

- Two questions with a weightage of 2 marks (no choice)
- Two questions with a weightage of 5 marks (no choice)
- One question with weightage of 8 marks (Internal Choice at the same CLO level)

Model Question Paper Pattern: 1 x 75 = 75 Marks (Each unit carries 20 marks)

- One question with a weightage of 2 marks (no choice)
- One question with a weightage of 5 marks (Internal Choice at the same CLO level)
- One question with weightage of 8 marks (Internal Choice at the same CLO level)

Internal component for Practicals (for 25 Marks)

Lab Performance	-	7 marks
Regularity	-	5 marks
Model Exam	-	10 marks
Attendance	-	3 marks
Total	-	25 marks

ESE Practicals Pattern

The End Semester Examination will be conducted for a maximum of 75 marks with a maximum 15 marks for the record and other submissions if any.

COURSE NUMBER	COURSE NAME	CATEGORY	L	T	P	CREDIT
BT23C01	Core paper I - Cell and Molecular Developmental Biology	CORE THEORY	73	2	-	4

OBJECTIVE

To facilitate the students to

- Familiarize various aspects of cellular organization and their role in DNA replication, transcription and translation.
- Develop comprehensive understanding on the complete cellular and molecular function of cell organelles in terms of cell to cell interaction, gene regulation, cellular signaling.
- Impart the skills of molecular biology and their applications in various disciplines
- Understand the principles and molecular mechanisms involved in cellular differentiation, morphogenesis, growth and Potency of the cell.

Course Outcomes

On the successful completion of the course, students will be able to

CLO Number	CLO Statement	Knowledge Level
CLO 1	Classify the cells based on their structural and genetic makeup of the organism.	K1
CLO 2	Examining the basic concepts of cell cycle and regulators involved in it.	K2
CLO 3	Implementing the concepts of cell signalling and communication in research fields.	K3
CLO 4	Exploration of the genetic mechanisms involved in studying the cellular activity of an organism.	K4

Mapping with Programme Outcomes

CLOS	PLO1	PLO2	PLO3	PLO4	PLO 5
CLO 1	S	S	S	S	S
CLO 2	S	M	S	M	M
CLO 3	S	S	M	S	S
CLO 4	S	M	S	S	M

S- Strong; M-Medium

CELL AND MOLECULAR DEVELOPMENTAL BIOLOGY

SYLLABUS

UNIT I: Basics of Cells

14 hrs

Cell as a basic unit: discovery of the cells, classification of cell types, development of cell theory, early chemical investigation in cell biology. Prokaryotic and Eukaryotic cell organization. Cytoplasmic compartments of the cell. Structure and Functions of organelles.

UNIT II: Mechanisms of Cell Transport

15 hrs

Chemical composition and fluidity of membranes; dynamic nature of membranes; transportation across cell membrane; membrane potentials; extracellular matrices– structure and function; cytoskeleton– structure and function, Protein Sorting - Protein degradation.

UNIT III: Cell Division, Cell cycle Regulation and Cell Signaling

15 hrs

Eukaryotic cell cycle, Cyclin, CDKs, Check points, Cell cycle inhibitors, DNA content, FACS, Regulation of cell cycle- factors and genes regulating cell cycle. Mitosis and Meiosis; Cell signaling – types of cell signaling - G protein mediated, Tyrosine kinase mediated signaling. Transposable elements-prokaryotes. Apoptosis-Mitochondrial pathway.

UNIT IV: Gene Regulation and Expression

15 hrs

Central Dogma of the cell. DNA-Structure, types, DNA replication in prokaryotes - Transcription in Prokaryotes and Eukaryotes - RNA Processing - Genetic code- Translation - Similarities and differences in prokaryotic and eukaryotic translation - Post Translational Modifications. DNA damage-types of DNA damage and factors affecting, Mutation, types and DNA Repair mechanism-types, Base Excision repair, SOS repair, NHEJ.

UNIT V: Embryology

14 hrs

Gametogenesis - Spermatogenesis and Oogenesis in mammals. Fertilization- Types of cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers in animals- Organogenesis.

TEXT BOOKS

S.No	Authors	Year	Title of the book	Publishers
1.	S C Rastogi	2020	Cell and Molecular Biology	New Age International Private Limited
2.	Sastry KV, Shukla V	2018	Developmental Biology	Rastogi Publications
3.	Thomas D. Pollard, William C.Earnshaw, Jennifer Lippincott-Schwartz, Graham Johnson	2016	Cell Biology	Saunders
4.	Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, and Peter Walter	2014	Molecular Biology of Cell 6th Edition	Garland Science
5.	Harvey Lodish; Arnold Berk; Chris A. Kaiser; Monty Krieger; Anthony Bretscher; Hidde Ploegh; Kelsey C. Martin; Michael Yaffe; Angelika Amon	2021	Molecular Cell Biology Ninth Edition	W H Freeman & Co

REFERENCE BOOKS

S.No	Authors	Year	Title of the book	Publishers
1	Bruce Alberts, Karen Hopkin, Alexander D. Johnson, David Morgan; Martin Raff, Keith Roberts; Peter Walter	2018	Essential Cell Biology 5 th Edition	W.W. Norton & Company
2	D.Freifelder	2015	Freifelders Essentials of Molecular Biology	Jones & Bartlett Publishers
3	Harvey Lodish; Arnold Berk; Chris A. Kaiser; Monty Krieger; Anthony Bretscher; Hidde Ploegh; Kelsey C. Martin; Michael Yaffe; Angelika Amon	2021	Molecular Cell Biology 9 th Edition	Macmillan's Publishers

Course Designer:

Dr. R. Nirmal Kumar

BT23C01 – Cell and Molecular Developmental Biology				
Module No.	Topic	No. of periods	Content delivery methods	CLO'S
UNIT I Basics of Cells				
1	Cell as a basic unit: discovery of the cells, classification of cell types	4	Lecture & Quiz https://www.youtube.com/watch?v=qM0--Or2ONs	CLO1
2	Development of cell theory, early chemical investigation in cell biology	3	Lecture & discussion https://www.youtube.com/watch?v=4OpBylwH9DU	CLO1, CLO2
3	Prokaryotic and Eukaryotic cell organization	3	Presentation & group discussion https://www.youtube.com/watch?v=URUJD5NEXC8	CLO1, CLO2
4	Cytoplasmic compartments of the cell. Structure and Functions of organelles	4	Lecture and role play	CLO1, CLO2, CLO3
UNIT II Mechanisms of Cell Transport				
5	Chemical composition and fluidity of membranes; dynamic nature of membranes	4	Lecture https://www.youtube.com/watch?v=qBCVVszQQNs	CLO1, CLO2
6	Transportation across cell membrane; membrane potentials	4	Lecture https://www.youtube.com/watch?v=Ptmlvtei8hw	CLO1, CLO2, CLO3
7	extracellular matrices– structure and function; cytoskeleton– structure and function	4	Lecture and quiz https://www.youtube.com/watch?v=M2LaNJbh-M4	CLO1, CLO2, CLO3
8	Protein Sorting - Protein degradation	3	Lecture and science simulation https://www.youtube.com/watch?v=PIRZtrSSiwY	CLO1, CLO2, CLO3
UNIT III Cell Division, Cell cycle Regulation and Cell Signaling				
9	Eukaryotic cell cycle, Cyclin, CDKs, Check points, Cell cycle inhibitors, DNA content, FACS,	3	Group Seminar	CLO2, CLO3
10	Regulation of cell cycle- factors and genes regulating cell cycle. Mitosis and Meiosis	4	Lecture & discussion https://www.youtube.com/watch?v=hSTeawTvoIU	CLO2, CLO3
11	Cell signaling – types of cell signaling - G protein mediated, Tyrosine kinase mediated signalling	4	Presentation & quiz https://www.youtube.com/watch?v=-dbRterutHY	CLO2, CLO3
12	Transposable elements-prokaryotes. Apoptosis-Mitochondrial pathway	4	Group seminar and discussion https://www.youtube.com/watch?v=VLRksFGhboo	CLO2, CLO3
UNIT IV Gene Regulation and Expression				
13	Central Dogma of the cell. DNA-Structure, types, DNA replication in prokaryotes	4	Video Lecture & quiz https://www.youtube.com/watch?v=whV_CkKT7F0	CLO4
14	Transcription in Prokaryotes and Eukaryotes - RNA Processing - Genetic code	3	Presentation and discussion https://www.youtube.com/watch?v=Nk_qSZcXpJE	CLO4
15	Translation - Similarities and differences in prokaryotic and eukaryotic translation - Post	4	Assignment and group discussion https://www.youtube.com/watch?v=7EPP3_WL-HM	CLO4

	Translational Modifications			
16	DNA damage-types of DNA damage and factors affecting, Mutation, types and DNA Repair mechanism-types, Base Excision repair, SOS repair, NHEJ	4	Lecture and presentation https://www.youtube.com/watch?v=sX6LncNjTFU	CLO4
UNIT V Embryology				
17	Gametogenesis - Spermatogenesis and Oogenesis in mammals	4	Flipped classroom	CLO3, CLO4
18	Fertilization- Types of cleavage	3	Lecture & discussion https://www.youtube.com/watch?v=vIJUT7mkKOU	CLO3, CLO4
19	blastula formation, embryonic fields	3	Lecture & video lecture https://www.youtube.com/watch?v=v9swHCSWVik	CLO3, CLO4
20	gastrulation and formation of germ layers in animals- Organogenesis.	3	Lecture & quiz https://www.youtube.com/watch?v=t-86dB3JkBw	CLO3, CLO4

COURSE NUMBER	COURSE NAME	CATEGORY	L	T	P	CREDIT
BT23CP1	Core Practical I (Lab in Cell and Molecular Developmental Biology & Microbiology)	CORE PRACTICALS	-	-	90	4

Objectives

- To develop the knowledge on different microbiological techniques and isolate microorganisms from the various sources and to establish pure cultures
- To isolate and differentiate different cell organelles and utilize staining techniques to visualize them
- To understand the molecular techniques in separating the genetic material from the organism
- To identify the components of blood cells and summarizes the concept of gametes.

Course Outcomes

On the successful completion of the course, students will be able to

CLO Number	CLO Statement	Knowledge Level
CLO1	Understand and identify techniques in isolating different microorganisms.	K1
CLO2	Acquire the skills in interpreting the specimens and inferring the results.	K2
CLO3	Demonstrate basic molecular techniques in isolating the genetic material from both prokaryotic and eukaryotic organisms	K3
CLO4	Will be capable of determining the components of blood cells and determine the concept of gametes	K3

Mapping with Programme Outcomes

CLOs	PLO1	PLO2	PLO3	PLO4	PLO 5
CLO1	S	S	M	M	S
CLO2	S	M	S	S	M
CLO3	S	S	M	M	S
CLO4	S	M	S	S	M

S- Strong; M-Medium

Lab in Cell and Molecular Developmental Biology (Semester I Practicals)

Syllabus

45 hrs

1. Use of simple compound microscope and Micrometry
2. Blood smear preparation and Identification of Blood cells
3. Plant cell sectioning- Dicot and monocot sections of stem and root - TS and CS
4. Preparations of onion peel and observations of cells
5. Osmosis and tonicity
6. Subcellular fractionation of Chloroplast
7. Isolation of Genomic DNA
8. Quantification of DNA
9. Observation of sperm & Egg
10. Mounting of chick Embryo - 24 hrs, 48 hrs, 72 hrs, 96 hrs.

Lab in Microbiology (Semester II Practicals)

Syllabus

45 hrs

1. Microbiological techniques–Sterilization techniques, Media preparation
2. Isolation and enumeration of microbes (bacteria & fungi) from soil.
3. Pure culture methods-pour plate, spread plate, streak plate method
4. Identification of Bacteria: Staining methods–simple, Grams, Capsule (Negative) and Spore Staining
5. Motility test: Hanging drop technique.
6. Biochemical Identification–IMViC–test, Oxidase and Catalase and TSI test
7. Hydrolysis test-Starch, Casein and Lipids
8. Growth curve of bacteria.
9. Anti-microbial sensitivity test–Disk diffusion test.
10. Fungal identification: lactophenol cotton blue staining and KOH mounding (morphology)

TEXT BOOKS

S.No	Authors	Title of the Book	Publishers	Year of Publication
1	Cappuccino, J. G., & Welsh, C.	Current Protocols in Cell Biology	Wiley Publication. 1 st Edition	2019
2	R. Saravanan , D. Dhachinamoorthi , CH. M M. Prasada Rao	A Handbook of Practical Microbiology	LAP LAMBERT Academic Publishing. 1 st Edition	2019
3	Collins, C. H., Lyne, P. M., Grange, J. M., & Falkinham III, J.	Collins and Lyne' s Microbiological Methods	Arnolds. 8 th Edition	2010
4	Cappuccino, J. G., & Welsh, C.	Microbiology: A Laboratory Manual.	Benjamin-Cummings Publishing Company	2004

Course Designer:

Dr.R.Nirmal Kumar

Dr.G.Anbarasi

COURSE NUMBER	COURSE NAME	CATEGORY	L	T	P	CREDIT
BT23A01	ALLIED PAPER I- BIOCHEMISTRY	ALLIED THEORY	73	2	-	4

Objectives

To facilitate the students to

- To understand the structure of simple sugars
- To elucidate the role played by different Biomolecules
- To analyze the structure of different sugars, lipids, amino acids and proteins.
- To analyze the various pathways involved in sugar utilization

Course Outcome

On the successful completion of the course, students will be able to

CLO Number	CLO Statement	Knowledge Level
CLO 1	Classify the biomolecules based on structure and function	K1
CLO 2	Comprehend the basics of enzymes and their role in different metabolic processes.	K2
CLO 3	Acquire knowledge about the Importance of lipids and their biosynthesis	K3
CLO 4	Analyze the significance of metabolic pathways and their role in cellular function	K3

Mapping with Programme Outcomes

CLOs	PLO1	PLO2	PLO3	PLO4	PLO 5
CLO 1	S	S	M	S	S
CLO 2	S	M	S	M	M
CLO 3	S	S	M	S	S
CLO 4	S	M	S	M	S

S- Strong; M-Medium

BIOCHEMISTRY

SYLLABUS

UNIT I: Structure and Function of Carbohydrates

15 hrs

Carbohydrates: Definition, classification, structure and biological functions of mono, di, oligo and polysaccharides (starch, glycogen, cellulose, dextrin, hyaluronic acid, keratin sulphate, heparin and chondroitin sulphate).

UNIT II: Enzymes

14 hrs

Enzymes – properties, classes of enzymes, enzyme reaction, theories of enzyme reaction, MM equation, LB plot, factors affecting enzyme reaction, enzyme units, enzyme assay, coenzyme, apo- and holo-enzymes. Co-factors, and prosthetic group, Isoenzymes. Enzyme inhibition-Reversible (competitive, uncompetitive, non-competitive) and irreversible inhibition. Mechanism based inhibitors.

UNIT III: Lipids

15 hrs

Biological significance, nomenclature and classification. Simple lipids; Fatty acids and their properties, triglycerides, waxes, steroids and prostaglandins. Compound lipids: Phospholipids, sphingolipids and glycolipids. Lipoproteins. β -oxidation of lipids, Biosynthesis of saturated fatty acids.

UNIT IV: Vitamins & Proteins

15 hrs

Vitamins – water soluble and fat soluble, importance of vitamins in life. Amino acids: structure, classification, physical and chemical properties. Proteins: Biological importance, classification, general properties. Primary structure- Human Insulin, Secondary structure - keratin tertiary structure- myoglobin and quaternary structure- Hemoglobin.

UNIT V: Metabolism of Biomolecules

14 hrs

Metabolism: Catabolism & Anabolism. Energy metabolic pathways – Glycolysis, Krebs's cycle, Oxidative phosphorylation. Substrate level phosphorylation, Gluconeogenesis, pentose phosphate pathway.

TEXT BOOKS

S.No	Authors	Year	Title of the book	Publishers
1	Nelson,D.L.and Cox,.M. Lehninger	2021	Principles of Biochemistry 8 th Edition	Macmillan Higher Education
2	U. Satyanarayana, U.Chakrapani	2021	Biochemistry, Sixth edition	Elsevier
3.	A.C. Deb	2001	Fundamentals of Biochemistry	New central book agency
4	Donald Voet, Charlotte W. Pratt, Judith G. Voet	2012	Principles of Biochemistry	Wiley; 4th Edition International Student Version
5	Jain, J.L, Sunjay Jain and Nitin Jain	2010	Biochemistry	Chand and Company, New Delhi

REFERENCE BOOKS

S.No	Authors	Year	Title of the book	Publishers
1	Victor Rodwell , David Bender , Kathleen Botham, Peter Kennelly, P.	2018	Harper's Biochemistry 1 st edition	McGraw Hill
2	Jeremy M.Berg, John L.Tymoczko and Lubertstryer	2002	Biochemistry	W H Freeman & Co. , Objectives

Course Designer:

Dr. V. Bhuvaneshwari

BT23A01– Allied paper I-Biochemistry				
Module No.	Topic	No. of periods	Content delivery methods	CLO'S
UNIT I - Structure and Function of Carbohydrates				
1	Carbohydrates: Definition, classification,	3	Lecture	CLO1
2	structure and biological functions of mono, di, oligo and polysaccharides	4	Discussion & Quiz https://create.kahoot.it/	CLO1, CLO2
3	(starch, glycogen, cellulose, dextrin, hyaluronic acid	4	Lecture	CLO1, CLO2
4	keratin sulphate, heparin and chondroitin sulphate).	4	https://youtu.be/aB6glWhgTcY Video Lecture and Assignment	CLO1, CLO2, CLO3
UNIT II- Enzymes				
5	Enzymes – properties, classes of enzymes, enzyme reaction, theories of enzyme reaction	3	Lecture & Quiz https://create.kahoot.it/	CLO1, CLO2
6	MM equation, LB plot, factors affecting enzyme reaction, enzyme units, enzyme assay,	3	Lecture	CLO2, CLO3
7	coenzyme, apo- and holo-enzymes. Co-factors, and prosthetic group, Isoenzymes	4	Seminar https://youtu.be/EzuKxqojS0Q	CLO2, CLO3, CLO4
8	Enzyme inhibition-Reversible (competitive, uncompetitive, non-competitive) and irreversible inhibition. Mechanism based inhibitors.	4	Demonstration https://youtu.be/afvo3OaTiyU	CLO2, CLO3, CLO4
UNIT III- Lipids				
9	Biological significance, nomenclature and classification. Simple lipids; Fatty acids and their properties,	3	Group Seminar- Flipped classroom	CLO2, CLO3, CLO4
10	triglycerides, waxes, steroids and prostaglandins.	4	Lecture and assessment (Quizalize)	CLO2, CLO3, CLO4
11	Compound lipids: Phospholipids, sphingolipids and glycolipids.	4	Lecture	
12	Lipoproteins. β -oxidation of lipids, Biosynthesis of saturated fatty acids.	4	Demonstration https://youtu.be/ppqpUVAasNc	CLO2, CLO3, CLO4
UNIT IV- Vitamins& Proteins				
13	Vitamins – water soluble and fat soluble, importance of vitamins in life.	4	Lecture-Videos ,PPT https://youtu.be/0hTnUEAXefQ	CLO2, CLO3, CLO4
14	Amino acids: structure, classification, physical and chemical properties.	4	Interaction on topics and Assignment https://youtu.be/rUlt8Xws_3Q	CLO2, CLO3, CLO4

15	Proteins: Biological importance, classification, general properties.	3	Flipped Classroom https://youtu.be/Q88TAt350iE	CLO2, CLO3, CLO4,
16	Primary structure- Human Insulin, Secondary structure - keratin tertiary structure- myoglobin and quaternary structure- Hemoglobin	4	Discussion and Seminar	CLO2, CLO3, CLO4
UNIT V- Metabolism of Biomolecules				
17	Metabolism: Catabolism & Anabolism.	4	Video Lecture and Discussion https://youtu.be/HrYRMknYHrk	CLO3, CLO4
18	Energy metabolic pathways – Glycolysis	4	https://youtu.be/8qij1m7XUhk Seminar and quiz	CLO3, CLO4
19	Kreb's cycle, Oxidative phosphorylation	3	Lecture and assessment (Quizalize)	CLO3, CLO4
20	Substrate level phosphorylation, Gluconeogenesis, pentose phosphate pathway	3	Lecture and assessment (Kahoot)	CLO3, CLO4

COURSE NUMBER	COURSE NAME	CATEGORY	L	T	P	CREDIT
BT23AP1	ALLIED PRACTICAL-I (LAB IN BIOCHEMISTRY AND BIOINSTRUMENTATION)	ALLIED PRACTICALS	-	-	90	2

Objectives

- To facilitate the students to evaluate the methods of biomolecule estimations, separation techniques and biochemical analysis
- To enable the students to Learn to make standard solutions
- Gain knowledge in usage of separation techniques
- Apply the knowledge of understanding volumetric, colorimetric and spectrophotometric analysis

Course Outcomes

On the successful completion of the course, students will be able to

CLO Number	CLO Statement	Knowledge Level
CLO1	Remember and differentiate the different techniques employed in estimating biomolecules	K1
CLO2	Categorizing the method to quantify proteins and sugars	K2
CLO3	Examining the enzymatic assays and their calculations	K3
CLO4	Comprehend the basics of chromatography techniques	K4

Mapping with Programme Outcomes

CLOs	PLO1	PLO2	PLO3	PLO4	PLO 5
CLO1	S	S	M	M	M
CLO2	S	S	M	M	S
CLO3	S	S	M	S	S
CLO4	S	M	S	M	M

S- Strong; M-Medium

SYLLABUS**45 Hrs**

1. Preparation and standardization of solutions
2. Qualitative Analysis of Carbohydrates – Glucose, Fructose, Sucrose, Starch
3. Qualitative Analysis of Amino acid – Glycine, Tyrosine, Cysteine, Tryptophan, Proline, glutamic acid
4. Estimation of proteins-Bradford's method
5. Estimation of total free amino acids – Ninhydrin Method
6. Estimation of Glucose (Dinitrosalicylic acid method)
7. Quantification of Vitamin C
8. Analysis of Oils - Acid Number

LAB IN BIOINSTRUMENTATION**(Semester II Practicals)****SYLLABUS****45 hrs**

1. Laboratory rules and regulations – Safety principles and Handling
2. pH measurement of samples using pH meter
3. Preparation of buffer-Phosphate Buffer
4. Centrifugation-Separation of organelles using Centrifugation
5. Paper Chromatography- Separation of plant pigments
6. Spectrophotometric method-Estimation of chlorophyll content
7. Thin Layer Chromatography for separation of amino acids
8. Analysis of Heavy metals from drinking water through AAS (demo)

TEXT BOOKS

S.No	Authors	Title of the Book	Publishers	Year of Publication
1	Sadasivam, S. and Manickam, A.	Biochemical methods	New Age International Publishers. 3 rd Edition	2018
2	Pingoud, A and Urbanke, C.	Biochemical Methods: A Concise Guide for Students and Researchers	Wiley-VCH. 1 st Edition	2010
3	Veerakumari, L	Bioinstrumentation	MJP Publishers, New Delhi, India	2009

Course Designers:

Dr. R. Nirmal Kumar

Dr. V. Bhuvaneshwari

DEPARTMENT OF BIOTECHNOLOGY-UG
CHOICE BASED CREDIT SYSTEM & OUTCOME BASED EDUCATION
BACHELOR OF SCIENCE (B.Sc.) – 2023-2026 BATCH
SYLLABUS & SCHEME OF EXAMINATION

Applicable to students admitted during the academic year 2023-2024 onwards (II Sem)

SEM	Part	Subject Code	Title of the Paper		Instruction hours/week	Contact hours	Tutorial	Duration of Examination	Examination Marks			Credits
									CA	ESE	TOTAL	
II	I	TAM2302/ HIN2302/ FRE2302	Language Tamil II/ Hindi II/ French II	Language	6	88	2	3	25	75	100	3
	II	ENG2302	English paper II	English	5	88	2	3	25	75	100	3
	III A	BT23C02	Core Paper II – Microbiology	CC	5	73	2	3	25	75	100	4
		BT23CP1	Core Practical I- (Lab in Cell and Molecular Developmental Biology and Microbiology)	CC	4	60	-	3	25	75	100	4
	III A	BT23A02/ CE23A02/ PS23A02	Allied Paper II- Bioinstrumentation/ Allied Chemistry for Biologist Paper- II/ Allied Physics Paper-II	GE	5	73	2	3	20	55	75 [#]	4
		BT23AP1/ CE23AP1/ PS23AP1	Allied Practical I Lab in Biochemistry & Bioinstrumentation / Allied Chemistry Practical for Biologists Allied Physics practical	GE	3	45	-	3	15	35	50 [#]	2
	IV	23PELS1	Professional English for Life Sciences	AEC	2	25	5	-	100	-	100	2
		NME23B2/ NME23A2	Basic Tamil II / Advanced Tamil II**	AEC	2	-	-	-	100	-	100	Grade
			Online course (Self-study)						-	-	-	-
		NM23GAW	Foundation Course I (General Awareness)	AEC	Self-Study Online				100	-	100	Grade

CC – Core Courses

CA – Continuous Assessment

GE – Generic Elective

AEC – Ability Enhancing Course

ESE - End Semester Examination

#Allied theory papers with practicals will be evaluated for 25/75 and converted into 20/55 whereas Allied practical's will be evaluated for 25/75 and converted into 15/35

**** - Outside Regular class hours**

QUESTION PAPER PATTERN

CIA Question Paper Pattern: Conducted for 45 Marks

One question from each unit with each question comprising of

Section A	–	3 x 2 = 6
Section B	–	3 x 5 = 15 (either or – same CLO Level)
Section C	–	3 x 8 = 24 (either or – same CLO Level)
Total		45

Model Question Paper Pattern: Conducted for 75 marks

(Q.P. Pattern (2,5,8) Each Unit 15 Marks)

Section A	–	5 x 2 = 10
Section B	–	5 x 5 = 25 (either or – same CLO Level)
Section C	–	5 x 8 = 40 (either or – same CLO Level)
Total		75

ESE Pattern

Section A	: 5 x 2 = 10
Section B	: 5 x 5 = 25 (either or – same CLO Level)
Section C	: 5 x 8 = 40 (either or – same CLO Level)
Total	75

Internal component for Theory

CIA Test	-	5	Conducted for 45 marks after 50 days
Model Exam	-	7	Conducted for 75 marks (Q.P. Pattern (2,5,8) Each Unit 15 Marks)
Seminar/Assignment/Quiz	-	5	
Class Participation	-	5	
Attendance	-	3	
25			+ ESE 75 Marks = 100 Marks

Internal component for Practicals (for 25 Marks)

Lab Performance	- 7 marks
Regularity	- 5 marks
Model Exam	- 10 marks
Attendance	- 3 marks
Total	- 25 marks

ESE Practicals Pattern

The End Semester Examination will be conducted for a maximum of 75 marks with a maximum 15 marks for the record and other submissions if any.

COURSE NUMBER	COURSE NAME	CATEGORY	L	T	P	CREDIT
BT23C02	Core Paper II- Microbiology	CORE THEORY	73	2	-	4

Learning Objectives

To facilitate the students

- To study the structure and function of microbial cells
- To enumerate different types of microbes
- To analyze the physiology of microbes
- To evaluate microbial growth
- To evaluate the use of microbes in different industries

Course Outcomes

On the successful completion of the course, students will be able to

CLO Number	CLO Statement	Knowledge Level
CLO 1	Acquire knowledge about the discovery of microbes and techniques utilized for their discovery	K1
CLO 2	Understand and gain knowledge about different types of Microorganism and their nutritive requirements for their growth	K2
CLO 3	Comprehend the ideology to culture and enumerate the microorganisms and its association with nature	K2
CLO 4	Inculcate knowledge on Industrial microbiology for digital transformation	K2

Mapping with Programme Outcomes

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5
CLO 1	S	M	S	S	M
CLO 2	S	M	L	M	M
CLO 3	M	L	M	L	M
CLO 4	S	M	L	M	M

S- Strong; M-Medium; L-Low

SYLLABUS

UNIT I: Introduction to Microscopy

14 h

Historical developments in microbiology, Definition and scope of microbiology, Microscopy: Light Microscope: Simple; Compound Microscopes–Dark field, light field, phase contrast, Fluorescent Microscopes, Electron microscope and Confocal Microscope.

UNIT II: Media and Culture Techniques

14 h

Microbiological Media: Types, preparation, methods of sterilization; enumeration of microorganisms in soil, water and air; isolation of microorganisms from environment; pure culture techniques, maintenance and Preservation; Staining: stains and types of staining-Lactophenol Cotton Blue Staining, Calcoflour staining, Leishmann Staining, Gram staining, Capsule staining.

UNIT III: Microbial nutrition, growth and control

15 h

Structure of bacterial cell, Growth and reproduction of bacteria. Nutrients, nutritional types of microorganisms, Autotrophic microbes, Chemotrophic microbes, Photosynthetic microbes, aerobic microbes, anaerobic microbes, Bacterial Growth, Measurement –Direct and Indirect. Bacterial growth-bacterial growth curve asynchronous growth, synchronous growth, limitation of microbial growth, Fermentative microbes.

UNIT IV: Biology and Economic importance of Microbes

15 h

Biology and economic importance of **Soil borne bacteria-** *Rhizobium* sp, *Azospirillum*. **Algae:** *Spirulina*, *Cyanobacteria* Food borne- *Staphylococcus aureus*, *Clostridium* sp, *Escherichia coli*, *Pseudomonas* sp. **Fungal Species:** *Aspergillus* sp, *Candida* sp, *Fusarium* sp, *Pleurotus* sp Plant viruses: NPV. Mammalian viruses: SARS-CoV-2 virus (COVID-19).

UNIT V: Industrial Microbiology

15 h

Introduction to microbes-based enzyme production; Enzymes used in detergents, textile and leather industries. Production of amylase and protease. Impact on Society, Business, Government and People - Introduction to 5.0. Development of microbial sensors for environmental monitoring and biomedical applications. Microalgae based technologies for waste water treatment.

TEXT BOOKS

S.No	Authors	Year	Title of the book	Publishers
1.	Michael J. Pelczar.Jr, E.C.S Chan, Noel R.Krieg	2020	Pelczar Microbiology 7th Edition	McGraw Hill
2.	Madigan Michael T. Martinko John M. Bender Kelly S.Buckley Daniel H. Stahl DavidA.	2017	Brock's Biology of Microorganisms 14th ed	Pearson
3.	Joanne Willey and Kathleen Sandman and Dorothy Wood	2020	Prescott's Microbiology, 11 th Edition	McGraw Hill
4.	Simon Baker, Jane Nicklin, Caroline Griffiths	2011	BIOS Instant Notes in Microbiology	Taylor & Francis
5.	P. Kaliraj and T. Devi. Higher Education for Industry 4.0 and Transformation to Education 5.0			

REFERENCE BOOKS

S.No	Authors	Year	Title of the book	Publishers
1.	M.T.Madigan,J.M.Martinko ,J.Parker.	2002	Brock's Biology of Microorganisms 10 thed	Prentice Hall
2.	Moat Albert. G, Foster. John.W, Speetor, Michel P	2002	Microbial Physiology 4 th ed	Wiley Liss Publishers.
3.	Das,H.K.	2004	TextBook of Biotechnology	Wiley Dreamtech India Pvt. Ltd

Course Content Prepared by:

Dr. G. Anbarasi

Dr. G. Archana

COURSE NUMBER	COURSE NAME	CATEGORY	L	T	P	CREDIT
BT23A02	Allied paper II – Bioinstrumentation	ALLIED THEORY	73	2	-	4

Learning Objectives

To facilitate the students to

- Acquire knowledge on design and application of instruments in biological field
- Become familiar with separation and purification techniques

Course Outcomes

On the successful completion of the course, students will be able to

CLO Number	CLO Statement	Knowledge Level
CLO1	Discuss the principle and methodology of various instruments and their process	K1
CLO2	Understand the applications in various fields of bioscience	K2
CLO3	Demonstrate knowledge and practical skills using instruments in biology and medical field	K3
CLO4	Analyze and interpret the techniques and results involved in research	K3

Mapping with Programme Outcomes

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	S	S	L	M	S
CLO2	M	S	M	L	S
CLO3	S	M	M	M	M
CLO4	M	M	S	L	S

S- Strong; M-Medium; L-Low

Syllabus

UNIT I: Laboratory techniques

14 h

Biosafety in laboratories: - General safety measures, Chemical and Biological hazards. Theory, Principle, Working and Applications of - pH meter, Weighing balance Centrifuge- Preparative, Analytical and Ultra, Laminar Air Flow, Autoclave, Hot Air Oven and Incubator. Buffers for biological experiments.

UNIT II: Chromatography Techniques

15 h

Theory, Principle, Apparatus, Methods and Applications of Paper Chromatography, TLC, HPTLC, Gel Filtration Chromatography, Ion Exchange Chromatography, Affinity Chromatography, Gas Chromatography and HPLC.

UNIT III: Electrophoretic techniques

14h

Theory, Principle, Apparatus, Methods and Applications of Paper Electrophoresis, Agarose Gel electrophoresis, PAGE-Native and SDS. Blotting- Principles, types, Steps involved Southern, Western and Northern Blotting.

UNIT IV: Colorimetric analysis and Spectroscopy

15 h

Colorimetric Analysis: Lambert's law, Beer's law, basic principles and working of Colorimeter. Principle, working, instrumentation and applications of UV/Vis spectroscopy, IR spectroscopy, Atomic Absorption Spectroscopy, NMR spectroscopy and Mass spectroscopy.

UNIT V: Radio-isotopic TechniquesImage analysis

15 h

Introduction, basic principles, types, procedure and applications of Geiger Muller Counter; Scintillation counting - solid, liquid, gas; Gamma counter and Image analysis.

TEXT BOOKS:

S.No	Authors	Year	Title of the book	Publishers
1.	MJ Reilly	2018	Bioinstrumentation	CBS Publishers & Distributors
2.	Dr. Priyanka Pandey	2023	Text Book on Bioinstrumentation	Walnut Publication
4	Rana, S.V.S	2012	Bio Techniques. Theory and Practices	Rastogi Publications, Meerut

REFERENCE BOOKS:

S.No	Authors	Year	Title of the book	Publishers
1.	RS Khandpur Sabari	2015	Handbook Of Analytical Instruments	McGraw Hill
2.	Dinesh Kumar Chatanta, Prahlad Singh Mehra	2012	Instrumental Methods of Analysis in Biotechnology	I K International Publishing House Pvt. Ltd; First Edition

Course Content Prepared by:**Dr. R. Nirmal Kumar****Dr. G. Shalini**

COURSE NUMBER	COURSE NAME	CATEGORY	L	T	P	CREDIT
BT23CP1	Core Practical I (Lab in Cell and Molecular Developmental Biology & Microbiology)	CORE PRACTICAL	-	-	105	4

Learning Objectives

To facilitate the students

- To develop the knowledge on different microbiological techniques and isolate microorganisms from the various sources and to establish pure cultures.
- To isolate and differentiate different cell organelles and utilize staining techniques to visualize them.
- To understand the molecular techniques in separating the genetic material from the organism.
- To identify the components of blood cells and summarize the concept of gametes.

Course Outcomes

On the successful completion of the course, students will be able to

CLO Number	CLO Statement	Knowledge Level
CLO1	Understand and identify techniques in isolating different microorganisms.	K1
CLO2	Acquire the skills in interpreting the specimens and inferring the results.	K2
CLO3	Demonstrate basic molecular techniques in isolating the genetic material from both prokaryotic and eukaryotic organisms	K3
CLO4	Will be capable of determining the components of blood cells and determine the concept of gametes	K3

Mapping with Programme Outcomes

CLOs	PLO1	PLO2	PLO3	PLO4	PLO 5
CLO1	M	S	M	S	M
CLO2	M	M	L	M	M
CLO3	M	L	S	M	L
CLO4	M	M	L	L	M

S- Strong; M-Medium; L-Low

Syllabus**45 h****Cell and Molecular Developmental Biology****(Semester I Practicals)**

1. Use of simple compound microscope and Micrometry
2. Blood smear preparation and Identification of Blood cells
3. Isolation and Identification of plant cells—parenchyma, collenchymas, sclerenchyma, epithelium
4. Cell fractionation and Identification of cell organelles (Demo)
5. Permanent slide preparation
6. Osmosis and tonicity
7. Cell division –Mitotic stages –Preparation of Onion Root Tip
8. Cell division –Meiotic stages –Preparation of *Tradescantia* Flower bud
9. Isolation and Quantification of Genomic DNA
10. Observation of sperm & Egg
11. Mounting of chick Embryo - 24 h, 48 h, 72 h, 96 h.

Syllabus**60 h****Microbiology****(Semester II Practicals)**

1. Sterilization techniques - media preparation for microbes.
2. Enumeration of bacteria & fungi in soil / water.
3. Pure culture techniques - pour plate, spread plate & streak plate methods.
4. Staining of microbes: Bacteria: simple staining, Gram's staining, capsular staining.
Fungi: Lactophenol-cotton blue staining
5. Basic tests for identification of bacteria:
 - a) Motility test - hanging drop
 - b) Biochemical tests: IMViC test, oxidase, catalase and TSI tests.
6. Replica plating in Bacteria:
 - a) Testing antibiotic sensitivity and
 - b) Testing for extracellular enzyme production.
7. Studying the growth of bacteria.
8. MBRT test for Milk quality analysis

TEXT BOOKS:

S.No	Authors	Year	Title of the book	Publishers
1.	A K Roy & M.M.Prasad	2010	Laboratory Manual of Microbiology: Practical Manual Series: 05	New India Publishing Agency
2.	Cappuccino	2014	Microbiology: A Laboratory Manual	Pearson Education India

REFERENCE BOOKS:

S.No	Authors	Year	Title of the book	Publishers
1.	Dr.H.Abdul Jaffer Ali	2017	Microbiology Laboratory Manual	Vijay Nicole Imprints
2.	Chaitanya K. V.	2013	Cell and Molecular Biology - A Lab Manual	PHI Learning

Course Content Prepared by:**Dr.R.Nirmal Kumar****Dr.G.Archana****Dr.V.Bhuvaneshwari**

COURSE NUMBER	COURSE NAME	CATEGORY	L	T	P	CREDIT
BT23AP1	Allied Practical-I (Lab in Biochemistry and Bioinstrumentation)	ALLIED PRACTICALS	-	-	90	2

Learning Objectives

- To enable the students to learn to make standard solutions
- To evaluate the methods of biomolecule estimations and biochemical analysis
- To gain knowledge in usage of separation techniques
- To facilitate the students to apply the knowledge of understanding volumetric, colorimetric and spectrophotometric analysis

Course Outcomes

On the successful completion of the course, students will be able to

CLO Number	CLO Statement	Knowledge Level
CLO1	Remember and differentiate the different techniques employed in estimating Biomolecules	K1
CLO2	Categorizing the method to quantify proteins and sugars	K2
CLO3	Examining the enzymatic assays and their calculations	K3
CLO4	Comprehend the basics of chromatography techniques	K4

Mapping with Programme Outcomes

CLOs	PLO1	PLO2	PLO3	PLO4	PLO 5
CLO1	S	S	M	M	M
CLO2	S	S	M	M	S
CLO3	S	S	M	S	S
CLO4	S	M	S	M	M

S- Strong; M-Medium; L-Low

Syllabus
Lab in Biochemistry (Semester I Practical)

45 h

1. Preparation of standard solutions
2. Qualitative Analysis of Carbohydrates – Glucose, Fructose, Sucrose, Starch
3. Qualitative Analysis of Amino acid – glycine, Tyrosine, Cysteine, Tryptophan, Proline, glutamic acid
4. Estimation of proteins-Bradford's method
5. Estimation of total free amino acids – Ninhydrin Method
6. Estimation of Glucose (Dinitrosalicylic acid method)
7. Estimation of Cholesterol- Zak's method
8. Quantification of Vitamin C
9. Analysis of Oils - Acid Number

Lab in Instrumentation and Analysis (Semester II Practical)

Syllabus

45 h

1. Laboratory rules and regulations –Safety principles and Handling
2. pH measurement of samples using pH meter
3. Preparation of buffer-Phosphate Buffer
4. Centrifugation-Separation of organelles using Centrifugation
5. Paper Chromatography- Separation of plant pigments
6. Spectrophotometric method -Estimation of chlorophyll content
7. Thin Layer Chromatography for separation of amino acids
8. Analysis of Heavy metals from drinking water through AAS (demo)

TEXT BOOKS:

S.No	Authors	Year	Title of the book	Publishers
1.	Geethalakshmi Sundararama, Anitha Arumugam	2017	Lab in Cell Biology, Microbiology and Bioinstrumentation: Laboratory Manual	Amazon Asia-Pacific Holdings Private Limited
2.	Deepak Shrivastava	2020	Practical Handbook of Biochemistry: Lab Manual	Notion Press

REFERENCE BOOKS:

S.No	Authors	Year	Title of the book	Publishers
1.	N.A. Khan & K.N.Singh	2014	Laboratory Manual of Biochemistry	Daya Publishing House
2.	Abhijit Paintal, Chinmoy Goswami, Rabindra Narain	2011	Handbook of Bioinstrumentation	Dominant Publishers & Distributors

Course Content Prepared by:

Dr. R. Nirmal Kumar

Dr. G. Shalini

DEPARTMENT OF BIOTECHNOLOGY
CHOICE BASED CREDIT SYSTEM (CBCS) & LEARNING OUTCOME BASED
CURRICULAR FRAMEWORK (LOCF)
BACHELOR OF SCIENCE (B.Sc.) – 2023-2026 BATCH
SYLLABUS & SCHEME OF EXAMINATION

Applicable to students admitted during the academic year 2023-2024 and onwards

Applicable to students admitted during the academic year 2023-2024 and onwards												
Semester	Part	Course Code	Title of the course	Course Type	Instruction hours/ Week	Contact hours	Tutorial hours	Duration of Examination	Examination Marks			Credits
									CA	ESE	Total	
III	I	TAM2303/ HIN2303/ FRE2303	Language III- T/H/F	L	6	88	2	3	25	75	100	3
	II	ENG2303	English Paper-III	E	5	73	2	3	25	75	100	3
	III	BT23C03	Core Paper -III Immunology and Immunotechnology	CC	4	58	2	3	25	75	100	4
	III	BT23CP2	Core Practical - II Immunology and Immunotechnology & Genetics and Genetic Engineering Practical	CC	4	60	-	-	-	-	-	-
	III	TH23A28/ BT23A03	IDC Allied paper Statistics for Biotechnology/ Basics of Computer application I	GE	4	58	2	3	20	55	75 ^e	4
	III	TH23AP1/ BT23AP2	Allied Practical II Statistics for Biotechnology- Practicals/ Basics of Computer Application Practical	GE	2	30	-	-	-	-	-	-
III/IV	III	CS23SBGP/ BT23SCE1	Skill Based Course GEN-AI / Coursera-Drug Hunting	SEC	3	44/45	1/-	-	100	-	100	3
III	IV	NM23DTG	Design Thinking	AEC	2	30	-	-	100	-	100	2
	IV	NM22UHR	Foundation Course Universal Human Values and Human Rights [#]	AECC	-	-	-	-	100	-	100	Gr.
	V	JOB2196	Job Oriented course – Food Safety and Quality Analysis	-	Outside working hours (60 hrs)							Gr.
I-V	VI	COM15SER	Community Services	GC	30 hrs outside class hours					Completed or not		
I-V	VI	16BONL1 16BONL2	Online course 1 Online course 2	ACC	-	-	-	-	-	-	-	-

L: Language

E : English

GC : General Courses

CA – Continuous Assessment

CC : Core Courses

GE : Generic Elective

SEC: Skill Based Course

AEC : Ability Enhancement Courses

AECC : Ability Enhancement Compulsory Courses

ACC: Additional Credit Courses

Gr: Grade

: Self study

e : CA conducted for 25 and converted into 20, ESE conducted for 75 and converted into 55

QUESTION PAPER PATTERN

CA Pattern

Section A	:	$3 \times 2 = 6$
Section B	:	$3 \times 5 = 15$ (either or – same CLO Level)
Section C	:	$3 \times 8 = 24$ (either or – same CLO Level)

Total **45 marks**

ESE Pattern

Section A	:	$5 \times 2 = 10$
Section B	:	$5 \times 5 = 25$ (either or – same CLO Level)
Section C	:	$5 \times 8 = 40$ (either or – same CLO Level)

Total **75 marks**

Internal Pattern for theory (for 25 Marks)

CIA Test	:	5 Conducted for 45 marks after 50 days
Model Exam	:	7 Conducted for 75 marks after 85 days (Q.P. Pattern (2,5,8) Each Unit 15 Marks)
Semester/Assignment/Quiz	:	5
Class Participation	:	5
Attendance	:	3

25 marks + ESE 75 marks

From the academic year 2024-25 and onwards marks allotted for attendance component in CA is modified as

91-100% attendance	: 3 Marks
81-90% attendance	: 2 Marks
75-80% attendance	: 1 Marks

CA Question Paper Pattern: 1 x 45 = 45 Marks

One question from each unit with each question comprising of

- One question with a weightage of 2 marks (no choice)
- One questions with a weightage of 5 marks ((Internal Choice at the same CLO level)
- One question with weightage of 8 marks (Internal Choice at the same CLO level)

Model Question Paper Pattern: 1 x 75 = 75 Marks (Each unit carries 20 marks)

- One question with a weightage of 2 marks (no choice)
- One question with a weightage of 5 marks (Internal Choice at the same CLO level)
- One question with weightage of 8 marks (Internal Choice at the same CLO level)

Internal component for Practicals (for 25 Marks)

Lab Performance	-	7 marks
Regularity	-	5 marks
Model Exam	-	10 marks
Attendance	-	3 marks
Total	-	25 marks

Evaluation pattern for ESE Practicals

The End Semester Examination will be conducted for a maximum of 75 marks with a maximum 15 marks for the record and other submissions if any.

COURSE CODE	TITLE OF THE COURSE	CATEGORY	L	T	P	CREDITS
BT23CO3	IMMUNOLOGY AND IMMUNOTECHNOLOGY	THEORY	58	2	-	4

Objectives:

To facilitate the students to

- To make the student to understand the concept immunology
- On successful completion of the subject the student should have understood:
Immunity, Antigen,
- Antibody, Cells of immune system and their function and regulations
- Gain new insights into Antigen -Antibody interactions and to demonstrate immunological techniques.

Course Learning Outcomes

On the successful completion of the course, students will be able to

CLO Number	CLO Statement	Knowledge Level
CLO1	Acquire knowledge about the basic concepts of immunological processes	K1
CLO2	Understand the genetic basis for immunological diversity and the generation of adaptive immune responses	K2
CLO3	Apply the ideology of antigen –antibody reactions in various immune techniques and its potential therapeutic applications	K3
CLO4	Analyse the principle behind the Immunodeficiency disorders and screen the suitable drug utilizing advanced molecular techniques	K4

Mapping with Programme Learning Outcomes

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	M	S	M	M	M
CLO2	S	M	S	S	S
CLO3	S	S	S	S	M
CLO4	M	M	S	M	S

S- Strong; M-Medium

BT23CO3 - IMMUNOLOGY AND IMMUNOTECHNOLOGY

Unit I: Basics of Immunology and Immune System

(12 hrs)

Introduction- Historical Development in Immunology. Biological aspects of Immunology, Self and non-self recognition, specificity, memory of immune system. Cells involved in immune response. Primary and Secondary lymphoid organs – Thymus, ***Bone marrow, Lymph nodes and Spleen. Hematopoiesis: Development, maturation, activation, regulation, differentiation and classification of T-cells and B-cells.**

Unit II: Components of Immune Cells

(11 hrs)

***Antigen- Essential features, classification of antigens, Epitopes, Haptens, Adjuvants, Cross reactivity, Synthetic antigens.** Antibody – Antibodies: Nature, Primary structure of immunoglobulins, Classification of Immunoglobulins: Types –IgG, IgM, ***IgA, IgD and IgE (Origin, structural functions).** Monoclonal and polyclonal antibody.

Unit III: Cellular and Humoral Immunity

(12 hrs)

***Types of Immunity: Cell mediated immunity, humoral immunity, Immune response; primary and secondary response.** Phagocytosis: mechanism of phagocytosis. Interferon: Types of Interferons. Null cells: Natural Killer cells. ***Major Histocompatibility Complex: structure and functions.** Complement system: Nature, ***components of complement. Pathways: Classical and alternative pathways.**

Unit IV: Immune Tolerance and Hypersensitivity

(11 hrs)

Immune tolerance, Immuno deficiencies; Immunosuppression, Transplantation – ***Immunological basis of transplantation reactions, laws of transplantation.** Allergy and hypersensitivity – Types of hypersensitivity. Immune response to infectious diseases, Immunodeficiency diseases – SCID, ***AIDS.**

Unit V: Applied Immunology

(12 hrs)

Monoclonal antibodies - Production and applications. Classification of Vaccines - Attenuated, sub-unit vaccine -***COVID vaccines, DNA and RNA vaccines and anti-idiotypic vaccines.** Immunodiagnostic methods-Immunodiffusion, agglutination, precipitation, ***complement fixation,** Immunofluorescence, Immunoblotting.***ELISA- Principle, Methodology and applications.**

***Link provided for the highlighted content offered in Blended Mode**

S.No	TOPIC	Links
Unit I: Basics of Immunology and Immune System		
1	Bone marrow, Lymph nodes and Spleen.	https://www.youtube.com/watch?v=cCPyWFK0IKs
2	Hematopoiesis: Development, maturation, activation, regulation, differentiation and classification of T-cells and B-cells.	https://www.youtube.com/watch?v=0deCbmh7PHs
Unit II: Components of Immune Cells		
3	Antigen- Essential features, classification of antigens, Epitopes, Haptens, Adjuvants, Cross reactivity, Synthetic antigens	https://www.pearson.com/channels/biology/asset/d4f6d275/b-cell-development
4	IgA, IgD and IgE (Origin, structural functions)	https://www.youtube.com/watch?v=v5-SZFVLBks
Unit III: Cellular and Humoral Immunity		
5	Types of Immunity: Cell mediated immunity, humoral immunity, immune response; primary and secondary response	https://www.youtube.com/watch?v=qUG4yZVPUQ
6	Major Histocompatibility Complex	https://www.youtube.com/watch?v=zGAAITbGZjQ
7	Components of complement. Pathways: Classical and alternative pathways.	https://www.youtube.com/watch?v=d6qFPegEYV0 https://www.youtube.com/watch?v=IUDSWPvfHgU
Unit IV: Immune Tolerance and Hypersensitivity		
8	Immunological basis of transplantation reactions, laws of transplantation.	https://www.youtube.com/watch?v=b6XbuS34TGo
9	AIDS	https://www.youtube.com/watch?v=BADDj82oces
Unit V: Applied Immunology		
10	COVID vaccines, DNA and RNA vaccines and anti-idiotypic vaccines	https://www.youtube.com/watch?v=Kd-E95tXfsY
11	Complement fixation	https://www.youtube.com/watch?v=FKH8BRI09h8
12	ELISA- Principle, Methodology and applications	https://www.youtube.com/watch?v=CWkrQrq0yxQ

TEXT BOOKS

S.No	Authors	Title of the book	Publishers	Year & Edition
1.	Jenni Punt, Sharon Stranford, Patricia Jones and Judith A Owen	Immunology	WH Freeman	2018 & 8 th Edition
2.	Peter J. Delves, Seamus J Martin , Dennis R Burton and Ivan Roitt M	Roitt's Essential Immunology	Wiley Blackwell	2017 & 13 th Edition
3.	Peter lydyard, Alex Whelan and Michael Fanger	Instant notes in Immunology	Taylor & Francis	2011 & 3 rd Edition

REFERENCE BOOKS

S.No	Authors	Title of the book	Publishers	Year & Edition
1.	Kenneth M.Murphy,Paul Travers and Mark Walport	JanewayImmunologie	Springer Spektrum	2014 & 9 th Edition
2.	Brown, TA.	Genomes 3	Garland Science Publishing, New York	2007 & 3 th Edition
3.	Dunham, I	Genome Mapping and sequencing	Horizon Scientific.	2003 & 1 st Edition

Course designers:

Dr. R. Nirmal Kumar

Dr. G. Anbarasi

Module No.	Topic	CLO level	No. of periods	Content delivery method	Student engagement	Participatory Learning / Experiential Learning / Problem based Learning
Unit I: Basics of Immunology and Immune System						
1.	Historical Development in Immunology	CLO1	1	PPT / OER	Quiz (Quizalize/ Socrative)	Participatory Learning
2.	Biological Aspects of immunology	CLO1	1	Lecture	Presentation	Experiential Learning
3.	Self and Non-self-recognition	CLO1	1	Lecture – Chalk and Talk / Group reading	Word cloud/ Mind map / Think Write and Share	Participatory Learning
4.	Memory of immune system	CLO1	1	OER	Debate, Quescussion, Pro-con grid	Problem-based Learning
5.	Cells involved in immune response- Lymphoid lineage	CLO1	1	Spotters/ Chalk and talk	Diagrams, Sketchboard	Experiential Learning
6.	Primary lymphoid organs- Bone marrow	CLO1	1	Virtual lab	Flipped classroom, Poster	Experiential Learning
7.	Primary lymphoid organ-Thymus	CLO1	1	Lecture	Blog, Design Activity	Participatory Learning
8.	Secondary lymphoid organ- Lymph nodes	CLO1	1	Lecture/ Virtual lab	Simulation	Experiential Learning
9.	Secondary lymphoid organ- Spleen	CLO1	1	Spotters/ Chalk and talk	Diagrams, Sketchboard	Experiential Learning
10.	Hematopoiesis: Development and Maturation	CLO1	1	Lecture and video	Blog, Design Activity	Participatory Learning
11.	Activation and Regulation of immune cells	CLO1	1	Chalk and talk/ Picture	Debate, Quescussion, Pro-con grid	Problem-based Learning
12.	Classification of T cells	CLO1	1	Lecture / OER	Simulation	Experiential Learning

Unit II: Components of Immune Cells						
13	Antigen- Essential features	CLO1	1	Pathogen observation and video	Think write and share	Experiential Learning
14	Classification of antigens	CLO1	1	OER and video	Debate, Quescussion, Pro-con grid	Problem-based Learning
15	Epitopes, Haptens	CLO1	1	PPT and video	Review collection, Case study	Problem-based Learning
16	Adjuvants, Cross reactivity	CLO2	1	PPT and video	Review collection, Case study	Problem-based Learning
17	Synthetic antigens	CLO2	1	PPT and video	Review collection, Case study	Problem-based Learning
18	Antibody – Structure of immunoglobulins	CLO2	1	ORE / PPT	Flipped classroom	Participatory Learning
19	Classification of antibody	CLO2	1	Lecture / Seminar	Diagrams, Sketchboard	Participatory Learning
20	IgG & IgM-Origin and structural functions	CLO2	1	Lecture / OER	Simulation	Experiential Learning
21	IgA, IgD&IgE - Origin and structural functions	CLO2	1	Lecture and video	Simulation	Experiential Learning
22	Monoclonal antibody	CLO2	1	Research article reading	Group reading and discussion	Problem-based Learning
23	Polyclonal antibody	CLO2	1	OER	Debate	Problem-based Learning
Unit III: Cellular and Humoral Immunity						
24	Cell mediated immunity	CLO2	1	Lecture PPT and Video	Flipped classroom, Presentation	Participatory Learning
25	Humoral immunity	CLO2	1	Lectureand Video	Blog, Immunity Setup Design Activity	Participatory Learning
26	Primary immune response	CLO2	1	Demonstratio nand Video	Discussion	Experiential Learning
27	Secondary immune response	CLO2	1	Virtual laband Video	Presentation	Problem-based Learning
28	Mechanism of Phagocytosis	CLO2	1	Lecture PPT	Pro/con grid	Participatory Learning

29	Types of Interferons	CLO2	1	Lecture PPT	Student seminar	Participatory Learning
30	Natural Killer Cells	CLO3	1	Seminar / PPT	Flipped classroom	Participatory Learning
31	Major histocompatibility complex - structure	CLO3	1	Video /Observation	Quiz	Participatory Learning
32	Major histocompatibility complex - Function	CLO1	1	Video / Observation	Blog, Design Activity	Experiential Learning
33	Components of complement system	CLO3	1	PPT Flipped Classroom	Review collection, Case study	Problem-based Learning
34	Complement – activation	CLO3	1	Video / Observation	Blog, Design Activity	Experiential Learning
35	Complement pathways	CLO3	1	Video / Observation	Group discussion	Experiential Learning
Unit IV: Immune Tolerance and Hypersensitivity						
36	Immune tolerance	CLO4	1	PPT Flipped Classroom	Review collection, Case study	Problem-based Learning
37	Immuno deficiencies	CLO4	1	Research article reading	Group reading and discussion	Experiential Learning
38	Immunosuppression	CLO4	1	Research article reading	Group reading and discussion	Experiential Learning
39	Transplantation	CLO4	1	PPT and video	Review collection, case thinking	Problem-based Learning
40	Laws of transplantation	CLO4	1	PPT and video	Review collection	Problem-based Learning
41	Allergy & hypersensitivity	CLO4	1	PPT, Socratic	Case study	Problem-based Learning
42	Types of hypersensitivity	CLO4	1	Brainstorming	Discussion	Participatory Learning
43	Immune response to infectious disease	CLO4	1	PPT, Socratic	Case study	Problem-based Learning
44	Immunodeficiency diseases	CLO4	1	PPT	Review collection, Case study	Problem-based Learning
45	SCID	CLO4	1	Socratic	Review collection, Case study	Problem-based Learning
46	AIDS	CLO4	1	Video /Observation	Quiz	Participatory Learning

Unit V: Applied Immunology						
47	Monoclonal antibodies- production and applications	CLO3, CLO4	1	Research article reading	Group reading and discussion	Problem-based Learning
48	Classification of Vaccines - Attenuated	CLO3, CLO4	1	Discussion	Quiz	Participatory Learning
49	Sub-unit vaccine - COVID vaccines	CLO3, CLO4	1	Research article reading and video	Case thinking	Problem-based Learning
50	DNA and RNA vaccines	CLO3, CLO4	1	Research article reading and video	Group reading and discussion	Experiential Learning
51	Anti-idiotype vaccines	CLO3, CLO4	1	Research article reading and video	Group reading and discussion	Experiential Learning
52	Immunodiagnostic methods- Immunodiffusion	CLO3, CLO4	1	PPT, Socratic	Case study	Problem-based Learning
53	Agglutination & precipitation	CLO3, CLO4	1	PPT	Case study	Problem-based Learning
54	Complement fixation	CLO3, CLO4	1	Demonstration and video	Discussion	Participatory Learning
55	Immunofluorescence	CLO3, CLO4	1	Interaction on topics and Assignment	Review collection	Participatory Learning
57	Immunoblotting	CLO3, CLO4	1	PPT	Case study	Problem-based Learning
58	ELISA	CLO3, CLO4	1	Lecture and video	Design thinking	Problem-based Learning

Name of the Course	BT23C03 - Immunology and Immunotechnology
Name of the Faculty	Dr. G. Anbarasi
Participatory Learning	29.3%
Experiential Learning	29.3%
Problem-based Learning	41.4%

COURSE CODE	TITLE OF THE COURSE	CATEGORY	L	T	P	CREDITS
BT23CP2	CORE PRACTICAL II- IMMUNOLOGY AND IMMUNOTECHNOLOGY & GENETICS AND GENETIC ENGINEERING PRACTICAL	PRACTICALS	-	-	120	4

Objectives:

To facilitate the students to

- Gain adequate expertise required to identify and enumerate immune cells and also execute
- agglutination reactions.
- To familiarize the students genetic engineering and gene transfer techniques.
- To Provide an opportunity to experimentally verify the theoretical principles of genetic
- Engineering in a more explicit and concentrated manner.

Course Learning Outcomes

On the successful completion of the course, students will be able to

CLO Number	CLO Statement	Knowledge Level
CLO1	Understand various immune cells and enumerate them and identify blood groups and types	K1
CLO2	Employ the ideology of antigen –antibody reactions in various immune techniques and its potential therapeutic applications	K2
CLO3	Apply the molecular techniques employed to study the genetic make up of an individual and manipulate it	K2
CLO4	Develop and apply the recent technology in screening the recombinant Clones	K4

Mapping with Programme Learning Outcomes

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	S	S	S	S	S
CLO2	S	M	S	M	M
CLO3	S	S	M	S	S
CLO4	S	M	S	S	M

S- Strong; M-Medium

**BT23CP2 - IMMUNOLOGY AND IMMUNOTECHNOLOGY & GENETICS AND
GENETIC ENGINEERING PRACTICAL**

IMMUNOLOGY AND IMMUNOTECHNOLOGY

(60 hrs)

1. Separation of Serum and plasma from Blood
2. Identification of WBC counting, RBC counting and differential blood count
3. Identification of blood group and Rh typing
4. Testing for typhoid antigens by Widal test
5. Testing for Anti streptolysin - O
6. Single Radial Immunodiffusion
7. Immunodiffusion – Ouchterlony Double Diffusion
8. Immunoelectrophoresis – Rocket immunoelectrophoresis
9. Enzyme Linked Immuno Sorbent Assay (ELISA) (Demo)

GENETICS AND GENETIC ENGINEERING

(60 hrs)

1. Dominant and Recessive trait in Pea plant- Mendelian Inheritance
2. Barr body identification in buccal cavity
3. Mitotic Preparation in Onion root tip
4. Meiosis – flower buds of *Rhoeodiscolor*
5. Staining of Chromosomes - Giemsa staining
6. Gene amplification by Gradient PCR
7. Restriction digestion of pUC 8/ pCambia 1302
8. Ligation of digested vector and amplified gene
9. Competent cell preparation
10. Transformation and Screening of recombinants- Blue white selection

TEXT BOOKS

S.No	Authors	Title of the book	Publishers	Year& Edition
1.	Carson, S and Miller, H.B.	Molecular Biology Techniques	Academic Press.	2019 & 4 th Edition
2.	Frank C Hay, Olwyn M.R.	Practical Immunology	Wiley- Blackwell,	2008 & 4 th edition

REFERENCE BOOKS

S.No	Authors	Title of the book	Publishers	Year& Edition
1.	David Male, Jonathan Brost, David Roth, Ivan Roitt	Immunology	Elsevier	2012 & 8 th edition
2.	Bineeta Singh, G.M. Lal	Practical manual of Genetics and Plant breeding	SS Publishing House	2022 & 1 st Edition
3.	Venison, S. John	Practical manual for Genetic Engineering	PHI Learning Pvt. Ltd.	2009 & 1 st Edition
4.	Sambrook J, E.F. Fritsch & T. Maniatis	Molecular cloning: A Laboratory Manual	Cold Spring Harbor Laboratory Press, New York	2000 & 4 th Edition

Course Designers:

Dr. G. Anbarasi

Dr. V. Bhuvaneshwari

COURSE CODE	TITLE OF THE COURSE	CATEGORY	L	T	P	CREDITS
BT23A03	BASICS OF COMPUTER APPLICATION I	THEORY	58	2	-	4

Objectives:

The main objectives of this course are to:

- To develop their skills, the necessary for office automation industry oriented applications
- To develop the basic skills required to write network ports

Course Learning Outcomes

On the successful completion of the course, students will be able to

CLO	CLO Statement	Knowledge Level
CLO1	Understand basics of computer hardware, software and internet tools	K1
CLO2	Apply the basic skills for computer and Internet.	K2
CLO3	Demonstrate the knowledge on computer skills and create personal, academic and business documents and databases	K3
CLO4	Apply their knowledge MS office and Internet of things in creating research related applications	K4

Mapping with Programme Learning Outcomes

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	S	S	S	M	S
CLO2	S	S	S	M	S
CLO3	S	S	M	M	M
CLO4	S	S	M	M	M

S- Strong; M-Medium

BT23A03 - BASICS OF COMPUTER APPLICATION I

Unit I: Basics of Computers

(12 hrs)

Definition of a Computer - Characteristics of computers, Applications of Computers. Block Diagram of a Digital Computer. Input devices and Output devices. Devices, hardware, software human ware, application software, system software, Memories - Primary, Auxiliary and Cache Memory. MS Windows – Desktop, Recycle bin, My Computer, Documents, Pictures, Music, Videos, Task Bar, Control Panel

Unit II: MS Word

(12 hrs)

Microsoft Word – Components of MS Word - Creating, Editing, Formatting and Printing of word. Documents, Insert Headers and Footers, Draw Tables, Table Auto format. Page layout. Margins, Orientation, Page Borders and Shading. Inserting Bookmark, Shapes, Word Art, Page Numbers, Mail Merge.

Unit III: MS-Excel

(11 hrs)

Overview of Excel features – Create new worksheet, Selecting cells, Entering and editing Text, Numbers, Inserting Rows/Columns –Changing column widths and row heights, Insert formulas-Statistical,mathematical and basic Formulae, Insert graphs, graph types and Interpreting the Data.Change font size, Colouring and shading the texts.

Unit IV: PowerPoint

(11 hrs)

PowerPoint: Basic of power point, creating and editing slides, formatting slides, Master slides, Templates, coloring text and objects, Transitions, heading slides, using clip art gallery, chart creations, managing files.

Unit V: Internet of Things and Development of India in IOT

(12 hrs)

Internet of Things: Introduction, Definition & characteristics of IOT, IOT in everyday life, Internet of everything. IOT Applications: Intelligent Traffic systems, Smart Parking, Smart cities and location sharing, Smart Agriculture, IOT in education. Development of India in IOT: Solar Plant System, ATM chip card system, IOT in health care industry, IOT in rural empowerment. Challenges in IOT: Big Data Management, Connectivity challenges.

TEXT BOOKS

S.No	Authors	Title of the book	Publishers	Year & Edition
1.	N. Krishnan	Computer fundamentals and windows with internet technology	SCITECH Publications	2001 & 1 st Edition

REFERENCE BOOKS

S.No	Authors	Title of the book	Publishers	Year & Edition
1.	Srinivasa K.G., Siddesh G.M., Hanumantha Raju R	Internet of Things	Cengage Learning India Pvt. Ltd	2018 & 1 st Edition
2.	R.K. Taxali	Pc Software For Windows 98 Made Simple	McGraw-Hill Education (India) Pvt Limited	2002 & 1 st Edition

Course Designers:

Dr.R.Nirmal Kumar

COURSE CODE	TITLE OF THE COURSE	CATEGORY	L	T	P	CREDITS
BT23AP2	BASICS OF COMPUTER APPLICATION PRACTICAL	PRACTICALS		-	30	2

Objectives:

- To apply the knowledge of Computer skills and the role of MS- WORD
- To get a clear idea about the process of MS-POWER POINT and its importance
- To understand about MS-EXCEL and the preparation of worksheet

Course Learning Outcomes

On the successful completion of the course, students will be able to

CLO	CLO Statement	Knowledge Level
CLO1	Understand the basics of Microsoft office and its various applications	K1
CLO2	Comprehend the power point usage in creating presentations for seminar	K2
CLO3	Apply the knowledge of MS excel in drawing graphs and interpreting the data	K2
CLO4	Analyze the usage of MS access in creating databases	K4

Mapping with Programme Learning Outcomes

CLOs	PLO1	PLO2	PLO3	PLO4	PLO 5
CLO1	S	S	S	S	S
CLO2	S	M	S	M	M
CLO3	S	S	M	S	S
CLO4	S	M	S	S	M

S- Strong; M-Medium

BT23AP2 - BASICS OF COMPUTER APPLICATION PRACTICAL

(30 hrs)

1. MS word-New page, font size, spacing, Paragraph writing and spacing
2. MS word- Underline, Tabulation, insert picture
3. MS powerpoint-Prepare presentations, slide design, tabulation, inserting clip arts,animations
4. MS power point –seminar presentation
5. MS excel-make charts, edit x-axis,y –axis, change graph style, insert data and interpret
6. MS excel-Perform basic mathematical and statistical tools-add, subtract, mean, average, Standard deviation
7. MS Access- Sort on name,place, pincode-create students data base
8. MS Access- Data base making with S.No, date,pincode, prod-id and prod-name
9. MS Access- Create employee database

TEXT BOOKS

S.No	Authors	Title of the book	Publishers	Year& Edition
1.	N. Krishnan	Computer fundamentals and windows with internet technology	SCITECH Publications	2001 & 1 st Edition

REFERENCE BOOKS

S.No	Authors	Title of the book	Publishers	Year & Edition
1.	Srinivasa K.G., Siddesh G.M., HanumanthaRaju R	Internet of Things	Cengage Learning India pvt. Ltd	2018 & 1 st Edition
2.	R.K. Taxali	Pc Software For Windows 98 Made Simple	McGraw-Hill Education (India) Pvt Limited	2002 & 1 st Edition

Course Designer:

Dr.R.Nirmal Kumar

COURSE CODE	TITLE OF THE COURSE	CATEGORY	L	T	P	CREDITS
JOB2196	Job oriented course-Food Safety and Quality Analysis	THEORY	40	-	-	Grade

Objectives:

To enable the students to

- Learn about the methods of sample preparation
- Understand the working principle of different instrumentation techniques
- Gain knowledge about quality parameters of a food products

Course Learning Outcomes

On the successful completion of the course, students will be able to

CLO	CO Statement	Knowledge Level
CLO1	Acquire knowledge on sample preparation and laboratory safety measures	K2
CLO2	Outline the underlying principle behind different instrumentation techniques	K3
CLO3	Understand the procedures involved in the analysis of different components of food	K2
CLO4	Explain the quality parameters of different food products	K3

Mapping with programme Learning outcomes

CLO	PLO1	PLO2	PLO3	PLO4
CLO1	S	S	S	M
CLO2	S	M	S	S
CLO3	S	S	M	S
CLO4	S	M	S	S

S: Strong, M: Medium

JOB2196- FOOD SAFETY AND QUALITY ANALYSIS

Unit I: Introduction to Food Analysis

(8 hrs)

Scope and Importance of Analysis. Adulteration. Composition of Foods, Proximate constituents and analysis, sampling and sample preparation- preparation of laboratory samples and storage of samples, safety rules in a laboratory, preparation of primary and secondary solutions, quality of data

Unit II: Proximate Analysis of Foods

(8 hrs)

Analysis of moisture content, ash content, mineral content, Carbohydrates, proteins, fats, pigments, vitamins and miscellaneous components. Microbial parameters of food products.

Unit III: Quality analysis of Various food products

(8 hrs)

Principle, theory and methods of analysis for – Cereals, Millets, Pulses and related products, Fruits and Vegetables, Oil and Oil seeds, Milk and milk products, Beverages-Tea coffee and cocoa, alcoholic and non – alcoholic beverages, sugar confectionery, Honey and honey related products

Unit IV: Water Quality Analysis

(8 hrs)

Packaged drinking water and water quality standards, sampling, water quality monitoring, hardness, chloride, pH, sulphates, phosphates, pesticides. Microbial parameters

Unit V: Food Laws and Regulations

(8 hrs)

Introduction to food laws, FSSAI, HACCP- Introduction, Definition, Principles and Role of HACCP in food industry. Laws and Regulations. Basics and Principles of GMP/GHP, GLP, AOAC, ISI, BIS.

TEXT BOOKS

S.No	Name of the Authors	Title of the Book	Publishers	Year & Edition
1	A.Y.Sathe`	A first course in food Analysis	New Age International Publishers	1999 & 1 st Edition
2.	Kirk, RS and Sawyer,R.	Pearson's Chemical Analysis of Foods.	Longman Scientific and Technical	1991 & 9 th Edition
3.	S. Suzanne Nielsen	Introduction to Chemical Analysis of Foods	CBS Publishers and Distributers	2002 & 2 nd Edition

REFERENCE BOOKS

S.No	Name of the Authors	Title of the Book	Publishers	Year & Edition
1.	Ranganna S.	Handbook of Analysis and Quality Control for Fruit and Vegetable Products	Tata-McGraw-Hill Publishers	2001 & 1 st Edition
2.	Leo ML Nollet	Handbook of food analysis: Physical characterization and nutrient analysis	CRC Press	2004 & 2 nd Edition
3.	Pomrenz Y & Meloan CE	Food Analysis - Theory and Practice.	CBS	1996 & 1 st Edition

Course Designer:

Dr. R. Nirmal Kumar

COURSE CODE	TITLE OF THE COURSE	CATEGORY	L	T	P	CREDITS
JOB2196	JOC –Food Safety and Quality Analysis Practical	PRACTICALS	-	-	20	Grade

Objectives:

To enable the students to

- Understand fundamental constituents of proximate analysis of food
- To obtain knowledge on various attributes of food and water samples as per recommended standards
- To Analyze the microbiological safety of food items
- To develop new methodologies to measure the quality of food

Course Learning outcomes

On the successful completion of the course, students will be able to

CLO	CO Statement	Knowledge Level
CLO1	Understand major food constituents in food	K2
CLO2	Gain knowledge on analysis of various attributes in food and water sample	K2
CLO3	To Analyse the microbiological parameters from food and water	K3
CLO4	Apply the concept of food safety in maintaining the food quality	K4

Mapping with programme Learning outcomes

CLOS	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	S	S	M	S	S
CLO2	S	M	S	M	S
CLO3	M	S	S	S	S
CLO4	M	S	S	M	M

S: Strong, M: Medium

JOB2196- FOOD SAFETY AND QUALITY ANALYSIS PRACTICAL

(20 hrs)

1. Determination of pH and moisture content in food
2. Estimation of protein content in food through Kjeldahl analyser
3. Estimation of fat content in food through Soxhlet apparatus
4. Determination of chlorides in water sample
5. Determination of hardness in water sample
6. Determination of Alkalinity of water sample
7. Microbiological Analysis : Total Plate count and total coliform count
8. Analysis using Atomic Absorption Spectrophotometer
9. Adulteration test- Baudin Test, Furfural Test and Quick test for Milk, turmeric and Oil, Honey suggested in FSSAI manual

TEXT BOOKS

S.No	Name of the Authors	Title of the Book	Publishers	Year & Edition
3.	S. Suzzane Neilsen	Introduction to the chemical analysis of foods	CBS	2001 & 1 st Edition
4.	Food safety and standards Authority of India, Ministry of health and family welfare	FSSAI Manual of methods for analysis of foods	Government of India	2016 & 1 st Edition

REFERENCE BOOKS

S.No	Name of the Authors	Title of the Book	Publishers	Year & Edition
1.	Dr. Geetha Swaminathan Ms. Mary George	Laboratory Chemical Methods in Food Analysis	Margham Publishers	2002 & 3 rd Edition
2.	Kirk, RS and Sawyer, R.	Pearson's Chemical Analysis of Foods.	Longman Scientific and Technical	1991 & 9 th Edition

Course Designer:

Dr. R. Nirmal Kumar

COURSE CODE	TITLE OF THE COURSE	CATEGORY	L	T	P	CREDITS
CS23SBGP	Gen-AI	Practical	-	1	44	3

Preamble

The objective of this course is to understand the breadth and depth of Generative Artificial Intelligence (Gen AI) and to impart knowledge on its ethical implications, practical applications, and emerging trends.

Course Learning Outcomes

On the successful completion of the course, students will be able to

CLO Number	CLO Statement	Knowledge Level
CLO1	Understand the fundamental concepts and ethical considerations of Generative AI.	K2
CLO2	Apply AI principles in practical settings using basic AI tools and platforms	K3
CLO3	Develop advanced skills in specialized AI applications such as text analysis, natural language processing, and image recognition.	K3
CLO4	Explore emerging trends in AI, integrating advanced AI tools into diverse professional practices.	K4

Mapping with Programme Learning Outcomes

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	S	S	S	S	M
CLO2	S	S	S	S	S
CLO3	S	S	M	S	S
CLO4	S	M	S	M	S

S- Strong; M-Medium;

CS23SBGP - Gen-AI

Unit 1: Introduction to Gen AI

(9 hrs)

Understanding Gen AI: Definition and scope of Gen AI - Overview of its applications in various fields - Introduction to essential skills needed for Gen AI. Ethical Considerations: Discussion on ethical guidelines and responsible use of AI - Understanding the impact of AI on society and individuals.

Hands-on Activity: Exploring AI Tools

- Working with appropriate content creation Gen-AI tools to engage with ChatGPT to explore various subjects, simulate interviews, or create imaginative written content.
- Working with appropriate writing and rephrasing Gen-AI tools to drafting essays on designated topics and refining the content with improved clarity, coherence, and correctness.

Unit 2: Basic AI Concepts

(8 hrs)

Introduction to AI: Basic concepts and terminology of artificial intelligence - Examples of AI in everyday life - Real-world examples of AI applications in different domains. Machine Learning Basics: Understanding the principles of machine learning - Overview of supervised and unsupervised learning.

Hands-on Activity: Simple AI Projects

- Working with appropriate educational content creation Gen-AI tools to generate quizzes and flashcards based on classroom material.
- Working with appropriate language learning Gen-AI tools to practice and enhance language skills through interactive exercises and games across multiple languages.

Unit 3: AI in Practice

(9 hrs)

Text Analysis and Natural Language Processing (NLP): Introduction to NLP concepts and techniques - Hands-on exercises analyzing text data and extracting insights. Image Recognition and Processing: Basics of image recognition algorithms and techniques - AI Tools for Text and Image Processing

Hands-on Activity: Text and Image Projects

- Working with appropriate image processing Gen-AI tools to experiment with AI-generated images.
- Working with appropriate object recognition Gen-AI tools to identify various objects such as text, images, products, plants, animals, artworks, barcodes, and QR codes.

Unit 4: AI for Productivity and Creativity

(9 hrs)

AI-enhanced Productivity and creativity Tools: Overview of productivity and creativity tools enhanced with AI capabilities - Tips for integrating AI into daily tasks and workflows. AI and Jobs: Exploring how AI impacts jobs and industries - Discussion on opportunities and challenges - Exploration of AI-powered creative tools and applications.

Hands-on Activity: Productivity and Creativity

- Working with appropriate content creation Gen-AI tools to generate interactive videos / blog posts / art / drawing / music and storytelling experience.
- Working with appropriate resume generation Gen-AI tools to create professional resumes efficiently.

Unit 5: Future of Gen AI and Final Project

(9 hrs)

Emerging Trends in Gen AI - Applications of Generative AI - Ethical and Societal Impact of Gen AI - Future Directions and Challenges - Case Studies in Generative AI.

Hands-on Activity: Trends in Gen AI

- Working with appropriate speech generation Gen-AI tools to customize synthetic speech for virtual assistance across different applications.
- Working with appropriate data analysis Gen-AI tools to perform data analysis, visualization, and predictive modeling tasks.
- Working with appropriate Gen-AI design tools to simplify the creation of visually appealing presentations.
- Working with appropriate website builder Gen-AI tools to develop professional websites with AI assistance.

Pedagogy

Demonstration of AI Tools, Lectures and Case studies.

Course Designer

Mrs. S. Ponmalar

DEPARTMENT OF BIOTECHNOLOGY

**CHOICE BASED CREDIT SYSTEM (CBCS) & LEARNING OUTCOME BASED
CURRICULAR FRAMEWORK (LOCF)**

**BACHELOR OF SCIENCE (B.Sc.) BIOTECHNOLOGY – 2023-2026 BATCH
SYLLABUS & SCHEME OF EXAMINATION**

Semester	Part	Course Code	Title of the Course	Course Type	Instruction hours /week	Contact hours	Tutorial hours	Duration of Examinations	Examination Marks			Credits
									CA	ESE	Total	
IV	I	TAM2304/ HIN2304/ FRE2304	Tamil Paper IV/ Hindi Paper IV/ French Paper IV	L	5	73	2	3	25	75	100	3
	II	ENG2304	English Paper IV	E	6	88	2	3	25	75	100	3
	III	BT23C04	Genetics and Genetic Engineering	CC	4	58	2	3	25	75	100	4
	III	BT23CP2	Immunology and Immunotechnology & Genetics and Genetic Engineering Practical	CC	4	60	-	5	25	75	100	5
	III	TH23A30/ BT23A04	Advanced Statistics For Biotechnology / Programming for Computer application	GE	4	58	2	3	20	55	75 [€]	4
	III	TH23AP1/ BT23AP2	Statistics for Biotechnology Practicals/ Basics of computer application practical	GE	2	30	-	3	15	35	50 [§]	2
III/IV	III	CS23SBGP/ BT23SCE1	GEN-AI / Drug Hunting	SEC	3	45	-	-	100	-	100	3
IV	IV	NM23EII	Entrepreneurship and Innovation (Ignite X)	AECC	2	30	-	-	100	-	100	2
	IV	NM23EVS	Environmental Studies	AECC	SS	-	-	-	100	-	100	Gr.
	V	COCOACT	Co-Curricular Activities	GC	-	-	-	-	100	-	100	1
I-IV	VI	COM15SER	Community Services - 30hrs	GC	-	-	-	-	-	-	-	-
I-V	VI	16BONL1 16BONL2	Online course 1 Online course 2	ACC	-	-	-	-	-	-	-	-

L: Language

CC : Core Courses

AECC : Ability Enhancement Compulsory Courses

E : English

GE : Generic Elective

GC : General Courses

ACC: Additional Credit Courses SEC: Skill Based Course SS: Self Study

CA – Continuous Assessment ESE - End Semester Examination Gr: Grade

€ : CA conducted for 25 and converted into 20, ESE conducted for 75 and converted into 55

§ : CA conducted for 25 and converted into 15, ESE conducted for 75 and converted into 35

QUESTION PAPER PATTERN

CA Pattern		
Section A	:	3 x 2 = 6
Section B	:	3 x 5 = 15 (either or – same CLO Level)
Section C	:	3 x 8 = 24 (either or – same CLO Level)
Total		45 marks
ESE Pattern		
Section A	:	5 x 2 = 10
Section B	:	5 x 5 = 25 (either or – same CLO Level)
Section C	:	5 x 8 = 40 (either or – same CLO Level)
Total		75 marks
<u>Internal Pattern for theory (for 25 Marks)</u>		
CIA Test	:	5 Conducted for 45 marks after 50 days
Model Exam	:	7 Conducted for 75 marks after 85 days (Q.P. Pattern (2,5,8) Each Unit 15 Marks)
Semester/Assignment/Quiz	:	5
Class Participation	:	5
Attendance	:	3
25 marks + ESE 75 marks		

From the academic year 2024-25 and onwards marks allotted for attendance component in CA is modified as

91-100% attendance : 3 Marks
81-90% attendance : 2 Marks
75-80% attendance : 1 Marks

CA Question Paper Pattern: 1 x 45 = 45 Marks

One question from each unit with each question comprising of

- One question with a weightage of 2 marks (no choice)
- One question with a weightage of 5 marks (Internal Choice at the same CLO level)
- One question with weightage of 8 marks (Internal Choice at the same CLO level)

Model Question Paper Pattern: 1 x 75 = 75 Marks (Each unit carries 20 marks)

- One question with a weightage of 2 marks (no choice)
- One question with a weightage of 5 marks (Internal Choice at the same CLO level)
- One question with weightage of 8 marks (Internal Choice at the same CLO level)

Internal component for Practicals (for 25 Marks)

Lab Performance	-	7 marks
Regularity	-	5 marks
Model Exam	-	10 marks
Attendance	-	3 marks
Total	-	25 marks

Evaluation pattern for ESE Practicals

The End Semester Examination will be conducted for a maximum of 75 marks with a maximum 15 marks for the record and other submissions if any.

Evaluation pattern for Part IV: Environmental Studies

Quiz	-	50 marks
Assignment	-	25 marks
Project/Case study	-	25 marks
Total	-	100 marks

Proposed Assessment Pattern IgniteX

Components	Marks
3 Quizzes (25 questions in each quiz)	50
30 Venture Activities (Assignment)	30
Milestone 3 (pitch deck presentation)	20
Total	100

COURSE CODE	COURSE NAME	CATEGORY	L	T	P	CREDITS
BT23C04	GENETICS AND GENETIC ENGINEERING	THEORY	58	2	-	4

Learning Objectives

To facilitate the students to

- To study the basic mendelian genetics
- To enumerate the effects on gene alterations
- To analyze the enzymes and tools involved in cloning
- To evaluate plasmids used and the strategies to execute them
- To evaluate screening techniques to identify clones

Course Learning Outcomes

On the successful completion of the course, students will be able to

CLO Number	CLO Statement	Knowledge Level
CLO1	Understand the principles of genetics and chromosomal theories	K1
CLO2	Express the knowledge on alterations in chromosomes and their ill effects on human beings	K2
CLO3	Apply basic tools employed in genetic engineering	K3
CLO4	Showcase the knowledge to construct clones and apply them for cloning in different hosts	K4

Mapping with Programme Learning Outcomes

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	M	S	M	S	M
CLO2	M	S	M	M	M
CLO3	M	S	S	S	M
CLO4	S	S	S	M	S

S- Strong; M-Medium

BT23C04 - GENETICS AND GENETIC ENGINEERING

UNIT I: Principles of Mendelian Inheritance

(12 hrs)

Mendel's experiments - Dominance, Segregation, Independent assortment. **Gene Interaction; Incomplete dominance, Codominance**, Complementary, Supplementary, Duplicate and Lethal gene interactions. Multiple allele: Epistasis, Dominant and Recessive epistasis. Chromosomal theory of inheritance. Linkage and crossing over, **Sex determination and Sex linkage in diploids.**

UNIT II: Alterations in chromosome

(11 hrs)

Chromosomal aberrations: Euploidy, Aneuploidy - Deletion, Duplication, Insertion and Translocation. **Population genetics: Hardy - Weinberg genetic equilibrium, Gene frequency, Gene pool, Inbreeding, Outbreeding.** Genetic drift, Pedigree analysis and genetic counseling. Human cytogenetics; Landmarks, Banding pattern, **Karyotyping**, CGH. Human Genetic Diseases - Down's, Turner's, Klinefelter's syndrome.

UNIT III: Tools for rDNA technology

(12 hrs)

Steps involved in gene cloning in prokaryotic and eukaryotic hosts. Manipulating Enzymes: **Restriction Endonucleases and types**, Exonucleases. **DNA Polymerases-Taq polymerase, Pfu DNA polymerase.** Ligases-T4 ligase, DNA ligase **DNA modifying enzymes**-Alkaline phosphatases, Calf Intestine Alkaline phosphatase (CIAP), Terminal deoxynucleotidyl transferases, Polynucleotide kinase.

UNIT IV: Cloning Vectors and their applications

(11 hrs)

Bacterial plasmids, pBR322, pUC18. **Cosmids (pJB8), Phagemids (pGEM).** M13 based Single strand vectors (M13-mp8), Shuttle vectors (YEp) and Expression vectors (pET) for prokaryotes. Problems encountered in expressing foreign genes in *E.coli*, BAC and YAC. Mammalian vector-SV40, Plant vector-Ti plasmid.

UNIT V: Gene cloning and Screening

(12 hrs)

Polymerase chain reaction: Primer designing. Types of PCR: Semi quantitative, Multiplex, Reverse Transcriptase-PCR, Real time - PCR. **Methods of labeling probes**, Genomic library, **cDNA library and PCR based cloning approach** (TA cloning), Genome Editing: CRISPR-Cas 9. Detection of cloned gene, **Selection of clones by hybridization probes – Blue white selection.**

***Link provided for the highlighted content offered in Blended Mode**

S.No	TOPIC	Links
UNIT I: Principles of Mendelian Inheritance		
1	Gene Interaction; Incomplete dominance, Codominance	https://www.youtube.com/watch?v=Bo1rlIFcehM
2	Sex determination and Sex linkage in diploids	https://www.youtube.com/watch?v=AzkXQBzZEIE
UNIT II: Alterations in chromosome		
3	Population genetics	https://www.youtube.com/watch?v=SRWXEMII0_U
4	Karyotyping	https://www.youtube.com/watch?v=AtGfc-ebRP8
UNIT III: Tools for rDNA technology		
5	Restriction Endonucleases and types	https://www.youtube.com/watch?v=VfRThB2VWkA
6	DNA modifying enzymes	https://www.youtube.com/watch?v=RjlGvRRVYuw
7	DNA Polymerases-Taq polymerase, Pfu DNA polymerase.	https://www.youtube.com/watch?v=j3wd1kCSrUg https://www.youtube.com/watch?v=gwYkOhC-TKA
UNIT IV: Cloning Vectors and their applications		
8	Cosmids (pJB8), Phagemids (pGEM)	https://www.youtube.com/watch?v=qBhBJzc-CRM
9	Plant vector-Ti plasmid	https://www.youtube.com/watch?v=yesNHd9h8k0
UNIT V: Gene cloning and Screening		
10	Methods of labeling probes	https://www.youtube.com/watch?v=29EC7L3t19c
11	cDNA library	https://www.youtube.com/watch?v=URtcaoNEIrI https://www.youtube.com/watch?v=E7eqc4r2iwI
12	Selection of clones by hybridization probes – Blue white selection	https://www.youtube.com/watch?v=4fnS2xKjIbg

TEXT BOOKS

S.No	Authors	Title of the book	Publishers	Year & Edition
1.	Harvey Lodish; Arnold Berk; Chris A. Kaiser; Monty Krieger; Anthony Bretscher; Hidde Ploegh; Kelsey C. Martin; Michael Yaffe; Angelika Amon	Molecular Cell Biology	Macmillan's Publishers	2021 & 9 th Edition
2.	Brown T. A	Gene cloning and DNA analysis an introduction.	Wiley Blackwell	2016 & 7 th Edition
3.	T A Brown	Introduction to Genetics. A molecular Approach.	Garland Science	2011 & 1 st Edition
4.	Hugh Fletcher and Ivor Hickey	BIOS Instant Notes in Genetics.	Garland Science	2012 & 4 th edition

REFERENC BOOKS

S.No	Authors	Title of the book	Publishers	Year & Edition
1.	D.Freifelder	Freifelders Essentials of Molecular Biology	Jones & Bartlett Publishers	2015 & 4 th Edition
2.	Anthony J.F. Griffiths, John Doebley, Catherine Peichel	An Introduction to Genetic Analysis.	W.H. Freeman & Co Ltd	2020 & 12 th Edition

Course Designer:

Dr. Anbarasi. G

Module No.	Topic	CLO level	No. of periods	Content delivery method	Student engagement	Participatory Learning / Experiential Learning / Problem based Learning
Unit I: Principles of Mendelian Inheritance						
1.	Mendel's experiment- Dominance, Segregation	CLO1 CLO2	1	Lecture – Chalk and Talk / Group reading	Debate, Quescussion, Pro-con grid	Problem-based Learning
2.	Independent assortment	CLO1 CLO2	1	PPT / OER	Case thinking	Problem-based Learning
3.	Gene Interaction; Incomplete & Codominance dominance	CLO1 CLO2	1	Chalk and talk/ Picture	One-minute presentation	Participatory Learning
4.	Complementary gene interactions	CLO1 CLO2	1	Research paper presentation	Case thinking	Problem-based Learning
5.	Supplementary gene interactions	CLO1 CLO2	1	Lecture PPT	One-minute presentation	Participatory Learning
6.	Duplicate and Lethal gene interactions	CLO1 CLO2	1	Student Seminar	Student Seminar	Participatory Learning
7.	Multiple allele: Epistasis	CLO1 CLO2	1	Virtual lab	Quiz	Participatory Learning
8.	Dominant and Recessive epistasis	CLO1 CLO2	1	Lecture PPT	Group Discussion	Participatory Learning
9.	Chromosomal theory of inheritance	CLO1 CLO2	1	Virtual lab	Design thinking	Problem-based Learning
10.	Linkage and crossing over	CLO1 CLO2	1	Research paper presentation	Group Discusssion	Participatory Learning
11.	Sex determination	CLO1 CLO2	1	Lecture PPT	Case thinking	Problem-based Learning
12.	Sex linkage in diploids	CLO1 CLO2	1	Lecture PPT	Diagrams, Sketchboard	Experiential Learning
UNIT II: ALTERATIONS IN CHROMOSOME						
13.	Chromosomal abberations: Euploidy,	CLO1 CLO2	1	Lecture – Chalk and Talk / Group reading	Design thinking	Problem-based Learning
14.	Aneuploidy - Deletion, Duplication, Insertion and Translocation	CLO1 CLO2	1	PPT / OER	Design thinking	Problem-based Learning
15.	Population genetics: Hardy - Weinberg genetic equilibrium	CLO1 CLO2	1	Chalk and talk/ Picture	Design thinking	Problem-based Learning

16.	Gene frequency, Gene pool	CLO1 CLO2	1	Research paper presentation	Case thinking	Problem-based Learning
17.	Inbreeding & Outbreeding	CLO1 CLO2	1	Lecture PPT	Panel discussion	Participatory Learning
18.	Genetic drift	CLO1 CLO2	1	Lecture PPT	Diagrams, Sketchboard	Experiential Learning
19.	Pedigree analysis and genetic counseling	CLO1 CLO2	1	Virtual lab	Quiz	Participatory Learning
20.	Human cytogenetics	CLO1 CLO2	1	Lecture PPT	Design thinking	Problem-based Learning
21.	Landmarks, Banding pattern, Karyotyping	CLO1 CLO2	1	Virtual lab	Simulation	Experiential Learning
22.	FISH, CGH	CLO1 CLO2	1	Research paper presentation	Case thinking	Problem-based Learning
23.	Human Genetic Diseases - Down's, Turner's, Klinefelter's syndrome	CLO1 CLO2	1	Brainstorming	Review collection, Case study	Problem-based Learning
UNIT III: Tools for rDNA technology						
24.	Steps involved in gene cloning in prokaryotic	CLO2 CLO3	1	Lecture – Chalk and Talk / Group reading	Optimization	Problem-based Learning
25.	Steps involved in gene cloning in eukaryotic hosts	CLO2 CLO3	1	PPT / OER	Optimization	Problem-based Learning
26.	Manipulating Enzymes: Restriction Endonucleases and types	CLO2 CLO3	1	Demonstration	Workshop	Experiential Learning
27.	Exonucleases	CLO2 CLO3	1	Student Seminar	Design thinking	Problem-based Learning
28.	DNA Polymerases-Taq polymerase	CLO2 CLO3	1	Virtual lab	One-minute presentation	Participatory Learning
29.	Pfu DNA polymerase	CLO2 CLO3	1	Lecture PPT	Presentation	Problem-based Learning
30.	Ligases-T4 ligase, DNA ligase	CLO2 CLO3	1	Demonstration	Workshop	Experiential Learning
31.	Ligases-T4 ligase, DNA ligase	CLO2 CLO3	1	Demonstration	Workshop	Experiential Learning
32.	DNA modifying enzymes- Alkaline phosphatases	CLO2 CLO3	1	Lecture PPT	Presentation	Problem-based Learning
33.	Calf Intestine Alkaline phosphatase (CIAP)	CLO2 CLO3	1	Virtual lab	Simulation	Experiential Learning

34.	Terminal deoxynucleotidyl transferases	CLO2 CLO3	1	Virtual lab	Simulation	Experiential Learning
35.	polynucleotide kinase	CLO2 CLO3	1	Student seminar	Student seminar	Participatory Learning
UNIT IV: Cloning Vectors and their applications						
36.	Bacterial plasmids	CLO3 CLO4	1	Lecture – Chalk and Talk	Simulation	Experiential Learning
37.	pUC18	CLO3 CLO4	1	Lecture PPT	Group Discussion	Participatory Learning
38.	Cosmids (pJB8)	CLO3 CLO4	1	PPT / OER	Article review	Experiential Learning
39.	Phagemids (pGEM)	CLO3 CLO4	1	Chalk and talk/ Picture	Simulation	Experiential Learning
40.	M13 based Single strand vectors (M13-mp8)	CLO3 CLO4	1	Chalk and talk/ Picture	One-minute presentation	Participatory Learning
41.	Shuttle vectors (YE _p) and Expression vectors (pET) for prokaryotes	CLO3 CLO4	1	Lecture PPT	One-minute presentation	Participatory Learning
42.	Problems encountered in expressing foreign genes in E.coli	CLO3 CLO4	1	Book/ Article review	Article review	Experiential Learning
43.	BAC and YAC	CLO3 CLO4	1	Research paper presentation	Presentation	Problem-based Learning
44.	Mammalian vector-SV40	CLO3 CLO4	1	Student seminar Lecture	Debate	Problem-based Learning
45.	Plant vector-Ti plasmid	CLO3 CLO4	1	Lecture PPT	Optimization	Problem-based Learning
UNIT V: Gene cloning and Screening						
46.	Polymerase chain reaction: Primer designing	CLO3 CLO4	1	Lecture – Chalk and Talk / Group reading	Troubleshooting	Problem-based Learning
47.	Types of PCR: Semi quantitative PCR	CLO3 CLO4	1	PPT / OER	Troubleshooting	Problem-based Learning
48.	Multiplex PCR	CLO3 CLO4	1	Field observations	Industry visit	Experiential Learning
49.	Reverse Transcriptase-PCR	CLO3 CLO4	1	Field observations	Industry visit	Experiential Learning
50.	Real time - PCR	CLO3 CLO4	1	Field observations	Industry visit	Experiential Learning
51.	Methods of labeling probes	CLO3 CLO4	1	Student Seminar	Student seminar	Participatory Learning

52.	Genomic library	CLO3 CLO4	1	Virtual lab	Quiz	Participatory Learning
53.	cDNA library and PCR based cloning approach (TA cloning)	CLO3 CLO4	1	Book/ Article review	Debate	Problem-based Learning
54.	cDNA library and PCR based cloning approach (TA cloning)	CLO3 CLO4	1	Virtual lab	Troubleshooting	Problem-based Learning
55.	Genome Editing-CRISPR-Cas 9	CLO3 CLO4	1	Research paper presentation	Troubleshooting	Problem-based Learning
56.	Detection of cloned gene	CLO3 CLO4	1	Field observations	Industry visit	Experiential Learning
57.	Selection of clones by hybridization probes	CLO3 CLO4	1	Student seminar	Student seminar	Participatory Learning
58.	Blue white selection	CLO3 CLO4	1	Lecture PPT	Debate	Participatory Learning

Name of the course	BT23C04-Genetics and Genetic Engineering
Name of the Faculty	Dr. G. ANBARASI
Participatory Learning	29.3%
Experiential Learning	29.3%
Problem-based Learning	41.4%

COURSE CODE	COURSE NAME	CATEGORY	L	T	P	CREDITS
BT23CP2	IMMUNOLOGY AND IMMUNOTECHNOLOGY & GENETICS AND GENETIC ENGINEERING PRACTICAL	PRACTICAL	-	-	120	5

Learning Objectives

To facilitate the students to

- Gain adequate expertise required to identify and enumerate immune cells and also execute agglutination reactions.
- To familiarize the students genetic engineering and gene transfer techniques.
- To Provide an opportunity to experimentally verify the theoretical principles of genetic Engineering in a more explicit and concentrated manner.

Course Learning Outcomes

On the successful completion of the course, students will be able to

CLO Number	CLO Statement	Knowledge Level
CLO1	Understand various immune cells and enumerate them and identify blood groups and types	K1
CLO2	Employ the ideology of antigen –antibody reactions in various immune techniques and its potential therapeutic applications	K2
CLO3	Apply the molecular techniques employed to study the genetic make up of an individual and manipulate it	K3
CLO4	Develop and apply the recent technology in screening the recombinant Clones	K4

Mapping with Programme Learning Outcomes

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	S	S	S	S	S
CLO2	S	M	S	M	M
CLO3	S	S	M	S	S
CLO4	S	M	S	S	M

S- Strong; M-Medium

**BT23CP2 - IMMUNOLOGY AND IMMUNOTECHNOLOGY & GENETICS AND
GENETIC ENGINEERING PRACTICAL**

IMMUNOLOGY AND IMMUNOTECHNOLOGY

(60 hrs)

1. Separation of Serum and plasma from Blood
2. Identification of WBC counting, RBC counting and differential blood count
3. Identification of blood group and Rh typing
4. Testing for typhoid antigens by Widal test
5. Testing for Anti streptolysin - O
6. Single Radial Immunodiffusion
7. Immunodiffusion – Ouchterlony Double Diffusion
8. Immuno-electrophoresis – Rocket immuno-electrophoresis
9. Enzyme Linked Immuno Sorbent Assay (ELISA) (Demo)

GENETICS AND GENETIC ENGINEERING

(60 hrs)

1. Dominant and Recessive trait in Pea plant- Mendelian Inheritance
2. Barr body identification in buccal cavity
3. Mitotic Preparation in Onion root tip
4. Meiosis – flower buds of *Rhoeodiscolor*
5. Staining of Chromosomes - Giemsa staining
6. Gene amplification by Gradient PCR
7. Restriction digestion of pUC 8/ pCambia 1302
8. Ligation of digested vector and amplified gene
9. Competent cell preparation
10. Transformation and Screening of recombinants- Blue white selection

TEXT BOOKS

S.No	Authors	Title of the book	Publishers	Year& Edition
1.	Carson, S and Miller, H.B.	Molecular Biology Techniques	Academic Press.	2019 & 4 th Edition
2.	Frank C Hay, Olwyn M.R.	Practical Immunology	Wiley-Blackwell,	2008 & 4 th edition

REFERENCE BOOKS

S.No	Authors	Title of the book	Publishers	Year& Edition
1.	David Male, Jonathan Brost, David Roth, Ivan Roitt	Immunology	Elsevier	2012 & 8 th Edition
2.	Bineeta Singh, G.M. Lal	Practical manual of Genetics and Plant breeding	SS Publishing House	2022 & 1 st Edition
3.	Venison, S. John	Practical manual for Genetic Engineering	PHI Learning Pvt. Ltd.	2009 & 1 st Edition
4.	Sambrook J, E.F. Fritsch & T. Maniatis	Molecular cloning: A Laboratory Manual	Cold Spring Harbor Laboratory Press, New York	2000 & 4 th Edition

Course Designers:

Dr. G. Anbarasi

Dr.D.S. Ranjith Santhosh Kumar

COURSE CODE	COURSE NAME	CATEGORY	L	T	P	CREDITS
BT23A04	PROGRAMMING FOR COMPUTER APPLICATION	THEORY	58	2	-	4

Learning Objectives

To facilitate the students to

- To learn about the fundamentals of C programming
- To learn the concepts of Python language
- To develop applications to analysis with data.

Course Learning Outcomes

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

CLO	CLO Statement	Knowledge Level
CLO1	Understand the programming ability in C Language.	K1
CLO2	Ability to write C Programming for logical concepts.	K2
CLO3	Apply algorithms for sequence analysis	K3
CLO4	Inculcate knowledge on basic Python programming skills.	K4

Mapping with Programme Learning Outcomes

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	S	S	S	M	S
CLO2	S	S	S	M	S
CLO3	S	S	M	M	M
CLO4	S	S	M	M	M

S- Strong; M-Medium

BT23A04 - PROGRAMMING FOR COMPUTER APPLICATION

Unit I: Computer Algorithms and Fundamentals in C (12 hrs)

Basics of Algorithms- Pseudo code-Flowchart-Stack-Queues.

Fundamentals in C:History of C- Basic Structure of a C program- Simple C Program- Character set - C tokens - Keywords - Identifiers - Constants – Variables – Data Types -Declaration of Variable - Assigning Values to Variables –Initialization.

Unit II: Operators and Expressions: Arrays (12 hrs)

Arithmetic operators – relational operators – logical operators – assignment operators – increment and decrement operators – conditional operators – special operators – arithmetic expression – evaluation of expression – Precedence of arithmetic operators – type conversion in expression – operator precedence and associativity – mathematical functions.

Arrays:

Introduction – One dimensional array – declaration of array – Initiating on two and multidimensional arrays.

Unit III: Decision Making, Branching and looping (11 hrs)

Introduction to if, if...else, nesting of if ...else statements- else if ladder – The switch statement, The : Operator – The goto Statement.

Decision Making and Looping:

Introduction - while loop –do loop –do while loop –for loop –Nested Loops–break–continue–goto–exit–return.

Unit IV: Python (11 hrs)

About python, features of python, python set up, fundamentals of python, values and data types, variables, key word, identifier of python, quotations, indentation, multi line statement, input-output and import function in python, advantages and disadvantages of python.

Unit V: Fruitful functions in python: (12 hrs)

Defining a function, function call, types of function, python function arguments, composition, python recursion and python lambda function.

TEXT BOOKS

S.No	Authors	Title of the book	Publishers	Year& Edition
1.	Mark Summerfield	Programming in Python 3: A Complete introduction to the Python Language	Addison-Wesley Professional	2009 & 2 nd Edition
2.	Martin C. Brown	PYTHON: The Complete Reference	McGraw-Hill Education Pvt Limited	2001 & 4 th Edition

REFERENCE BOOKS

S.No	Authors	Title of the book	Publishers	Year& Edition
1.	Guido van Rossum and Fred L. Drake Jr,	An Introduction to Python, Revised and updated for Python 3.2	Network Theory Ltd.	2011
2.	Wesley J Chun	Core Python Applications Programming	Prentice Hall	2012

Course Designers:

Dr. G. Shalini

Dr. R. Nirmal Kumar

COURSE CODE	COURSE NAME	CATEGORY	L	T	P	CREDITS
BT23AP2	BASICS OF COMPUTER APPLICATION PRACTICAL	PRACTICAL	-	-	60	2

Learning Objectives

- To learn about the fundamentals of C programming
- To learn the concepts of Python language
- To develop applications to analysis with data.

Course Learning Outcomes

On the successful completion of the course, students will be able to

CLO	CLO Statement	Knowledge Level
CLO1	Understand practical way of program in C Language.	K1
CLO2	Ability to write C Programming for problem solving	K2
CLO3	Apply algorithms for DNA and NGS based sequence analysis	K3
CLO4	To inculcate knowledge on basic Python programming skills and develop application based tools.	K4

Mapping with Programme Learning Outcomes

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	S	S	S	M	S
CLO2	S	M	S	M	S
CLO3	S	S	S	M	M
CLO4	S	M	M	S	M

S- Strong; M-Medium

BT23AP2 - BASICS OF COMPUTER APPLICATION PRACTICAL

BASICS OF COMPUTER APPLICATION

(30 hrs)

1. MS word-New page, font size, spacing, Paragraph writing and spacing
2. MS word- Underline, Tabulation, insert picture
3. MS powerpoint-Prepare presentations , slide design, tabulation, inserting clip arts,animations
4. MS power point –seminar presentation
5. MS excel-make charts, edit x-axis,y –axis, change graph style, insert data and interpret
6. MS excel-Perform basic mathematical and statistical tools-add, subtract, mean, average, Standard deviation
7. MS Access- Sort on name,place, pincode-create students database
8. MS Access- Database making with S.No, date,pincode, prod-id and prod-name
9. MS Access- Create employee database

PROGRAMMING IN COMPUTER APPLICATION

(30 hrs)

1. Write a C program to find the sum, average, standard deviation for a given set of numbers.
2. Write a C program to generate n prime numbers.
3. Write a C program to generate Fibonacci series.
4. Write a C program to sort the given set of numbers in ascending order.
5. Write a python program that displays the following information: Your name, Full address, Mobile number, College name, Course subjects.
6. Write a python program to make a simple calculator
7. Write a python program to find the largest three integers using if-else and conditional operator.

TEXT BOOKS

S.No	Authors	Title of the book	Publishers	Year& Edition
1.	N. Krishnan	Computer fundamentals and windows with internet technology	SCITECH Publications	2001 & 1 st Edition
2.	Mark Summerfield	Programming in Python 3: A Complete introduction to the Python Language	Addison-Wesley Professional	2009 & 1 st Edition
3.	Martin C. Brown	PYTHON: The Complete Reference	McGraw-Hill Education Pvt Limited	2001 & 1 st Edition
4.	Wesley J Chun	Core Python Applications Programming	Prentice Hall	2012 & 3 rd Edition

REFERENCE BOOKS

S.No	Authors	Title of the book	Publishers	Year & Edition
1.	Srinivasa K.G., Siddesh G.M., HanumanthaRaju R	Internet of Things	Cengage Learning India pvt. Ltd	2018 & 1 st Edition
2.	R.K. Taxali	Pc Software For Windows 98 Made Simple	McGraw-Hill Education (India) Pvt Limited	2002 & 1 st Edition
3.	Mrs. Sneha Akash Mane, Dr. Sampat D. Navale, Dr. Tushar T. Shelke, Prof. Nitin B. Kohale	Text book And Lab Manual of Computer Applications	Pritam Publications	2022 & 1 st Edition
4.	Brian W.Kernighan and Dennis M.Ritchie	The C Programming Language	Prentice-Hall	2018 & 1 st Edition

Course Designer:

Dr. R. Nirmal Kumar



**BACHELOR OF SCIENCE IN BIOTECHNOLOGY
CHOICE BASED CREDIT SYSTEM (CBCS)
LEARNING OUTCOME BASED CURRICULAR FRAMEWORK (LOCF)
SYLLABUS & SCHEME OF EXAMINATION
BACHELOR OF SCIENCE IN BIOTECHNOLOGY- 2023-2026 BATCH**

Semester	Part	Course Code	Title of the Course	Course Type	Instruction hours/ Week	Contact hours	Tutorial hours	Duration of Examination	Examination Marks			Credits
									CA	ESE	TOTAL	
V	III	BT23C05	Nanobiotechnology	CC	4	58	2	3	25	75	100	4
		BT23C06	Plant Biotechnology	CC	4	58	2	3	25	75	100	4
		BT23C07	Animal Biotechnology	CC	4	58	2	3	25	75	100	4
		BT23CP3	Nanobiotechnology, Plant Biotechnology and Animal Biotechnology Practical	CC	5	75	-	5	25	75	100	5
		BT23E01/ BT23E02/ BT23E03	Pharmaceutical Biotechnology/ Bioentrepreneurship / Bioethics, Biosafety and IPR	DSE	3	43	2	3	25	75	100	4
		BT21AC1/ BT21AC2	Cancer Biology/ Stem cell Technology & Tissue Engineering	ACC	SS	-	-	3	25	75	100	5*
		BT23PROJ	Project and Viva Voce	DSE	5	-	-	-	25	75	100	5
		BT22SBP1	Biomolecular Computing Practical	SEC	3	41	4	-	100	-	100	3
		BT23COM	Comprehensive Examination	GC	-	-	-	-	100	-	100	Gr.
	IV	NM21CS1	Cyber Security I	AECC	-	30	-	-	100	-	100	Gr.
		BT23INST	Field Work /Institutional training	DSE					100	-	100	2
I-IV	VI	COM15SER	Community Services (30 Hours)	GC	-	-	-	-	-	-	-	-
I-V	VI	16BONL1 16BONL2	Online Course I Online Course II	ACC	-	-	-	-	-	-	-	-

CC: Core Courses

DSE: Discipline Specific Elective

AECC: Ability Enhancement Compulsory Courses

GC: General Courses

SEC: Skill Enhancement Course

ACC: Additional Credit Courses

CA – Continuous Assessment ESE - End Semester Examination

Gr.: Grade SS: *ALC-Self-study.

COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	CREDITS
BT23C05	NANOBIOTECHNOLOGY	THEORY	58	2	-	4

Preamble

- To understand the concepts and types of Nanomaterials.
- To realize the physical, chemical and biological method of synthesis and characterization of nanomaterials.
- To apply the nanomaterials for biological applications
- To analyze the importance of molecular nanotechnology

Course Learning Outcomes

On the successful completion of the course, students will be able to

CLO Number	CLO Statement	Knowledge Level
CLO1	Understand the concepts and types of Nanomaterials.	K1
CLO2	Acquire the impact of physical, chemical and biological method of synthesis and characterization of nanomaterials.	K2
CLO3	Apply the nanomaterials for biological applications	K3
CLO4	Interpret the importance of molecular nanotechnology	K4

Mapping with Programme Learning Outcomes

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	M	S	L	M	M
CLO2	M	S	S	M	M
CLO3	S	S	M	S	S
CLO4	M	M	M	M	S

*S- Strong; M-Medium; L- Low

BT23C05 – NANOBIOTECHNOLOGY (58 Hours)

Unit I: Introduction to Nanobiotechnology (12 hrs)

Introduction to Nano-world. The nanoscale dimension and paradigm, Types, Nanocrystal, Nanorods, Nanoshells, Nanotubes, Quantum dots. ***Properties of nanomaterials and their classifications (1D, 2D and 3D etc).**

Unit II: Synthesis of Nanomaterials (12 hrs)

***Approaches for synthesis of nanoparticles: Top-down -Ultra sonication and bottom up – microemulsion.** Physical method - Ball milling, Electro spinning, Physical vapor deposition. Chemical method – Sol gel Process, Chemical Precipitation, Hydrothermal Method. Biological method of Synthesis - Plant, bacteria, fungi mediated method. Biological Methods- Growth and Stabilization

Unit III: Characterization of Nanomaterials (11 hrs)

***Characterization of Nanomaterials- Identification of Surface Plasmon Resonance using UV Visible Spectroscopy, Identification of functional groups using Fourier Transform Infrared Spectroscopy, Identification of Size and charge by Nanoparticle track analyzer, Zeta potential, Electron Microscope-Scanning Electron Microscopy, High Resolution-Transmission Electron Microscopy, Atomic Force Microscopy. Energy Dispersive X-ray Spectroscopy and X-ray diffraction spectroscopy.**

Unit IV: Molecular Nanotechnology (11 hrs)

***Molecular Nanotechnology, DNA-based Nanostructures, Mastering the complex DNA nanostructure, DNA tweezers, DNA actuators, DNA scissors, Lipid-based Nanostructures- Micelles, Liposomes, Self-assembly of protein nanoarchitecture, Applications of protein nanostructures**

Unit V: Applications of Nanobiotechnology (12 hrs)

Nanobiotechnology in Diagnostic equipment, Biosensors, Surgical supplements, Tissue engineering, ***Gene delivery, Drug delivery, Cancer therapy**, Cosmetics. Environmental Application- Photocatalysis of pollutants and Heavy metals. Applications of nanobiotechnology in food processing, packaging and in agriculture.

TEXT BOOKS

S.No	Authors	Title of the book	Publishers	Year & Edn
1	Chris Binns	Introduction to Nanoscience and Nanotechnology	Wiley Publication	2010 & 2nd Edn
2	Stuart Lindsay	Introduction to Nanoscience	Oxford University Press.	2009

REFERENCE BOOKS

S.No	Authors	Title of the book	Publishers	Year & Edn
1	Murthy, Shankar, Raj, Rath, Murday	Text book of Nanoscience and nanotechnology	Springer, Universities Press	2013
2	MA Shah, Tokeer Ahmed	Principles of Nanoscience and nanotechnology	Alpha Science International	2010

Course designer:

Dr. V. Bhuvaneshwari

***Link Provided for the Highlighted Content Offered in Blended Mode**

S.No	Topics	Links
Unit I: Introduction to Nanobiotechnology		
1.	Properties of nanomaterials	https://www.youtube.com/watch?v=0cGw6M9ODl8
2.	classifications (1D, 2D and 3D etc).	https://www.youtube.com/watch?v=xEd4NYpc5OU
Unit II: Synthesis of Nanomaterials		
3.	Approaches for synthesis of nanoparticles	https://www.youtube.com/watch?v=bLKsHAtxDrM
4.	Top-down -Ultra sonication,	https://www.youtube.com/watch?v=1Xw8oLyH7P0
5.	bottom up – microemulsion	https://www.youtube.com/watch?v=gnceaaxlgAo
Unit III: Characterization of Nanomaterials		
6.	Characterization- FT-IR, UV Spectroscopy,	https://www.youtube.com/watch?v=IFYs3XDu4fQ
7.	Nanoparticle track analyzer, Zeta potential,	https://www.youtube.com/watch?v=IFYs3XDu4fQ
Unit IV: Molecular Nanotechnology		
8.	DNA-based Nanostructures	https://www.youtube.com/watch?v=hSYOaKYeDI4
9.	Mastering the complex DNA nanostructure	https://www.youtube.com/watch?v=QtgB6iApaHA
10.	DNA tweezers	https://www.youtube.com/watch?v=x3GgdqKC9WI
11.	DNA actuators	https://www.youtube.com/shorts/f5v5UQQrZwI
12.	DNA scissors	https://www.youtube.com/watch?v=ZQf7ewZGZXg
Unit V: Applications of Nanobiotechnology		
13.	Gene delivery	https://www.youtube.com/watch?v=SZIBFWmQqBc
14.	Drug delivery	https://www.youtube.com/watch?v=f7hMhL_N4k8
15.	Cancer therapy	https://www.youtube.com/watch?v=6kmfDNVjRdw

Module No.	Topic	CLO level	No. of periods	Content delivery method	Learning methods
Unit I: Introduction to Nanobiotechnology					
1.	Introduction to Nano-world.	CLO1	1	PPT / OER	Participatory Learning
2.	The nanoscale dimension and paradigm,	CLO1	1	Lecture – Chalk and Talk / Group reading	Participatory Learning
3.	Types,	CLO1	1	Chalk and talk/ Picture	Participatory Learning
4.	Nanocrystal,	CLO1	1	PPT / OER	Participatory Learning
5.	Nanorods,	CLO1	1	Chalk and talk/ Picture	Problem-based Learning
6.	Nanoshells,	CLO1	1	Research paper presentation	Problem-based Learning
7.	Nanotubes,	CLO1	1	Research paper presentation	Problem-based Learning
8.	Quantum dots.	CLO1	1	OER/PPT	Experiential Learning
9.	Properties of nanomaterials and	CLO1	1	OER/PPT	Experiential Learning
10.	their classifications 1D,	CLO1	1	OER/PPT	Experiential Learning
11.	2D	CLO1	1	Book/ Article review	Experiential Learning
12.	and 3D etc).	CLO1	1	Research paper presentation	Experiential Learning
UNIT II: Synthesis of Nanomaterials					
13.	Approaches for synthesis of nanoparticles	CLO2	1	Lecture – Chalk and Talk / Group reading	Participatory Learning
14.	Top-down approach- Ultra sonication	CLO2	1	PPT / OER	Participatory Learning
15.	Bottom-up approach- microemulsion	CLO2	1	Chalk and talk/ Picture	Participatory Learning
16.	Physical method- Ball milling,	CLO2	1	Research paper presentation	Problem-based Learning
17.	Electro spinning,	CLO2	1	Demonstration	Problem-based Learning

18.	Physical vapor deposition.	CLO2	1	Student Seminar	Problem-based Learning
19.	Chemical method-- Sol gel Process,	CLO2	1	Virtual lab	Experiential Learning
20.	Chemical Precipitation, Hydrothermal Method.	CLO2	1	Book/ Article review	Experiential Learning
21.	Biological method of Synthesis - Plant,	CLO2	1	Virtual lab	Experiential Learning
22.	bacteria,	CLO2	1	Research paper presentation	Problem-based Learning
23.	fungi mediated method.	CLO2	1	Book/ Article review	Problem-based Learning
24.	Biological Methods- Growth and Stabilization		1	Lecture – Chalk and Talk / Group reading	Participatory Learning
UNIT III: Characterization of Nanomaterials					
25.	Characterization of Nanomaterials-	CLO2	1	PPT / OER	Problem-based Learning
26.	Identification of Surface Plasmon Resonance using UV Visible Spectroscopy,	CLO2	1	Chalk and talk/ Picture	Problem-based Learning
27.	Identification of functional groups using Fourier Transform Infrared Spectroscopy,	CLO2	1	Lecture and Discussion	Experiential Learning
28.	Identification of Size and charge by Nanoparticle track analyzer,	CLO2	1	Lecture and Discussion	Participatory Learning
29.	Zeta potential	CLO2	1	PPT / OER	Participatory Learning
30.	Electron Microscope	CLO2	1	Virtual lab	Experiential Learning
31.	Scanning Electron Microscopy,	CLO2	1	Chalk and talk/ Picture	Participatory Learning
32.	High Resolution-Transmission Electron Microscopy,	CLO2	1	Research paper presentation	Problem-based Learning
33.	Atomic Force Microscopy,	CLO2	1	Research paper presentation	Problem-based Learning
34.	Energy Dispersive X-ray Spectroscopy and	CLO2	1	Student Seminar	Experiential Learning
35.	X-ray diffraction spectroscopy.	CLO2	1	Demonstration	Experiential Learning

UNIT IV: Molecular Nanotechnology					
36.	Molecular Nanotechnology,	CLO4	1	Lecture – Chalk and Talk / Group reading	Participatory Learning
37.	DNA-based Nanostructures,	CLO4	1	PPT / OER	Participatory Learning
38.	Mastering the complex DNA nanostructure,	CLO4	1	Chalk and talk/ Picture	Participatory Learning
39.	DNA tweezers,	CLO4	1	Chalk and talk/ Picture	Participatory Learning
40.	DNA actuators,	CLO4	1	Demonstration	Experiential Learning
41.	DNA scissors.	CLO4	1	Student Seminar	Experiential Learning
42.	Lipid-based Nanostructures-	CLO4	1	Book/ Article review	Problem-based Learning
43.	Micelles,	CLO4	1	Virtual lab	Problem-based Learning
44.	Liposomes,	CLO4	1	Research paper presentation	Problem-based Learning
45.	Self-assembly of protein nanoarchitecture	CLO4	1	Research paper presentation	Problem-based Learning
46.	Application of protein nanostructures	CLO4	1	Field observations and observation of renewable organic material	Problem-based Learning
Unit V: Applications of Nanobiotechnology					
47.	Nanobiotechnology in Diagnostic equipment, Surgical supplements, Tissue engineering, *Gene delivery, Drug delivery, Cancer therapy, Cosmetics.	CLO3	1	Lecture – Chalk and Talk / Group reading	Participatory Learning
48.	Biosensors,	CLO3	1	PPT / OER	Participatory Learning
49.	Surgical supplements,	CLO3	1	Chalk and talk/ Picture	Participatory Learning
50.	Tissue engineering,	CLO3	1	Video Lecture and Discussion	Problem-based Learning
51.	Gene delivery,	CLO3	1	Demonstration	Experiential Learning
52.	Drug delivery,	CLO3	1	Student Seminar	Experiential Learning
53.	Cancer therapy,	CLO3	1	Virtual lab	Experiential Learning

54.	Cosmetics.	CLO3	1	Book/ Article review	Problem-based Learning
55.	Environmental application- Photocatalysis of pollutants	CLO3	1	Virtual lab	Problem-based Learning
56.	and Heavy metals.	CLO3	1	Research paper presentation	Problem-based Learning
57.	Applications of nanobiotechnology in food processing, packaging	CLO3	1	Field observations and observation of renewable organic material	Problem-based Learning
58.	and in agriculture.	CLO3	1	Research paper presentation	Problem-based Learning

Name of the course	BT22C05-Nanobiotechnology
Name of the Faculty	Dr. V. Bhuvaneshwari
Participatory Learning	29.3 %
Experiential Learning	29.3 %
Problem-based Learning	41.4 %

COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	CREDITS
BT23C06	PLANT BIOTECHNOLOGY	THEORY	58	2	-	4

Preamble

- To understand the evolution of plant and its genome
- To explore the compounds, present in plants and how they influence the cell culture
- To study the vital components, require for plant tissue culture
- To understand the role of plant vectors and how they are utilized for human welfare
- To explore how biotechnology is used to create transgenic plants and Biosafety

Course Learning Outcomes

On the successful completion of the course, students will be able to

CLO Number	CLO Statement	Knowledge Level
CLO1	Understand the history of Biotechnology and state the importance of organization of plant genome	K1
CLO2	Apply acquainted with the molecular basis of action of plant hormones and gene expression	K2
CLO3	Illustrate about various culture medium preparations, haploid, triploid plant production and its applications	K3
CLO4	Apply symbiotic organisms as a vector for gene transfer to produce transgenic plants and develop molecular technique skills for crop improvement.	K4

Mapping with Programme Learning Outcomes

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	S	M	S	M	S
CLO2	S	S	S	M	M
CLO3	S	S	S	S	M
CLO4	S	S	S	S	S

S- Strong; M-Medium

BT23C06 - PLANT BIOTECHNOLOGY (58 Hours)

Unit I: Introduction and Scope

(12 hrs)

History of plant biotechnology, Conservation of Plant using Biotechnology- In situ and Ex situ methods. **Structural features of a representative plant gene.** Plant genome organization: Chloroplast and Mitochondrial. **Model Plants: Arabidopsis.**

Unit II: Plant tissue culture

(11 hrs)

Plant breeding: Heterosis and male sterility, **Plant tissue culture - laboratory organization, sterilization methods**, types and composition of media and preparation. **Plant Growth Regulators - Auxins, cytokinins and gibberellins, Absciscic acid, Brassinosteroids, Strigolactones, Ethylene and Jasmonic acid.** Phytochrome– role in photomorphogenesis

Unit III: Propagation techniques

(12 hrs)

Micropropagation techniques - direct and indirect organogenesis. Callus culture, Cell culture, **Isolation of protoplast, fusion and culture, Hybrid and cybrid production.** Somatic embryogenesis, **Synthetic seed production**, Haploid- Anther and Pollen culture Somaclonal variation.

Unit IV: Cloning of Plant Vectors

(11 hrs)

Biological N₂ fixation: Mechanism of nif and nod genes. Transformation: Stable and Transient gene expression, Gene transformation methods: Chemical, Biolistic, *Agrobacterium* **characteristics and Mechanism of T-DNA transfer**, Plant viral vector-CaMV.

Unit V: Applications of Plant Biotechnology

(12 hrs)

Transgenic plants: Chitinase gene based fungal resistance, Coat protein mediated virus resistance, **Insect resistance (Bt genes) and Herbicide resistance.** Quality improvement-Golden rice and Flavr Savr tomato. Plantibodies and Edible **vaccines (interleukins and interferons).** GM food: Biosafety issues and regulations in India. Agencies and its role: USDA and GEAC.

TEXT BOOKS

S.No	Authors	Title of the book	Publishers	Year & Edn
1	Singh B.D.	Plant Biotechnology.	Kalyani Publishers	2022 & 4th Edn
2	H S Chawla	Introduction to Plant Biotechnology.	Oxford & IBH Publishing	2020 & 3rd Edn
3	Adrian Slater, Nigel Scott, Mark Fowler	Plant Biotechnology: The Genetic Manipulation of Plants.	Oxford	2008 & 2nd Edn
4	Razdan M K	Introduction to Plant Tissue Culture	Oxford & IBH Publishing	2019 & 3rd Edn

REFERENCE BOOKS

S.No	Authors	Title of the book	Publishers	Year & Edn
1	Paul Christou and Harry Klee	Handbook of Plant Biotechnology.	Wiley India Pvt Ltd	2009 & Volume 2
2	Agnès Riccio, Surinder Chopra, Shelby J. Fleische	Plant Biotechnology: Experience and Future Prospects	Springer	2016

Course designers:

Dr. R. Nirmal Kumar

Dr. G. Anbarasi

***Link Provided for the Highlighted Content Offered in Blended Mode**

S.No	Topics	Links
Unit I: Introduction and Scope		
1.	Structural features of a representative plant gene.	https://youtu.be/kz4f7vIQFnM?si=CUdFMZpgNXgigfIO
2.	Organization of chloroplast genome and mitochondrial genome.	https://m.youtube.com/watch?v=m5_voDrCleQ
Unit II: Plant Tissue Culture		
3.	Plant Tissue Culture Laboratory Setup Sterilization Techniques in Plant Tissue Culture	https://www.youtube.com/watch?app=desktop&v=H4QDv16u784 https://www.youtube.com/watch?v=Pd5RUVrIOLA https://www.youtube.com/watch?v=_yL7_oS8apI
4.	Plant growth regulators	https://www.youtube.com/watch?v=YiitTnj92wA
Unit III: Propagation techniques		
5.	Micropropagation techniques - direct and indirect organogenesis.	http://ndl.iitkgp.ac.in/he_document/aklectures/aklectures/4_3_9_1654?e=0 organogenesis
6.	Protoplast isolation, fusion, and culture	https://youtu.be/4IKDkxBb4uY?si=UAjIFkhnO0U6mEro
7.	Hybrid and cybrid production.	http://ndl.iitkgp.ac.in/he_document/nptel/102103016_module1_lec13_1
8.	Synthetic seed production	http://ndl.iitkgp.ac.in/he_document/swayam_ugc_moocs/synthetic_seed_technology_28_1544_cec_Self_learning
Unit IV: Cloning of Plant Vectors		
9.	Agrobacterium and crown gall tumors.	http://ndl.iitkgp.ac.in/he_document/inflibnet_epgp/IN_I_e_P_P_1_B_409_P_0_g_E_4541_M_0_A_t_a_a_r_i_g_e_4567_4568
10.	Mechanism of T-DNA transfer to plants;	http://ndl.iitkgp.ac.in/he_document/inflibnet_epgp/IN_I_e_P_P_1_B_409_P_0_g_E_4541_M_0_A_t_a_a_r_i_g_e_4567_4568
11.	Biological N ₂ fixation: Mechanism of nif and nod genes.	https://www.youtube.com/watch?v=Ip0CX40BfnU
Unit V: Applications of Plant Biotechnology		
12.	Crop improvement	http://ndl.iitkgp.ac.in/he_document/nptel/IN_N_1_B_1188_P_B_1603_A_o_p_B_i_c_i_1605_1606
13.	Herbicide resistance	http://ndl.iitkgp.ac.in/he_document/nptel/IN_
14.	Insect resistance	http://ndl.iitkgp.ac.in/he_document/nptel/nptel/courses_104_108_104108056_video_lec36?e=2 transgenic%20plants
15.	Virus resistance	http://ndl.iitkgp.ac.in/he_document/nptel/IN_
16.	Edible Vaccines	https://www.youtube.com/watch?v=8n4hONDoSSc

Module No.	Topic	CLO level	No. of periods	Content delivery method	Learning methods
Unit I: Introduction and Scope					
1	Plant Biotechnology	CLO1	1	Lecture – Chalk and Talk / Group reading	Participatory Learning
2	History of Plant Biotechnology	CLO1 CLO2	1	PPT	Participatory Learning
3	Plant conservation through Biotechnology-In situ	CLO1 CLO2	1	Flipped classroom	Participatory Learning
4	Plant conservation through Biotechnology-Ex situ	CLO1 CLO2	1	Chalk and talk	Experiential Learning
5	Gene	CLO1 CLO2	1	Chalk and talk	Experiential Learning
6	Structural features of a representative plant gene	CLO1 CLO2	1	Video, Virtual lab	Experiential learning
7	Genome	CLO1 CLO2	1	Video, PPT	Participatory Learning
8	Genome Organization	CLO1 CLO2	1	Video, Student seminar	Participatory Learning
9	Plant Genome	CLO1 CLO2	1	Video, Virtual lab	Experiential Learning
10	Endosymbiosis	CLO1 CLO2	1	Lecture	Problem-based Learning
11	Chloroplast genome	CLO1 CLO2	1	Video, Flipped class room	Participatory Learning
12	Mitochondrial Genome	CLO1 CLO2	1	Video, Lecture / OER	Experiential Learning
Unit II: Plant tissue culture					
13	Plant breeding: Heterosis	CLO2 CLO3	1	Lecture / Seminar	Experiential Learning
14	Male sterility	CLO2 CLO3	1	Lecture / Seminar	Participatory Learning
15	Laboratory organization	CLO2 CLO3	1	Lecture / Seminar	Participatory Learning
16	Sterilization methods	CLO2 CLO3	1	Lecture / Seminar	Problem-based Learning
17	Types and composition of media	CLO2 CLO3	1	Lecture / Seminar	Participatory Learning
18	Media Preparation	CLO2 CLO3	1	Lecture	Experiential Learning
19	Auxins, cytokinins and gibberellins	CLO2 CLO3	1	OER	Participatory Learning

20	Abscisic acid, Brassinosteroids, Strigolactones	CLO2 CLO3	1	Video, Lecture / OER	Experiential Learning
21	Ethylene and Jasmonic acid	CLO2 CLO3	1	Video, Lecture / OER	Problem-based Learning
22	Phytochrome	CLO2 CLO3	1	Video, Lecture / OER	Participatory Learning
23	Role in Photomorphogenesis	CLO2 CLO3	1	Video, Lecture/ Virtual lab	Problem-based Learning
Unit III: Propagation techniques					
24	Micropropagation technique	CLO2 CLO3 CLO4	1	Lecture	Experiential Learning
25	Direct and indirect organogenesis.	CLO2 CLO3 CLO4	1	Video, Lecture	Experiential Learning
26	Callus culture	CLO2 CLO3 CLO4	1	Video / Observation	Problem-based Learning
27	Cell culture	CLO2 CLO3 CLO4	1	Lecture	Problem-based Learning
28	Isolation of protoplast	CLO2 CLO3 CLO4	1	Lecture PPT	Participatory Learning
29	fusion and culture of protoplast	CLO2 CLO3 CLO4	1	Lecture	Experiential Learning
30	Hybrid and cybrid production	CLO2 CLO3 CLO4	1	Lecture	Experiential Learning
31	Somatic embryogenesis	CLO2 CLO3 CLO4	1	Video, Demonstration	Experiential Learning
32	Synthetic seed production	CLO2 CLO3 CLO4	1	Video, Lecture PPT	Participatory Learning
33	Haploid- Anther culture	CLO2 CLO3 CLO4	1	Video, Demonstration	Participatory Learning
34	Haploid-Pollen culture	CLO3 CLO4	1	Video, Lecture PPT	Problem-based Learning
35	Somaclonal variation.	CLO3 CLO4	1	Video	Problem-based Learning
Unit IV: Cloning of Plant Vectors					
36	Nitrogen fixation	CLO3 CLO4	1	Video, Lecture	Problem-based Learning
37	Symbiotic nitrogen fixation in Rhizobia	CLO3 CLO4	1	Video, Demonstration	Experiential Learning

38	Types of Nif genes and their role	CLO3 CLO4	1	Video, Research article reading	Problem-based Learning
39	Mechanism of Nif genes in nitrogen fixation	CLO3 CLO4	1	Video, PPT	Problem-based Learning
40	Transformation: Stable and Transient gene expression	CLO3 CLO4	1	Video, PPT	Experiential learning
41	Gene transformation methods: Chemical	CLO3 CLO4	1	Video, PPT	Problem-based Learning
42	Gene transformation methods: Biolistic	CLO3 CLO4	1	Video, PPT	Participatory Learning
43	<i>Agrobacterium</i> characteristics	CLO3 CLO4	1	Brainstorming	Problem-based Learning
44	Ti and Ri plasmids	CLO3 CLO4	1	Brainstorming	Experiential learning
45	Mechanism of T-DNA transfer	CLO3 CLO4	1	PPT	Participatory Learning
46	Plant viral vector-CaMV	CLO3 CLO4	1	PPT	Experiential Learning
Unit V: Applications of Plant Biotechnology					
47	Transgenic plants: Crop improvement.	CLO1 CLO3 CLO4	1	Video, Research article reading	Participatory Learning
48	Chitinase gene based fungal resistance	CLO1 CLO3 CLO4	1	Video, Discussion	Problem-based Learning
49	Coat protein mediated virus resistance	CLO1 CLO3 CLO4	1	Video, Research article reading	Problem-based Learning
50	Insect resistance (Bt genes)	CLO1 CLO3 CLO4	1	Video, Lecture	Problem-based Learning
51	Herbicide resistance	CLO1 CLO3 CLO4	1	Video, Virtual lab	Problem-based Learning
52	Quality improvement-Golden rice	CLO1 CLO3 CLO4	1	PPT, Socratic	Problem-based Learning
53	Flavr Savr tomato	CLO1 CLO3 CLO4	1	PPT, Socratic	Problem-based Learning
54	Plantibodies	CLO1 CLO3 CLO4	1	PPT	Problem-based Learning
55	Edible vaccines (interleukins and interferons)	CLO1 CLO3 CLO4	1	PPT	Problem-based Learning

56	Genetically modified food	CLO1 CLO3 CLO4	1	Lecture	Problem-based Learning
57	Biosafety issues and regulations in India	CLO1 CLO3 CLO4	1	Lecture	Problem-based Learning
58	Agencies and its role: USDA and GEAC.	CLO1 CLO3 CLO4	1	Lecture	Problem-based Learning

Name of the course	BT23C06-Plant Biotechnology
Name of the Faculty	Dr. G. Anbarasi
Participatory Learning	29.3 %
Experiential Learning	29.3 %
Problem-based Learning	40.4 %

COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	CREDITS
BT23CO7	ANIMAL BIOTECHNOLOGY	THEORY	58	2	-	4

Preamble

- To teach the basics of animal cell culture and required media
- To inculcate the practical knowledge on animal cell culture techniques and transformation methods
- To study the method of genetic transformation in animal cells
- To make students understand the improved cell culture preservation techniques

Course Learning Outcomes

On the successful completion of the course, students will be able to

CLO Number	CLO Statement	Knowledge Level
CLO1	Understand the basic concepts of Animal cell culture and cell laboratory	K1
CLO2	Aquire the media preparation, preservation, trypsinization, counting, maintenance and application of cell lines.	K2
CLO3	Interpret the strategies for gene transfer and gene expressions with their applications.	K3
CLO4	Analyze advancements with genetic modification and stem cell technology in production of transgenic animals and learn the assisted reproductive technology and its applications	K4

Mapping with Programme Learning Outcomes

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	S	M	S	S	S
CLO2	S	S	S	M	L
CLO3	S	S	S	L	M
CLO4	S	M	M	M	S

S- Strong; M-Medium; L-Low

BT23CO7 - ANIMAL BIOTECHNOLOGY (58 Hours)

Unit 1: Introduction to Animal cell culture (12 hrs)

Animal cell culture; History and development. Pluripotency, Media, balanced salt solutions. Physical, chemical and metabolic functions of constituents of culture media. Role of carbon dioxide, Serum, growth factors and amino acids in media. Serum containing and serum free media. Constitution of a media for cell line. ***Essential equipments required for animal cell culture. Contaminations in Animal Cell Culture.**

Unit II: Animal cell culture and types (12 hrs)

Types of cell culture- Primary, Secondary, Organ culture and cell lines. Role of feeder layers in cell culture, Cell separation techniques, cell synchronization, ***Cell counting methods, Biology of cultured cells- Apoptosis and PCD.**

Unit III: Methods of transformation in cell culture (12 hrs)

Transfection of cells in culture- ***Animal viral vectors for transfection (Retrovirus, Baculovirus)**, Physical methods of transfection, HAT selection, selectable markers. Micro manipulation of cells, ***Gene targeting, Gene silencing and Gene knockout Mice and their applications.**

Unit IV: Applications of Animal cell culture (11 hrs)

Protein production by genetically engineered mammalian cell lines, **Cell culture as a source of valuable products -Transgenic Animals, *Stem cells,types and their applications;**

Unit V: Basic ART and Preservation (11 hrs)

Collection and preservation of embryos, Semen banking, ***Artificial Insemination, In vitro Fertilization (IVF), Intra Cytoplasmic Sperm Injection (ICSI) and Test tube babies (Louise Joy Brown and Kanupriya Agarwal), Cryopreservation, Cell banking procedures.** Ethical issues in Animal Biotechnology.

TEXT BOOKS

S.No	Authors	Title of the book	Publishers	Year & Edn
1	Rajesh Kumar Yadav	Animal Biotechnology and Genetic Engineering.	Oxford Book Company	2021 & 1st Edn
2	B. Singh and S.K Gautam	Textbook of Animal Biotechnology.	The Energy and Resources Institute, TERI	2014 & 1st Edn
3	A. K. Srivastava	Animal Biotechnology	Oxford and IBH Publishing Company Pvt. Limited	2018

REFERENCE BOOKS

S.No	Authors	Title of the book	Publishers	Year & Edn
1	Portner, R.	Animal cell Biotechnology.	Human Press.	2012 & 2nd Edn
2	R. Ian Freshney	Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications.	Wiley- Blackwell	2016 & 7 th Edn

Course designers:

Dr. D. S. Ranjith Santhosh Kumar

***Link Provided for the Highlighted Content Offered in Blended Mode**

S.No	Topics	Video Link
Unit 1: Introduction to Animal cell culture		
1.	Essential equipment required for animal cell culture. Contaminations in Animal Cell Culture.	https://www.youtube.com/watch?v=d-roLEvRfMk https://www.youtube.com/watch?v=VN1LkyBkKzs https://www.youtube.com/watch?v=CGOHvdKBGnA
Unit II: Animal cell culture and types		
2.	Cell counting methods, Biology of cultured cells- Apoptosis and PCD	https://www.youtube.com/watch?v=MZV4_QkonAE https://www.youtube.com/watch?v=CMQsyBqQB6s&t=115s https://www.youtube.com/watch?v=Iw--t_NfZHG
Unit III: Methods of transformation in cell culture		
3.	Animal viral vectors for transfection, Gene targeting, Gene silencing and Gene knockout and their applications	https://www.youtube.com/watch?v=vKEixrIat-Y https://www.youtube.com/watch?v=U3Z4u0DKbx0&t=39s https://www.youtube.com/watch?v=9O3uxdDD1cA
Unit IV: Applications of Animal cell culture		
4.	Stem cells and their applications; Cell culture as a source of valuable products - Transgenic Animals	https://www.youtube.com/watch?v=poj2Eg9Ho9M https://www.youtube.com/watch?v=Awtjro5At3g https://www.youtube.com/watch?v=x0ZqjULMcw4 https://www.youtube.com/watch?v=RzYhcXjksKc
Unit V: Storage and Preservation		
5.	AI, IVF, ICSI and Test tube babies. Cryopreservation	https://www.youtube.com/watch?v=OSyxbp8tXkk https://www.youtube.com/watch?v=uXsCngh89fl https://www.youtube.com/watch?v=xNmX3tBeC58 https://www.youtube.com/watch?v=6jx8bD6wWTs https://www.youtube.com/watch?v=tCNtKrxlZPs

Module No.	Topic	CLO Level	No. of periods	Content delivery method	Learning methods
Unit I: Introduction to Animal Cell Culture					
1	History & development of animal cell culture	CLO1, CLO3	1	Lecture	Participatory Learning
2	Pluripotency	CLO1, CLO4	1	PPT + Case Study	Experiential Learning
3	Media and balanced salt solutions	CLO1	1	Chalk Talk	Participatory Learning
4	Functions of media constituents	CLO1, CLO2	1	Lecture + Video	Experiential Learning
5	Role of CO ₂ in media	CLO1, CLO3	1	Flipped Classroom	Experiential Learning
6	Role of serum, growth factors, amino acids	CLO1, CLO4	1	Discussion	Participatory Learning
7	Serum-containing vs serum-free media	CLO2	1	Group Discussion	Participatory Learning
8	Constitution of media for cell lines	CLO2, CLO3	1	Virtual Lab	Experiential Learning
9	Essential equipment for cell culture	CLO2	1	Video + Lab Setup	Experiential Learning
10	Types of contamination	CLO2, CLO4	1	Case-based Learning	Problem-based Learning
11	Contaminations	CLO2	1	Lecture	Participatory Learning
12	Control strategies	CLO1, CLO2, CLO3	1	Group Work	Participatory Learning
Unit II: Animal Cell Culture Types					
13	Primary and secondary cultures	CLO2, CLO4	1	Lecture	Participatory Learning
14	Organ culture	CLO2, CLO3	1	PPT + Seminar	Experiential Learning
15	Cell lines	CLO2	1	PPT	Participatory Learning
16	Feeder layers in culture	CLO2, CLO3	1	Video + Discussion	Experiential Learning
17	Cell separation techniques	CLO2, CLO4	1	Lecture + Video	Problem-based Learning
18	Cell synchronization	CLO2	1	Chalk Talk	Participatory Learning

19	Cell counting methods	CLO2, CLO3	1	Demonstration	Experiential Learning
20	Biology of cultured cells	CLO2, CLO3	1	Video + Reading	Problem-based Learning
21	Apoptosis	CLO2, CLO4	1	Lecture	Problem-based Learning
22	PCD vs Apoptosis	CLO2	1	Group Discussion	Participatory Learning
23	Culture monitoring	CLO2, CLO3	1	Seminar	Experiential Learning
24	QC	CLO2	1	Quiz	Participatory Learning
Unit III: Methods of Transformation in Cell Culture					
25	Overview of transfection methods	CLO3	1	Lecture	Participatory Learning
26	Retroviral vectors	CLO3, CLO4	1	PPT + Case Study	Problem-based Learning
27	Baculoviral vectors	CLO3	1	Video + Discussion	Experiential Learning
28	Physical methods (e.g. electroporation)	CLO3	1	Demo	Experiential Learning
29	HAT selection	CLO3, CLO4	1	PPT + Quiz	Participatory Learning
30	Selectable markers	CLO3	1	Chalk Talk	Participatory Learning
31	Micromanipulation	CLO3	1	Virtual Lab	Experiential Learning
32	Gene targeting	CLO3, CLO4	1	Lecture + Article	Problem-based Learning
33	Gene silencing	CLO3	1	PPT + Video	Problem-based Learning
34	Gene knockout	CLO3, CLO4	1	TED Talk + Case	Problem-based Learning
35	Knockout mice	CLO3	1	Case Study	Participatory Learning
36	Applications	CLO3, CLO4	1	Group Quiz	Participatory Learning
Unit IV: Applications of Animal Cell Culture					
37	Protein production by mammalian cells	CLO3, CLO4	1	PPT	Experiential Learning
38	Engineered cell lines for product generation	CLO2, CLO4	1	Case Discussion	Problem-based Learning
39	Transgenic animals	CLO3, CLO4	1	Video + Seminar	Experiential Learning
40	Stem cell types	CLO1, CLO4	1	PPT + Video	Participatory Learning
41	Stem cell applications	CLO2, CLO4	1	Group Activity	Problem-based Learning

42	iPSCs	CLO1, CLO4	1	Article + Discussion	Participatory Learning
43	Therapeutic cloning	CLO3, CLO4	1	TED Talk	Participatory Learning
44	Future applications	CLO2, CLO4	1	Seminar	Participatory Learning
45	Ethical overview of applications	CLO3, CLO4	1	Group Discussion	Problem-based Learning
46	Applications summary	CLO2, CLO4	1	Team Poster	Participatory Learning
47	Future Aspects	CLO1, CLO4	1	Quiz + Reflection	Participatory Learning
Unit V: ART & Preservation					
48	Embryo preservation	CLO2, CLO4	1	Lecture	Participatory Learning
49	Semen banking	CLO3, CLO4	1	Video + Discussion	Experiential Learning
50	Artificial Insemination (AI)	CLO2, CLO4	1	Demo	Experiential Learning
51	IVF	CLO3, CLO4	1	Simulation	Problem-based Learning
52	ICSI	CLO1, CLO4	1	Video + PPT	Experiential Learning
53	Test tube babies (Louise & Kanupriya)	CLO2, CLO4	1	Case Review	Problem-based Learning
54	Cryopreservation	CLO3, CLO4	1	Lecture	Experiential Learning
55	Cell banking	CLO2, CLO4	1	Lab Tour + Video	Experiential Learning
56	Ethical issues	CLO3, CLO4	1	Discussion	Problem-based Learning
57	Regulatory framework	CLO2, CLO4	1	PPT	Participatory Learning
58	Regulatory reflection	CLO1, CLO4	1	Quiz + Feedback	Participatory Learning

Name of the course	BT23C07-Animal Biotechnology
Name of the Faculty	Dr. D. S. Ranjith Santhosh Kumar
Participatory Learning	33 %
Experiential Learning	33 %
Problem based Learning	34%

COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	CREDITS
BT23CP3	NANOBIOTECHNOLOGY, PLANT BIOTECHNOLOGY AND ANIMAL BIOTECHNOLOGY PRACTICAL	PRACTICAL	-	-	75	5

Preamble

- To develop the knowledge on plant and animal culture techniques
- To synthesize and analyze the nanoparticles using different methods
- To Illustrate different plant culture techniques using various explants
- To understand the presence of different phytochemicals in the plants

Course Learning Outcomes

On the successful completion of the course, students will be able to

CLO Number	CLO Statement	Knowledge Level
CLO1	Perform the plant tissue culture and illustrate callus development.	K1
CLO2	Demonstrate and develop technical skills in Protoplast isolation and phytochemical analysis	K2
CLO3	Analyze the technical skills in preparation of nanoparticles using different methods	K3
CLO4	Correlate the advanced techniques involved in cryopreservation and animal cell culture	K4

Mapping with Programme Learning Outcomes

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	S	S	S	M	S
CLO2	S	M	M	M	S
CLO3	S	S	M	M	S
CLO4	S	M	S	M	S

S- Strong; M-Medium

**BT23CP3 - NANOBIO TECHNOLOGY, PLANT BIOTECHNOLOGY AND ANIMAL
BIOTECHNOLOGY PRACTICAL (75 hours)**

NANOBIO TECHNOLOGY

1. Synthesis of copper oxide nanoparticles by sol-gel method
2. Synthesis of Zinc oxide nanoparticles by microwave method
3. Synthesis of Silver Nanoparticles by biogenic methods
4. Determination of surface plasmon resonance using UV-visible spectroscopy
5. Determination of average size and charge of nanoparticles using Particle Size Analyzer (Demo)
6. Characterization of functional groups in Nanoparticles using FTIR (Fourier Transformed Infra-Red Spectroscopy).

PLANT BIOTECHNOLOGY

1. Plant tissue culture media preparation & sterilization.
2. Callus induction
3. Micropropagation
4. Isolation of plant protoplast & viability test.
5. Embryo culture
6. Anther culture for haploid production
7. Artificial seed preparation
8. Phytochemical screening of plant secondary metabolites -Qualitative analysis
9. Analyze the DNA extraction, primer design, and amplification of specific gene using Polymerase Chain Reaction (PCR)

ANIMAL BIOTECHNOLOGY

1. Preparation of Animal Tissue culture medium and membrane filtration
2. Preparation of Primary cell culture using Chick embryo fibroblast
3. Isolation of Genomic DNA from blood
4. Cell viability Test -Trypan blue staining
5. Cytotoxicity assay using *Danio rerio* (Demo)
6. Cryopreservation and thawing (Demo)

TEXT BOOKS

S.No	Authors	Title of the book	Publishers	Year & Edn
1	Winkelmann, Kurt	Practical Aspects of Creating an Interdisciplinary Nanotechnology Laboratory Course for Freshmen	Journal of Nano Education 1.1	2009
2	Jenkins, N	Animal Cell Biotechnology: Methods and Protocols.	Humana press, New Jersey	1999
3	Nagar Santosh, Adhav Madhavi	Practical Biotechnology and Plant Tissue Culture	S Chand & Company	2010
4	Karl- Hermann Neumann, Ashwani Kumar, Jafargholi Imani	Plant Cell and Tissue Culture - A Tool in Biotechnology: Basics and Application.	Springer	2020 & 2 nd Edn

REFERENCE BOOKS

S.No	Authors	Title of the book	Publishers	Year & Edn
1	Poinern, G.E.J	A Laboratory Course in Nanoscience and Nanotechnology	CRC Press	2014
2	R. Ian Freshney	Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications.	Wiley-Blackwell	2016 & 7 th Edn
3	Razdan M K	Introduction to Plant Tissue Culture	Oxford & IBH Publishing	2019 & 3 rd Edn

Course Designers:

Dr. V. Bhuvaneshwari

Dr. D.S. Ranjith Santhosh Kumar

COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	CREDITS
BT23E01	PHARMACEUTICAL BIOTECHNOLOGY	THEORY	43	2	-	4

Preamble

- To learn about the essential qualities of a candidate drug and testing methods.
- To understand the basic science and clinical application of biotechnology-products.
- Provides a well-balanced framework in various aspects including dosage forms, administration and therapeutic application.

Course Learning Outcomes

On the successful completion of the course, students will be able to

CLO Number	CLO Statement	Knowledge Level
CLO1	Understand the likelihood of using biotechnological principles in pharmaceutical industries.	K1
CLO2	Analyze the dynamics and kinetics of drugs in relation to the routes of administration.	K2
CLO3	Compare how different drug formulations were developed for the market.	K3
CLO4	Evaluate the various modes of action for the developed pharmaceutical products and understand the roles, responsibilities and organizational structure of regulatory bodies.	K4

Mapping with Programme Learning Outcomes

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	S	S	M	M	S
CLO2	S	S	S	M	M
CLO3	S	M	M	S	S
CLO4	S	S	S	M	M

S- Strong; M-Medium

BT23E01 - PHARMACEUTICAL BIOTECHNOLOGY (43 Hours)

Unit I-Introduction to Pharmaceutical biotechnology (9 hrs)

Introduction to concepts and technologies in pharmaceutical biotechnology. New classes of pharmaceuticals, pharmaceutical industry in the modern era. Source of drugs – plant, animals, microbes and minerals. Drug isolation and evaluation. Physico – chemical properties of the drugs and Drug receptors.

Unit II- Pharmacokinetics (9 hrs)

Routes of Drug Administration - Enteral Routes and Parenteral Routes. Drug absorption- Biologic Factors. Drug distribution- Compartments, Protein Binding, Apparent volume of distribution (AVD or Vd). Drug biotransformation-Sites of drug metabolism, Enzyme Induction, Enzyme inhibition. Drug elimination-Renal Glomerular Filtration, Renal Tubular Secretion, Renal Tubular Reabsorption and Biliary Excretion.

Unit III- Product forms (9 hrs)

Tablets-formulation, binding agent, coating, tablet presses and types, Excipients, Capsules, Solutions-oral liquids, Injections and topical medication. Preservatives and phenolic compounds in drug formulations, pharmaceutical labeling and Guidelines for packing procedure and use of different techniques.

Unit IV- Pharmaceutical Products (8 hrs)

Therapeutic categories such as vitamins, laxatives, analgesics, non-steroidal contraceptives, Antibiotics, interferons, hormones (insulin, growth hormone) examples with respect to system.

Unit V- Manufacturing Principles and Regulatory Aspects (8 hrs)

Good Manufacturing Practice (GMP): Quality control, Chemical reactions that affect pharmaceutical products – Oxidation, reduction, hydrogenation, dehydrogenation. Regulatory authorities –Central drug standards control organization, food and drug administration, European regulations.

TEXT BOOKS

S. No	Authors	Title of the book	Publishers	Year & Edn
1.	Shayne Cox Gad	Drug discovery-Handbook	Wiley	2005
2.	Ronald D. Schoenwald	Pharmacokinetics in Drug Discovery Development	CRC Press	2002

REFERENCE BOOKS

S. No	Authors	Title of the book	Publishers	Year & Edn
1.	Kristian Stromgaard, Povl Krogsgaard- Larsen and Ulf Madsen	Textbook of drug design and discovery	CRC Press- Taylor & Francis group	2017

Course designers:

Dr. G. Shalini

Dr. V. Bhuvaneshwari

COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	CREDITS
BT23E02	BIOENTREPRENEURSHIP	THEORY	43	2	-	4

Preamble

- To motivate and help students in inculcating entrepreneurial mind-set
- To teach students various life science related business opportunities and take them forward
- To address the strength and interest of a student and shaping them to become a successful entrepreneur
- To teach students formulate a business plan in taking their business forward

Course Learning Outcomes

On the successful completion of the course, students will be able to

CLO Number	CLO Statement	Knowledge Level
CLO1	Understanding level of the students will be able to identify the challenges of being a Bioentrepreneur	K1
CLO2	Analyze the Business proposal for starting a company	K2
CLO3	Acquire about Vermicomposting and Sericulture	K3
CLO4	Illustrate set up Mushroom Cultivation and business plan	K4

Mapping with Programme Learning Outcomes

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	S	S	M	S	M
CLO2	S	S	M	S	M
CLO3	S	S	M	M	M
CLO4	S	M	M	M	M

S- Strong; M-Medium

BT23E02 – BIOENTREPRENEURSHIP (43 Hours)

Unit I: Introduction and Scope (9 hrs)

Basics of Bioentrepreneurship -Biotechnology in a Global scale; ***Types of Bio-industries – Biopharma, Bioagri and Bioservice innovations – Successful Entrepreneur – Creativity, Leadership, Managerial skills**, Team building, Decision making; Public and private funding agencies (MSME, DBT, BIRAC, Startup & Make in India).

Unit II: Single Cell Protein and Vermiculture (8 hrs)

***Single Cell Protein Production: Algae-Spirulina, Bacteria, Yeast. Experimental design; harvesting and Drying.** Earthworms-Ecological types - Vermiculture. Vermicomposting- Compost pit- Vermi bed- applications.

Unit III: Medical innovation (8 hrs)

Medical Device entrepreneurship - A New Era of Surgeries through Robotic Operations, remote patient monitoring devices, ***3D Printing in Medical Devices. Scaffold preparation, Diagnostic kits. Impact of innovation in medical devices, Case studies.**

Unit IV: Mushroom cultivation (9 hrs)

***Phases of Mushroom Cultivation; Selection of an acceptable mushroom species/strains, Management of mushroom development, Mushroom harvesting;** Mushroom diseases, Medicinal and Nutritional properties of mushroom.

Unit V: Business plan (9 hrs)

Business plan preparation; business feasibility analysis by SWOT, business plan proposal for virtual startup company; statutory and legal requirements for starting a company/venture; basics in accounting practices. *Market Conditions, Identifying the need of the customers.

TEXT BOOKS

S.No	Authors	Title of the book	Publishers	Year & Edn
1	Craig Shimasaki	Biotechnology Entrepreneurship: Starting, Managing, and Leading Biotech Companies Hardcover	Academic Press	2014
2	Alberto Onetti Antonella Zucchella	Business Modeling for Life Science and Biotech Companies: Creating Value and Competitive Advantage with the Milestone Bridge. (8 June 2018)	CBS Publishers & Distributors Pvt. Ltd	2018 & 1 st Edn
3	David Adams, John Sparrow	Enterprise for Life Scientists: Developing Innovation and Entrepreneurship in the Biosciences.	Scion Publishing Ltd	2007 & 1 st Edn

REFERENCE BOOKS

S.No	Authors	Title of the book	Publishers	Year & Edn
1	Stephen Russell	The Essential Guide to Cultivating Mushrooms: Simple and Advanced Techniques for Growing Shiitake, Oyster, Lion's Mane, and Maitake Mushrooms at Home	Storey Publishing LLC	2014
2	Pushpa Srivastava	Nutraceutical Spirulina: Commercial Cultivation Using Rural Technology in India. First Edn	Aavishkar Publishers, Distributors, Jaipur	2017 & 1 st Edn

Course designers:

Dr. G. Anbarasi

Dr. V. Bhuvaneshwari

*COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	CREDITS
BT23E03	BIOETHICS, BIOSAFETY AND IPR	THEORY	43	2	-	4

Preamble

- To understand the concepts of Bioethics and Biosafety
- To realize the impact of Gene cloning in societal problems and Bioethics, Biosafety and GLP
- To know about the importance of Ethical Clearance
- To get knowledge about Patents Rights in the field of Research

Course Learning Outcomes

On the successful completion of the course, students will be able to

CLO Number	CLO Statement	Knowledge Level
CLO1	Understand the concepts of Bioethics and Biosafety.	K1
CLO2	Interpret the impact of Gene cloning in societal problems and Bioethics, Biosafety and GLP.	K2
CLO3	Acquire the importance of Ethical Clearance	K3
CLO4	Analyze about Patents Rights in the field of Research.	K4

Mapping with Programme Learning Outcomes

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	S	S	S	S	S
CLO2	S	M	M	S	S
CLO3	S	M	M	S	S
CLO4	S	S	S	S	S

S- Strong; M-Medium

BT23E03 - BIOETHICS, BIOSAFETY AND IPR (43 Hours)

Unit 1: Human Rights

(8 hrs)

Human Rights: Definition, Classification and Scope of Human Rights. United Nations Commission for Human Rights, National and State Human Rights Commission. Article 21 of Indian Constitution – UDHR. Social issues of Human rights.

Unit II: Bioethics

(9 hrs)

Impact of gene cloning & Bioethics-Issues concerning reproduction, Birth, life and Death (Artificial insemination, egg donation, IVF, embryo transplants, Prenatal diagnosis and sex selection & Abortion).

Unit III: IPR

(9 hrs)

Patents - Introduction -Treaties and Conventions of Patents, Patent Cooperation Treaty - TRIPS Basis of Patentability – Non-Patentable Inventions - Patent Application Procedure in India. Other Forms of IP: Copyright - Trade Mark – Industrial designs – Farmer’s Rights. Patenting of Biotechnology products and processes.

Unit IV: Ethical issues in IPR

(8 hrs)

Bioethics of IPR - ethical criteria in biotechnology- animal ethics; Licensing of animal house - Human cloning - Ethical issues - Ethical clearance norms for conducting studies on human subjects.

Unit V: Biosafety regulations and guidelines

(9 hrs)

Biosafety - General guidelines - DBT guidelines on biosafety in conducting research in biology / biotechnology - Risk assessment studies- Hazardous materials used in Biotechnology- Handling and Disposal - Good manufacturing practices & Good Laboratory practices, Containment facilities and Biosafety practices - Regulation on field experiments and release of GMO’s - Labelling of GM foods - Guidelines for research in transgenic plants and Animals.

TEXT BOOKS

S. No	Authors	Title of the book	Publishers	Year & Edn
1	Ignacimuthu. S	Bioethics	Narosa Publication house	2009
2	Sree Krishna. V	Bioethics and Biosafety in Biotechnology	Blackstone Press.	2007

REFERENCE BOOKS

S. No	Authors	Title of the book	Publishers	Year & Edn
1	John.A.Thomas	Biotechnology and safety assessment	CRC Press-Taylor and Francis.	2004
2	Beauchamp & Leroy	Contemporary issues in Bioethics	Wardsworth Pub. Co. Belmont, California	1999

Course designer:

Dr. V. Bhuvaneshwari

***Link provided for the highlighted content offered in Blended Mode**

S.No.	Topics	Links
Unit – I- Introduction and Scope		
1	Social issues of Human rights.	https://www.youtube.com/watch?v=w_CgO8bs6Lc
Unit – II- Single Cell Protein and Vermiculture		
2	Sex Selection & Abortion	https://www.youtube.com/watch?v=v17mO4k58A0 https://www.youtube.com/watch?v=EF_IChTU4Xc
Unit – III- Medical innovation		
3	Patenting of Biotechnology products and processes.	https://www.youtube.com/watch?v=zcoVdLxhcc4
Unit – IV- Mushroom cultivation		
4	Ethical clearance norms for conducting studies on human subjects.	https://www.youtube.com/watch?v=4f7xqwc2lzs
Unit –V- Business plan		
5	Labelling of GM foods	https://www.youtube.com/watch?v=wzG1NOMuaZc
6	Guidelines for research in transgenic plants and Animals.	https://www.youtube.com/watch?v=-c3l4Tyl8Q

Module No.	Topic	CLO level	No. of periods	Content delivery method	Learning methods
Unit – I- Introduction and Scope					
1	Human Rights: Definition,	CLO1	1	Lecture	Participatory Learning
2	Classification	CLO1	1	PPT	Participatory Learning
3	and Scope of Human Rights.	CLO1	1	Lecture and Video	Participatory Learning
4	United Nations Commission for Human Rights,	CLO1	1	PPT and Video	Experiential Learning
5	National and	CLO1	1	PPT and Video	Experiential Learning
6	State Human Rights Commission.	CLO1	1	Video and discussion	Problem-based Learning
7	Article 21 of Indian Constitution – UDHR.	CLO1	1	PPT	Problem-based Learning
8	Social issues of Human rights.	CLO1	1	Lecture and PPT	Experiential Learning
Unit – II- Single Cell Protein and Vermiculture					
9	Impact of gene cloning &	CLO2	1	Video and PPT	Problem-based Learning
10	Bioethics-Issues concerning reproduction,	CLO2	1	Video and Discussion	Participatory Learning
11	Birth, life and Death	CLO2	1	Video, Lecture and PPT	Participatory Learning
12	(Artificial insemination,	CLO2	1	Video and PPT	Problem-based Learning
13	egg donation,	CLO2	1	Lecture and video	Experiential Learning
14	IVF,	CLO2	1	PPT and Discussion	Experiential Learning
15	embryo transplants,	CLO2	1	Lecture and video	Problem-based Learning
16	Prenatal diagnosis and	CLO2	1	Discussion	Problem-based Learning
17	sex selection & Abortion).		1	Lecture and video	Problem-based Learning
Unit – III- Medical innovation					
18	Patents - Introduction - Treaties	CLO3	1	Lecture	Problem-based Learning
19	and Conventions of Patents,	CLO3	1	Research article reading	Problem-based Learning
20	Patent Cooperation Treaty - TRIPS	CLO3	1	Discussion	Participatory Learning

21	Basis of Patentability –	CLO3	1	Video and PPT	Problem-based Learning
22	Non-Patentable Inventions -	CLO3	1	Video and Demonstration	Experiential Learning
23	Patent Application Procedure in India.	CLO3	1	Video and PPT	Participatory Learning
24	Other Forms of IP: Copyright - Trade Mark –	CLO3	1	Video and Lecture	Experiential Learning
25	Industrial designs – Farmer's Rights.	CLO3	1	Video and Seminar	Participatory Learning
26	Patenting of Biotechnology products and processes.		1	Lecture	Experiential Learning
Unit – IV- Mushroom cultivation					
27	Bioethics of IPR -	CLO4	1	Video and PPT	Problem-based Learning
28	ethical criteria in biotechnology-	CLO4	1	Video and Lecture	Problem-based Learning
29	animal ethics;	CLO4	1	Video and Discussion	Participatory Learning
30	Licensing of animal house-	CLO4	1	Video and Research article reading	Experiential Learning
31	Human cloning -	CLO4	1	Video and Brainstorming	Participatory Learning
32	Ethical issues -	CLO4	1	Video and Observation	Experiential Learning
33	Ethical clearance norms for conducting studies on human subjects.	CLO4	2	PPT	Problem-based Learning
Unit –V- Business plan					
34	Biosafety - General guidelines -	CLO4	1	Lecture	Participatory Learning
35	DBT guidelines on biosafety in conducting research in biology / biotechnology -	CLO4	1	OER	Problem-based Learning
36	Risk assessment studies- Hazardous materials used in Biotechnology-	CLO4	1	Seminar	Participatory Learning
37	Handling and Disposal -	CLO4	1	Lecture	Participatory Learning
38	Good manufacturing practices &	CLO4	1	OER	Experiential Learning
39	Good Laboratory practices,	CLO4	1	Virtual lab	Experiential Learning
40	Containment facilities and Biosafety practices -	CLO4	1	Video and Virtual lab	Experiential Learning

41	Regulation on field experiments and release of GMO's - Labelling of GM foods -	CLO4	1	Video and PPT	Problem-based Learning
42	Guidelines for research in transgenic plants and Animals.	CLO4	1	Video and Lecture	Problem-based Learning

Name of the course	BT23E03-BIOETHICS, BIOSAFETY AND IPR
Name of the Faculty	Dr P. Suganya
Participatory Learning	30 %
Experiential Learning	30 %
Problem-based Learning	40 %

COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	CREDITS
BT21AC1	CANCER BIOLOGY	THEORY	-	-	-	5

Preamble

- To learn the principles of cancer biology.
- Explore the molecular pathways responsible for genome instability in cancer cells.
- To gain core knowledge of the cellular targets and molecular mechanisms.

Course Learning Outcomes

On the successful completion of the course, students will be able to

CLO Number	CLO Statement	Knowledge level
CLO1	Understand the basics of Cancer Biology	K1
CLO2	Comprehend the Cancer at the Molecular level	K2
CLO3	Acquire brief knowledge about the types of Cancer	K3
CLO4	Analyze the different techniques of detection and Treatment and prevention of Cancer	K4

Mapping with Programme Learning Outcomes

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	S	S	S	S	S
CLO2	S	S	S	S	S
CLO3	S	S	S	S	S
CLO4	S	S	S	S	M

S- Strong; M-Medium

BT21AC1- CANCER BIOLOGY

Unit I-Introduction to cancer biology

Cancer: Introduction; Origin of Cancer- The Mutation Concept, The Epigenetic Concept, Viral Concept, Unified genetic concept of cancer; Difference between Normal and Cancer cells; Signs and symptoms.

Unit II- Cancer at the Molecular level

Cancer as a genetic disease; Genetic Alterations in Cancer cells, Point mutation, splice mutation, alternate splicing; Mutation in regulatory sequences, deletions, Insertion, Chromosome abnormalities, Genetic defects and the time course of hereditary cancer.

Unit III-Types of Cancer

Blood & Lymph – Leukemia, Malignant lymphoma, Bone- Soft tissue Sarcoma, Thorax- Breast cancer, Male genitalia- Prostate cancer, Female genitalia- Cervical cancer; Tumor suppressor genes; Classification of Tumor suppressor genes.

Unit IV- Detection and Treatment of Cancer

Early detection, Molecular detection of Carcinomas, Cancer warning signals; Markers in blood urine; Therapies- Chemotherapy, Gene therapy, Radiotherapy, Biological therapy (Immuno therapy).

Unit V-Prevention

Tobacco smoking, sunlight, diet, ionizing radiation, alcohol drugs, promiscuity, lifestyle and cancer prevention, Environmental factors and cancer, potentially carcinogenic substances for humans.

TEXT BOOKS

S.No	Authors	Title of the book	Publishers	Year & Edn
1	A. Sarkar	Biology of Cancer	Discovery Publishing House	2011
2	Ranajit Sen	Principles and Management of Cancer	B.I. Publications Pvt Ltd	2004
3	M.R.Ahuja	Cancer- Causes and Prevention	UBS Publishers Distributors Pvt	1997

REFERENCE BOOKS

S.No	Authors	Title of the book	Publishers	Year & Edn
1.	Francesco Pezzella, MahvashTavassoli, David J. Kerr	Textbook of Cancer Biology	Oxford University Press	2019
2.	Robin Hesketh	Introduction to Cancer Biology	Cambridge University Press	2012

Web Resources

1. <http://csbl.bmb.uga.edu/mirrors/JLU/DragonStar2017/download/introduction-to-cancer-biology.pdf>
2. <http://webserver1.oneonta.edu/faculty/bachman/cancer/207lectures.htm>

Course designer:

Dr. G. Shalini

COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	CREDITS
BT21AC2	STEM CELL TECHNOLOGY AND TISSUE ENGINEERING	THEORY	-	-	-	5

Preamble

- To understand the basic of stem cell
- To gain knowledge in the Mechanisms and applications of Stem Cell
- To acquire knowledge in the areas of tissue engineering.

Course Learning Outcomes

On the successful completion of the course, students will be able to

CLO Number	CLO Statement	Knowledge level
CLO1	Understand the concept of stem cells.	K1
CLO2	Describe the concept of stem cell cloning and its applications.	K2
CLO3	Analyze treatment of human diseases connected to stem cell therapy.	K3
CLO4	Evaluate the structural and organization of tissues, analyze the role of different biomaterials and its applications in tissue engineering. .	K4

Mapping with Programme Learning Outcomes

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	S	S	S	S	S
CLO2	S	S	S	S	S
CLO3	S	S	S	S	S
CLO4	S	S	S	S	M

S- Strong; M-Medium

BT21AC2 - STEM CELL TECHNOLOGY AND TISSUE ENGINEERING

Unit I- Concept and types of stem cells

Introduction to stem cells, Basic concepts and properties, Totipotency, Pluripotency, Embryonic stem cells, Germinal stem cells, adult stem cells, Tumor stem cells, Stem cell plasticity, General methods of characterization of stem cells, Early events in development.

Unit II- Stem Cells and Cloning

Cell cycle regulation in stem cells, Therapeutic and reproductive cloning, Nuclear Transfer (NT) method, Isolation of Embryonic stem (ES) cells, Salient features and application of NT and ES cells, Safety of NT and ES cells.

Unit III- Overview of embryonic and adult stem cells for therapy

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

Unit IV- Structural and organization of tissues

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

Unit V- Engineering biomaterials for tissue engineering

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

TEXT BOOKS

S.No	Authors	Title of the book	Publishers	Year & Edn
1	Atala A &Lanza R	Handbook of Stem Cells	Academic Press	2012
2	Robert Lanza and Anthony Atala	Essential of Stem Cell Biology	Elsevier Academic Press	2013

REFERENCE BOOKS

S.No	Authors	Title of the book	Publishers	Year & Edn
1.	Marshak L	Stem Cell Biology	Cold Spring Harbor Publication	2001
2.	Robert Lanza, Robert Langer, Joseph Vacanti	Principles of Tissue Engineering	Academic Press	2000

Web Resources

1. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1129084/>
2. <https://www.sciencedirect.com/topics/engineering/tissue-engineering>

Course designer:

Dr. G. Shalini

COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	CREDITS
BT22SBP1	BIOMOLECULAR COMPUTING PRACTICAL	PRACTICALS	-	4	41	3

Preamble

- To learn the fundamentals of protein structure and modelling
- To learn phylogenetic relationships
- To learn the concepts of docking
- To effectively utilize docking platforms

Course Learning Outcomes

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

CLO	CLO Statement	Knowledge Level
CLO1	Understand the biological databases and its applications	K1
CLO2	Analyze to design phylogenetic trees and interpret the evolution pattern	K2
CLO3	Apply the concept of protein structure, design drugs and dock	K3
CLO4	Illustrate research into the minds of biologists and innovate new drugs for safeguarding the society	K4

Mapping with Programme Learning Outcomes

CLO	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	S	S	M	S	S
CLO2	M	M	S	M	M
CLO3	S	S	S	S	S
CLO4	M	M	S	S	M

S-Strong, M-Medium

BT22SBP1 - BIOMOLECULAR COMPUTING PRACTICAL

1. Biological databases and Gene Prediction

- a. Sequence database – NCBI, GenBank, DDBJ, EMBL, Swiss-Prot, PFAM
- b. Structural database – PDB, SCOP, CATH
- c. Gene structure and function prediction – GenScan and GeneMark
- d. Primer Designing concepts – Primer3 (tool)

2. Sequence alignment and Phylogenetic analysis

- a. Protein sequence analysis - ExPASy proteomics tools
- b. Pairwise sequence alignment- BLASTn, BLASTp and BLASTx
- c. Multiple sequence alignment – ClustalW, Omega
- d. Phylogenetic tree evaluation and Phylogenetic Program – MEGA

3. Macromolecular Structure Prediction and Validation

- a. Homology Modeling –SWISS-MODEL
- b. Model validation using ProSA, WhatCheck, Errat and ProCheck
- c. Structure visualization- RasMol and PyMol

4. Chemical structure and ADME rules

- a. Small molecule building, using ISIS DRAW and CHEMSKETCH
- b. Chemical database – PubChem, DrugBank, ChemBank, Hazardous Substances Data Bank
- c. File formats and conversion – Open Babel, SMILES
- d. Drug properties, Toxicity, Drug likeness, Lipinski's rule of five- SWISSADME tool

5. Molecular Docking and analysis

- a. Active site prediction (CASP, PDBSum)
- b. Structure-based drug design and Ligand based drug design
- c. Virtual Screening and Scoring Function
- d. Pharmacophore design and identification
- e. Molecular docking - PyRx
- f. Drug-Receptor interaction - Discovery Studio

TEXT BOOKS

S. No	Authors	Title of the book	Publishers	Year & Edn
1.	Jin Xiong	Essential Bioinformatics	Cambridge University Press	2006
2.	Andréa's D. Baxevanis and B.F. Francis Ouellette	Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins	Wiley-Interscience	2004
3.	David W Mount	Bioinformatics: Sequence and Genome	Cold Spring Harbor Laboratory Press	2001
4.	Andrew R. Leach	Molecular Modelling: Principles and Applications.	Pearson	2001 & 2 nd Edn

REFERENCE BOOKS

S. No	Authors	Title of the book	Publishers	Year & Edn
1.	Guido van Rossum and Fred L. Drake Jr,	An Introduction to Python, Revised and updated for Python 3.2	Network Theory Ltd.	2011
2.	Wesley J Chun	Core Python Applications Programming	Prentice Hall	2012

Course Designers:

Dr. G. Shalini

Dr. V. Bhuvaneshwari

BACHELOR OF SCIENCE IN BIOTECHNOLOGY
CHOICE BASED CREDIT SYSTEM (CBCS) &
LEARNING OUTCOMES - BASED CURRICULUM FRAMEWORK (LOCF)
SCHEME & SYLLABUS OF EXAMINATION
2023-2026
BATCH
SEMESTER VI

Semester	Part	Course Code	Title of the Course	Course Type	Instruction hours/ Week	Contact hours	Tutorial hours	Duration of Examination	Examination Marks			Credits
									CA	ESE	TOTAL	
VI	III	BT23C08	Genomics and Proteomics	CC	5	73	2	3	25	75	100	4
		BT23C09	Fermentation Technology	CC	5	73	2	3	25	75	100	4
		BT23C10	Environmental Biotechnology	CC	5	73	2	3	25	75	100	4
		BT23CP4	Genomics and Proteomics, Fermentation Technology, Environmental Biotechnology Practical	CC	7	105	-	6	25	75	100	6
		BT23E04/ BT23E05/ BT23E06	Marine Biotechnology / Food Technology and Regulation / Drug discovery and development	DSE	5	73	2	3	25	75	100	4
		BT22SB02	Computational Bio-Networking	SEC	3	43	2	-	100	-	100	3
		BT22AC3/ BT23AC4	Forensic Biotechnology / Human Anatomy and Physiology	ACC	SS	-	-	3	25	75	100	5
I-VI			Grand Total								4000	140

CC: Core Courses DSE : Discipline Specific Elective ACC : Additional Credit
Courses SEC: Skill Enhancement Course
CA – Continuous Assessment ESE - End Semester Examination SS : Self study

QUESTION PAPER PATTERN

For Core and Allied theory paper (First 3 Units)

CA Question from each unit comprising of

One question with a weightage of 2 Marks :2 x 3 = 6

One question with a weightage of 5 Marks (Internal Choice at the same CLO level) :5 x 3 =15

One question with a weightage of 8 Marks (Internal Choice at the same CLO level) :8 x 3 =24

Total :45 Marks

End Semester Examination – Question Paper Pattern and Distribution of Marks

ESE Question Paper Pattern for Core and Allied Course: 5 x 15 = 75 Marks

Question from each unit comprising of One question with a weightage of 2 Marks : 2 x 5=10

One question with a weightage of 5 Marks (Internal Choice at the same CLO level): 5 x 5 =25

One question with a weightage of 8 Marks (Internal Choice at the same CLO level): 8 x 5 =40

Attendance component in CA

From the academic year 2024-25 and onwards marks allotted for attendance component in CA is modified as

91-100% attendance: 3 Marks

81-90% attendance : 2 Marks

75-80% attendance : 1 Marks

Continuous Internal Assessment Pattern

Theory

CIA Test : 5 marks (Conducted for 45 marks after 50 days)

Model Exam : 7 marks (Conducted for 75 marks after 85 days (Each Unit 15 Marks))

Seminar/Assignment/Quiz : 5 marks

Class Participation : 5 marks

Attendance : 3 marks

Total : 25 Marks

Practical

Lab Performance - 7 marks

Regularity - 5 marks

Model Exam - 10 marks

Attendance - 3 marks

Total - 25 marks

Evaluation pattern for ESE Practical

The End Semester Examination will be conducted for a maximum of 75 marks with a maximum 15 marks for the record and other submissions if any.

Evaluation pattern for Skill Based Theory Subject

Test 1 (Theory) - 30 marks (Conducted for 50 marks and converted to 30 marks)

Test 2 (Theory) - 50 marks

Assignment - 10 marks

Seminar - 10 marks

Total - 100 marks

Evaluation pattern for Skill Based Practical Subject

Test 1 (Theory/Practical)	- 30 marks (Conducted for 50 marks and converted to 30 marks)
Test 2 (Theory/Practical/Project)	- 50 marks
Lab Performance	- 10 marks
Regularity	- 10 marks
Total	- 100 marks

Internal component for ALC-25 marks

CA	-10 marks
Model exam	-15 marks
Total	-25marks

Model/End Semester for UG - Advance Learner Courses

Section A: 5 questions out of 8 - open choice 5x5: 25 marks

Section B: 5 questions out of 8 - open choice 5x10: 50 marks

Total: 75 marks

COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	CREDIT
BT23C08	GENOMICS AND PROTEOMICS	THEORY	73	2	-	4

Preamble

- This course teaches students about genome organization, sequencing, and editing tools, along with proteomic approaches to study protein structure and function. It also helps them understand experimental data and apply genomics and proteomics in disease diagnosis and drug discovery.

Prerequisite

- Basic Knowledge in molecular biology, genetic engineering and Bioinformatics.

Course Learning Outcomes

On the successful completion of the course, students will be able to

CLO Number	CLO Statement	Knowledge Level
CLO1	Illustrate the fundamental concepts and advanced techniques in genomics and proteomics.	K1
CLO2	Interpret recent developments in genomics and proteomics for understanding human disease biology.	K2
CLO3	Discover proteomic tools for protein structure-function analysis and prediction.	K3
CLO4	Correlate and implement functional genomics and proteomics techniques for biological data analysis.	K4

Mapping with Programme Learning Outcomes

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	M	M	S	S	M
CLO2	M	M	S	M	M
CLO3	M	S	M	M	M
CLO4	S	M	S	M	S

*S- Strong; M-Medium; L-Low

GENOMICS AND PROTEOMICS - BT23C08 -73 HRS

UNIT I: Introduction and Scope (15 Hrs)

Definition of genomics and proteomics. Structural genomics: Organization of *E. coli* genome, Human genome, Chloroplast and Mitochondrial genomes. Human Genome Project. Genome mapping: Genetic maps and Physical maps. Genetic mapping: Linkage mapping, Markers for mapping (RFLP, SNPs, microsatellite markers). Physical mapping of genome Comparative gene mapping.

UNIT II: Genome Sequence and Editing (14 Hrs)

Genome sequencing: Expressed sequence Tags (ESTs). Sanger sequencing, Maxam and Gilbert sequencing, automated sequencing, Whole genome shotgun sequencing, Illumina sequencing (solex technology), nanopore sequencing. Next-generation sequencing (NGS). Genome Editing Technologies: Zinc Finger Nucleases (ZFNs), TALENS, CRISPR-Cas9, Base Editing and Prime Editing. Applications of Genome Sequencing and Editing.

UNIT III: Omics Tools For Gene Expression (15 Hrs)

Single cell sequencing; ChIP-Seq: Identification of human biomarkers using genomics. Transcriptomics – transcript analysis – global gene expression analysis, DNA chips, micro arrays – differential gene expression. Non array based whole transcriptome analysis, differential display, serial analysis of gene expression (SAGE).

UNIT IV: Proteomics and Tools for Structural Proteomics (15 Hrs)

Introduction to the concept of proteome, proteomic analysis, importance of proteomics in biological functions. Domains types and importance. Methods to determine 3D structures- X- ray crystallography, nuclear magnetic resonance (NMR), cryogenic electron microscopy (cryo-EM). Mass spectroscopy- ESI-TOF MS and MALDI-TOF MS. AlphaFold-Protein structure database.

UNIT V: Tools and Techniques for Functional Proteomics (14 Hrs)

From Genomics to Proteomics, Strategies of Protein Separation and quantification: Liquid chromatography in Proteomics. Protein sequencing-Edman degradation. Protein- protein interactions using Yeast two-hybrid system, Protein chips in functional proteomics, Comparative proteomics.

Reference Link

S.No	Topics	Links
UNIT I : Introduction and Scope		
1.	Human genome project	https://www.youtube.com/watch?v=MvuYATh7Y74
2.	Linkage mapping	https://www.youtube.com/watch?v=ownsru2JO0w
3.	Physical mapping of genome	https://www.youtube.com/watch?v=I1fy7MvtzLY
UNIT II: Genome Sequence and Editing		
4.	Sanger's Sequencing	https://www.youtube.com/watch?v=KTstRrDTmWI
5.	Next-generation sequencing (NGS).	https://www.youtube.com/watch?v=bDsfd6V-U1c
6.	Base Editing and Prime Editing.	https://www.youtube.com/watch?v=8LHTyyye6Z0
UNIT III: Omics Tools For Gene Expression		
7.	Transcriptomics – transcript analysis – global gene expression analysis	https://www.youtube.com/watch?v=WlqwStlHxMs
8.	micro arrays – differential gene expression	https://www.youtube.com/watch?v=Hv5flUOsE0s https://www.youtube.com/watch?v=xBr2qznEaqw
9.	serial analysis of gene expression (SAGE).	https://www.youtube.com/watch?v=9OeM25EwopY
UNIT: IV Proteomics and Tools for Structural Proteomics		
10.	X-ray crystallography,	https://www.youtube.com/watch?v=hSYOaKYeDI4
11.	nuclear magnetic resonance (NMR)	https://www.youtube.com/watch?v=feEjuBW1lCc
12.	cryogenic electron microscopy (cryo-EM).	https://www.youtube.com/watch?v=qc2PbmI5qMw
13.	MS/MS methods	https://www.youtube.com/watch?v=7NEWDmT1sCo
14.	ESI-TOF MS	https://www.youtube.com/watch?v=9AWBAI-Owzk
15.	Mass spectroscopy-MALDI-TOF.	https://www.youtube.com/watch?v=nccPXw2Avu8
16.	Alphafold	https://youtu.be/7q8Uw3rmXyE?si=RQjxrjuD6f3735tW
UNIT V: Tools and Techniques for Functional Proteomics		
17.	Protein-Protein interaction using Yeast two-hybrid system	https://www.youtube.com/watch?v=2p6G3yA-hO4
18.	Protein chips in functional proteomics	https://www.youtube.com/watch?v=9TYgNWyENRE

Text Book

S.No	Authors	Title of the book	Publishers	Year and Edition
1	Primrose, S. B., & Twyman, R. M.	Principles of Genome analysis and Genomics	Blackwell publishing	2013 7 th Edn
2	Cristianini, N., & Mattheis, A.	Genome Interpretation: A Deep Learning Perspective	Cambridge University Press	2023 3 rd Edn
3	Lesk, A. M.	Introduction to Genomics and Bioinformatics	Oxford University Press	2023 4 th Edn
4	Tymann, R.	Principles of Proteomics	Garland Science Publisher	2013 2 nd Edn

Books for Reference

S.No	Authors	Title of the book	Publishers	Year and Edition
1	Henderson, D. S., & Lovell, C. E.	Clinical Genomics: From NGS to Patient Analysis	Academic Press, Elsevier	2023 2 nd Edn
2	Orengo, C., & Thornton, J. M.	Computational Proteomics: Methods and Applications	Wiley- Blackwell Publishing	2022 3 rd Edn
3	Attwood, T. K., & Taylor, D. J.	Modern Proteomics and Genomics Analytics: Principles and Practice	CRC Press, Francis States,	2023 4 th Edn

Course Designer

1. Dr. R. Nirmal Kumar

Pedagogy

- PowerPoint Presentations, Group Discussion, Seminar, Quiz Assignment, Experience Discussion

Course Content and Presentation Schedule

Module No.	Topic	CLO level	No. of Hours	Content delivery method	Learning methods
UNIT I : Introduction and Scope - (15 Hrs)					
1.	Definition of genomics and proteomics.	CLO1 CLO2 CLO3	1	Lecture – Chalk and Talk / Group reading	Participatory Learning
2	Structural genomics:	CLO1 CLO2 CLO3	1	PPT	Participatory Learning
3	Organization of <i>E. coli</i> genome,	CLO1 CLO2 CLO3	1	PPT	Participatory Learning
4	Human genome,	CLO2 CLO3 CLO4	1	Research paper presentation	Problem-based Learning
5	Chloroplast and	CLO2 CLO4	1	Demonstration	Experiential Learning
6	Mitochondrial genomes.	CLO2 CLO3 CLO4	1	Student Seminar	Experiential Learning
7	Human Genome Project.	CLO2 CLO3	1	Flipped class room	Experiential Learning
8	Genome mapping: Genetic maps and	CLO3 CLO4	1	Research Article	Experiential Learning
9	Physical maps.	CLO3 CLO4	1	Research Article	Experiential Learning
10	Genetic mapping: Linkage mapping,	CLO3 CLO4	1	Research Article	Experiential Learning
11	Markers for mapping(RFLP,	CLO3 CLO4	1	Review Article	Problem-based Learning
12	SNPs,	CLO3 CLO4	1	Field observations	Problem- based Learning
13	microsatellite markers).	CLO3 CLO4	1	Student seminar Lecture	Participatory Learning
14	Physical mapping of genome	CLO2 CLO3 CLO4	1	Seminar	Participatory Learning
15	Comparative gene mapping.	CLO2 CLO3 CLO4	1	Research articles	Problem- based Learning
UNIT II: Genome Sequence and Editing - (14 Hrs)					
16	Genome sequencing:	CLO1 CLO2 CLO3	1	Lecture – Chalk and Talk	Participatory Learning

17	Expressed sequence Tags (ESTs).	CLO1 CLO2 CLO3	1	PPT / OER	Participatory Learning
18	Sanger sequencing,	CLO1 CLO2 CLO3	1	Chalk and talk	Participatory Learning
19	Maxam and Gilbert sequencing,	CLO2 CLO3	1	Research paper	Problem- based Learning
20	Automated Sequencing,	CLO2 CLO4	1	Research paper	Experiential Learning
21	Whole genome Shotgun sequencing,	CLO2 CLO3 CLO4	1	Research paper	Problem- based Learning
22	Illumina sequencing (solex technology),	CLO2 CLO3	1	Research paper	Experiential Learning
23	Nano pore sequencing.	CLO3 CLO4	1	Book/ Article review	Experiential Learning
24	Next- generation sequencing (NGS).	CLO3 CLO4	1	Virtual lab	Experiential Learning
25	Genome Editing Technologies:	CLO3 CLO4	1	Research paper presentation	Problem- based Learning
26	Zinc Finger Nucleases (ZFNs),	CLO3 CLO4	1	Research paper	Problem- based Learning
27	TALENs,	CLO4	1	Student seminar	Problem- based Learning
28	CRISPR-Cas9,	CLO3 CLO4	1	Student seminar	Participatory Learning
29	Base Editing and Prime Editing. Applications of Genome Sequencing and Editing.	CLO2 CLO3 CLO4	1	Workshop Training	Problems- based Learning
UNIT III: Omics Tools For Gene Expression - (15 Hrs)					
30	Single cell sequencing-;	CLO1 CLO2	1	Lecture – Chalk and Talk	Problem- based Learning
31	ChIP-Seq-	CLO2 CLO3 CLO4	1	Technical talk	Participatory Learning
32	Identification of	CLO1 CLO2 CLO3	1	PPT / OER	Problem- based Learning
33	human biomarkers using genomics	CLO1 CLO2 CLO3	1	Chalk and talk	Participatory Learning
34	Transcriptomic s -	CLO2 CLO3	1	Lecture and Discussion	Participatory Learning
35	transcript analysis-	CLO2 CLO4	1	Demonstration	Experiential Learning

36	Global gene expression	CLO2 CLO3 CLO4	1	Demonstration	Experiential Learning
37	Analysis,	CLO2 CLO3 CLO4	1	Virtual lab	Experiential Learning
38	DNA chips	CLO3 CLO4 CLO4	1	Book/ Article review	Problem- based Learning
39	Micro arrays –	CLO3 CLO4	1	Research paper presentation	Problem- based Learning
40	differential gene expression.	CLO3 CLO4	1	Research paper presentation	Problem- based Learning
41	Non array based whole transcriptome analysis,	CLO3 CLO4	1	Research Experiments	Problem- based Learning
42	Differential Display,	CLO3 CLO4	1	Review papers	Participatory Learning
43	serial analysis of gene expression	CLO3 CLO4	1	Research Experiments	Experiential Learning
44	(SAGE)	CLO3 CLO4	1	Research Experiments	Participatory Learning
UNIT: IV Proteomics and Tools for Structural Proteomics - (15 Hrs)					
45	Introduction	CLO1 CLO2	1	Lecture – Chalk and Talk	Participatory Learning
46	to the concept of proteome,	CLO3 CLO4	1	Research Experiments	Experiential Learning
47	Proteomic analysis	CLO1 CLO2 CLO3	1	PPT	Problem- based Learning
48	Importance of proteomics	CLO1 CLO2 CLO3	1	Chalk and talk/ Picture	Problem- based Learning
49	in biological functions.	CLO2 CLO3	1	Chalk and talk	Participatory Learning
50	Domains types	CLO2 CLO4	1	Demonstration	Problem- based Learning
51	and importance.	CLO2 CLO3 CLO4	1	Student Seminar	Experiential Learning
52	Methods to determine 3D structures-	CLO2 CLO3	1	Research paper presentation	Problem- based Learning
53	X-ray crystallography,	CLO3 CLO4	1	Book/ Article review	Experiential Learning
54	nuclear magnetic resonance (NMR),	CLO3 CLO1 CLO4	1	Virtual lab	Experiential Learning
55	Cryogenic electron microscopy (cryo-EM).	CLO3 CLO4 CLO2	1	Research paper presentation	Problem- based Learning

56	Mass spectroscopy	CLO3 CLO4 CLO2	1	Field observations and observation of renewable organic material	Problem-based Learning
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57	ESI-TOF MS and	CLO3 CLO4	1	Student seminar Lecture	Participatory Learning
58	MALDI TOF MS.	CLO2 CLO3 CLO4	1	Research paper presentation	Participatory Learning
59	Alphafold-Protein structure database	CLO1 CLO2	1	Research paper presentation	Problem-based Learning

UNIT V: Tools and Techniques for Functional Proteomics - (14 Hrs)

60	From Genomics	CLO1 CLO2	1	PPT	Participatory Learning
61	to Proteomics	CLO3 CLO4	1	PPT / OER	Participatory Learning
62	Strategies of Protein Separation	CLO3 CLO4	1	Chalk and talk/ Picture	Problem-based Learning
63	And quantification	CLO2 CLO4	1	Video Lecture and Discussion	Problem-based Learning
64	Liquid chromatograph	CLO2 CLO3 CLO4	1	Demonstration	Experiential Learning
65	in Proteomics	CLO2 CLO3	1	Student Seminar	Experiential Learning
66	Protein Sequencing	CLO3 CLO4	1	Virtual lab	Experiential Learning
67	Edmann degradation	CLO3 CLO4	1	Book/ Article review	Experiential Learning
68	Protein -protein interactions	CLO3 CLO4	3	Virtual lab	Experiential Learning
69	using Yeast two-hybrid system	CLO2 CLO3 CLO4	1	Research paper presentation	Problem-based Learning
70	Protein chips in functional proteomics	CLO1 CLO2	1	Research Article	Problem-based Learning
71	Comparative proteomics.	CLO3 CLO4	1	Research Article	Problem-based Learning

SNO	LEARNING METHODS	PERCENTAGE
1	Participatory Learning	30 %
2	Experiential Learning	30 %
3	Problem-based Learning	40 %

COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	CREDIT
BT23C09	FERMENTATION TECHNOLOGY	THEORY	73	2	-	4

Preamble

- Fermentation Technology deals with the principles and industrial applications of microbial processes for producing valuable products such as antibiotics, enzymes, biofuels, and beverages. The course integrates fundamentals of fermentation, bioprocess engineering, and fermenter design with practical applications to build technical expertise for research and industry.

Prerequisite

- Basic knowledge of microbiology, microbial culture techniques, and bioprocess fundamentals.

Course Learning Outcomes

On the successful completion of the course, students will be able to

CLO Number	CLO Statement	Knowledge Level
CLO1	Understand the principles, scope, and applications of fermentation and microbial strain improvement	K1
CLO2	Describe the types, design, and control of bioreactors and upstream essentials	K2
CLO3	Apply upstream and downstream processes for fermentation and product recovery	K3
CLO4	Evaluate industrial applications of fermentation in pharmaceuticals, food, agriculture, environment and chemical	K4

Mapping with Programme Learning Outcomes

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	S	S	S	S	S
CLO2	M	M	S	M	M
CLO3	M	S	S	S	M
CLO4	S	S	M	S	M

*S- Strong; M-Medium

FERMENTATION TECHNOLOGY - BT23C09- 73HRS

UNIT 1: Basics of Fermentation technology

(15 Hrs)

Introduction: Basic principles of fermentation, Scope and application of fermentation technology, industrially important microorganism: Isolation, Screening- primary and Secondary screening methods; Strain improvement- Selection of natural variants; Selection of induced mutants - Auxotroph mutants (glutamic acid); Use of recombination system. Pure culture maintenance.

UNIT II: Bioreactor types and Upstream essentials

(15 Hrs)

Bioreactor: Components, design and functions. Types of bioreactors - CSTR, Packed bed, Air lift bioreactor, Immobilized bed bioreactors, Photobioreactors. Bioprocess control and monitoring variables-Temperature, Agitation, Pressure and pH. Computers in bioprocess control system.

UNIT III: Upstream processing

(14hrs)

Upstream processing: Media formulation: Media designing - Submerged and Solid state processes; Sterilization: Methods of sterilization (Batch and Continuous sterilization); Air sterilization-Air filters design and Mechanism of air sterilization; Inocula Development, Scale up. Phases of cell growth, Factors affecting cell growth. Microbial Growth kinetics: Specific growth rate, Substrate utilization, Monod's model and yield coefficients.

UNIT IV: Downstream Processing

(14 Hrs)

Introduction, Solid-liquid separation - Flotation, Flocculation and Filtration (Rotary Drum Vacuum filter); Centrifugation- Tubular Bowl, Decanter Centrifuge; Cell disruptions (Mechanical, Enzymatic and Chemical). Concentration – Protein precipitations. Membrane filtration - Ultrafiltration, Reverse Osmosis. Product polishing: drying - Spray driers and Freeze driers and Crystallization.

UNIT V: Industrial Applications

(15 Hrs)

Introduction, Pharmaceuticals: Antibiotics (Penicillin); Vitamins (Riboflavin). Food Industry: Fermented foods (yogurt, cheese); Beverages (Beer, Wine); Enzymes (amylases, proteases). Agriculture: Biofertilizers (Rhizobium); Silage production. Environment: Bioremediation; Biofuels (Ethanol). Chemicals: Organic acids (Citric, Lactic); Amino acids (Glutamic acid).

Reference Link

S.No	Topics	Links
UNIT I: Basics of Fermentation technology		
1.	Basic principles of fermentation	https://www.youtube.com/watch?v=Vm45aQzhA0g
2.	Scope and Application of Fermentation Technology	https://youtu.be/bWxPpK7t5IE?si=YZdwf9D1SOp7rT-O
3.	Isolation, screening- primary and secondary screening methods; Strain improvement	https://youtu.be/QRItTCQVAb4?si=Okx0AI_WVv3DwFOX
UNIT II: Bioreactor types and Upstream essentials		
4.	Bioreactor: Components, design and functions	https://youtu.be/azdVSr7DBlg?si=c-D7VEHcn-R8qnFu
5.	Types of bioreactors	https://youtu.be/5lVkr_feW7I?si=Q-jikwAlMLaxBhOe
6.	Bioprocess control and monitoring variables	https://youtu.be/ndoXG0NfiYc?si=Q_y_1udoWLbLb_jJ
UNIT III: Upstream processing		
7.	Media formulation: Media designing	https://youtu.be/_4EtUlcO2Q8?si=Lpw0dbABQ0MBOzo5
8.	Innocula Development	https://youtu.be/7ZzlRMXyj-g?si=qnJ1Qwi3sqI3iLm2
9.	Phases of cell growth	https://youtu.be/UTFX1NnuHQY?si=Kfo0ve2FEofRGuNL
10.	Factors affecting cell growth	https://youtu.be/N1DaPuO5gRY?si=D0KyBXDIwB0Ta_RN
11.	Monod's model and yield coefficients	https://youtu.be/N1DaPuO5gRY?si=D0KyBXDIwB0Ta_RN
UNIT IV: Downstream processing		
12.	Introduction, Solid-liquid separation - Flotation, Flocculation and Filtration (Rotary Drum Vacuum filter); Centrifugation- Tubular Bowl, Decanter Centrifuge; Cell disruptions (Mechanical, enzymatic and chemical)	https://youtu.be/n5usKgWZwbU?si=YYAk2SCFwb2KuF05
UNIT V: Industrial applications		
13	Protease production	https://youtu.be/19nN-nPZ_RY?si=sbUjLwkwy6-lxMbS
14	Amylases production	https://youtu.be/p6YJuiVB76M?si=MKW9ODYmSJeApMdy
15	Penicillin production	https://youtu.be/0QpC364DHNU?si=O4gTvKHJNRhCo4Qr
16	Citric Acid production	https://youtu.be/6kOHou2OjBE?si=d65Y4ZgeG_EaVOB-

Text Book

S.No	Authors	Title of the book	Publishers	Year and Edition
1	Stanbury, P. F., & Whitaker, A.	Principles of Fermentation technology	Pergamon press	2005 2 nd Edn
2	Rao, D. G.	Introduction to Biochemical engineering	McGraw-Hill publications	2010 1 st Edn
3	Dunns, P.	Industrial Microbiology	Gerald Reed, Chapman & Hall publications	2007 4 th Edn
4	Doran, P. M.	Bioprocess Engineering Principles	Academic Press	2012 2 nd Edn
5	Waites, M. J., Morgan, N. L., Rockey, J. S., & Higton, G.	Industrial Microbiology	Blacwell Science	2002 1st Edn

Books for Reference

S.No	Authors	Title of the book	Publishers	Year and Edition
1	El-Mansi, A., Bryce, C. F. A., Demain, A. L., & Allman A. R.	Fermentation microbiology and Biotechnology	Taylor and Francis	2007 2 nd Edn
2	Casida, L. E.	Industrial Microbiology	John Wiley & Sons Inc., United States	2019 2 nd Edn

Course Designer

Dr. G. Anbarasi

Pedagogy

- PowerPoint Presentations, Group Discussion, Seminar, Quiz Assignment, Experience Discussion

Course Content and Presentation Schedule

Module No.	Topic	CLO level	No. of Hours	Content delivery method	Learning methods
UNIT 1: Basics of Fermentation technology - (15 Hrs)					
1.	Introduction:	CLO1 CLO3 CLO4	1	Lecture – Chalk and Talk / Group reading	Participatory Learning
2.	Basic principles of fermentation,	CLO1 CLO3 CLO4	1	Lecture – Chalk and Talk / Group reading	Participatory Learning
3.	Scope and	CLO1 CLO3 CLO4	1	PPT / OER Participatory	Problem-based Learning
4.	application of fermentation technology,	CLO1 CLO3 CLO4	1	PPT	Experiential Learning
5.	Industrially important microorganism:	CLO1 CLO4	1	Virtual lab, Demonstration	Experiential Learning
6.	Isolation,	CLO1 CLO3 CLO4	1	Research paper presentation	Problem-based Learning
7.	Screening-	CLO1 CLO3	1	Review Article	Problem-based Learning
8.	primary and	CLO1 CLO3	1	Field observations	Experiential Learning
9.	Secondary screening methods;	CLO1 CLO3	1	Research Article	Experiential Learning
10.	Strain improvement-	CLO1 CLO3	1	Study material/Flipped Class room	Participatory Learning
11.	Selection of natural variants;	CLO1 CLO3 CLO4	1	Brainstorming	Participatory Learning
12.	Selection of induced mutants -	CLO1 CLO3 CLO4	1	Research article reading	Research article reading
13.	Auxotroph mutants (glutamic acid);	CLO1 CLO3 CLO4	1	Seminar	Participatory Learning
14.	Use of recombination system	CLO1 CLO4	1	Research articles	Problem-based Learning
15.	Pure culture maintenance	CLO3 CLO4	1	Field observations	Participatory Learning

Unit – II: Bioreactor types and Upstream essentials - (15 Hrs)

16.	Bioreactor:	CLO2 CLO3	1	Virtual lab, Demonstration	Participatory Learning
17.	Components, design and functions.	CLO2 CLO3	1	PPT / OER	Participatory Learning
18.	Types of bioreactors -	CLO2 CLO3	1	Chalk and talk	Participatory Learning
19.	CSTR,	CLO2 CLO3	1	Lecture and PPT	Problem-based Learning
20.	Packed bed,	CLO2 CLO3	1	PPT/Virtual lab	Experiential Learning
21.	Air lift bioreactor,	CLO2 CLO3	1	Research paper	Problem-based Learning
22.	Immobilized bed bioreactors,	CLO2 CLO3	1	Research paper	Experiential Learning
23.	Photobioreactors.	CLO2 CLO3	1	Workshop Training	Problems-based Learning
24.	Bioprocess control and	CLO2 CLO3	1	Virtual lab	Experiential Learning
25.	monitoring variables-	CLO2 CLO3	1	Lecture and PPT	Problem-based Learning
26.	Temperature,	CLO2 CLO3	1	Research paper	Problem-based Learning
27.	Agitation,	CLO2 CLO3	1	Student seminar	Problem-based Learning
28.	Pressure and	CLO2 CLO3	1	Student seminar	Participatory Learning
29.	pH.	CLO2 CLO3	1	Student seminar	Participatory Learning
30.	Computers in bioprocess control system.	CLO2 CLO3	1	Virtual lab and Demonstration	Problem-based Learning

UNIT III: Upstream processing - (14 Hrs)

31.	Upstream processing, Media formulation: Media designing	CLO1 CLO2 CLO3	1	Chalk and talk	Participatory Learning
32.	Submerged and	CLO1 CLO3 CLO4	1	Demonstration	Experiential Learning
33.	Solid state processes;	CLO1 CLO3 CLO4	1	Demonstration	Experiential Learning
34.	Sterilization: Methods of sterilization (Batch and	CLO1 CLO3 CLO4	1	Lecture and Discussion	Participatory Learning
35.	continuous sterilization);	CLO1 CLO3 CLO4	1	Virtual lab	Experiential Learning

36.	Air sterilization-Air filters design and	CLO1 CLO3 CLO4	1	PPT	Problem-based Learning
37.	mechanism of air sterilization;	CLO1 CLO3 CLO4	1	Research paper presentation	Problem-based Learning
38.	Innocula Development,	CLO1 CLO3 CLO4	1	Research paper presentation	Problem-based Learning
39.	Scale up.	CLO1 CLO3 CLO4	1	PPT	Problem-based Learning
40.	Phases of cell growth,	CLO1 CLO3 CLO4	1	Brainstorming	Participatory Learning
41.	Factors affecting cell growth.	CLO2 CLO3 CLO4	1	Research Experiments	Experiential Learning
42.	Microbial Growth kinetics: Specific growth rate,	CLO1 CLO3 CLO4	1	Research Experiments	Experiential Learning
43.	Substrate utilization,	CLO1 CLO3 CLO4	1	Chalk and talk	Participatory Learning
44.	Monod's model and yield coefficients.	CLO1 CLO3 CLO4	1	Demonstration	Experiential Learning
UNIT IV: Downstream Processing - (14 Hrs)					
45.	Introduction,	CLO3 CLO4	1	Lecture – Chalk and Talk	Participatory Learning
46.	Solid-liquid separation - Flotation,	CLO2 CLO4	1	PPT	Problem-based Learning
47.	Flocculation and	CLO2 CLO4	1	Chalk and talk/ Picture	Problem-based Learning
48.	Filtration (Rotary Drum Vacuum filter);	CLO3 CLO4	1	Chalk and talk	Experiential Learning
49.	Centrifugation- Tubular Bowl,	CLO2 CLO4	1	Demonstration	Problem-based Learning
50.	Decanter Centrifuge;	CLO2 CLO4	1	Student Seminar	Experiential Learning
51.	Cell disruptions (Mechanical,	CLO3 CLO4	1	Research paper presentation	Problem-based Learning
52.	Enzymatic and Chemical).	CLO3 CLO4	1	Book/ Article review	Experiential Learning
53.	Concentration – Protein precipitations.	CLO3 CLO4	1	Virtual lab	Experiential Learning

54.	Membrane filtration -	CLO3 CLO4	1	Research paper presentation	Problem-based Learning
55.	Ultrafiltration, Reverse Osmosis.	CLO3 CLO4	1	Book/ Article review	Problem-based Learning
56.	Product polishing: drying -	CLO2 CLO3	1	Brainstorming	Participatory Learning
57.	Spray driers and Freeze driers and	CLO2 CLO3	1	Research paper presentation	Problem-based Learning
58.	Crystallization.	CLO2 CLO4	1	Lecture – Chalk and Talk	Participatory Learning
UNIT V: Industrial Applications - (15 Hrs)					
59.	Introduction,	CLO1 CLO2 CLO3 CLO4	1	Research article reading	Problem-based Learning
60.	Pharmaceuticals: Antibiotics (Penicillin);	CLO1 CLO2 CLO3 CLO4	1	Demonstration	Experiential Learning
61.	Vitamins (Riboflavin).	CLO1 CLO2 CLO3 CLO4	1	Demonstration	Experiential Learning
62.	Food Industry: Fermented foods (yogurt,	CLO1 CLO2 CLO3 CLO4	1	Demonstration	Problem-based Learning
63.	cheese);	CLO1 CLO2 CLO3 CLO4	1	Research paper presentation	Problem-based Learning
64.	Beverages (Beer,	CLO1 CLO2 CLO3 CLO4	1	Virtual lab	Participatory Learning
65.	Wine);	CLO1 CLO2 CLO3 CLO4	1	Research paper presentation	Problem-based Learning
66.	Enzymes (amylases,	CLO1 CLO2 CLO3 CLO4	1	Field observations	Problem-based Learning
67.	proteases).	CLO1 CLO2 CLO3 CLO4	1	Virtual lab	Experiential Learning
68.	Agriculture: Biofertilizers (Rhizobium);	CLO1 CLO2 CLO3	1	Virtual lab	Participatory Learning

		CLO4			
69.	Silage production.	CLO1 CLO2 CLO3 CLO4	1	Virtual lab	Participatory Learning
70.	Environment: Bioremediation; Biofuels (Ethanol).	CLO1 CLO2 CLO3 CLO4	1	Research article reading	Problem based Learning
71.	Chemicals: Organic acids (Citric acid,	CLO1 CLO2 CLO3 CLO4	1	Demonstration	Experiential Learning
72.	Lactic acid);	CLO1 CLO2 CLO3 CLO4	1	Demonstration	Experiential Learning
73.	Amino acids (Glutamic acid)	CLO1 CLO2 CLO3 CLO4	1	PPT	Problem-based Learning

SNO	LEARNING METHODS	PERCENTAGE
1	Participatory Learning	30 %
2	Experiential Learning	30 %
3	Problem-based Learning	40 %

COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	CREDIT
BT23C10	ENVIRONMENTAL BIOTECHNOLOGY	THEORY	73	2	-	4

Preamble

- This course helps students learn about biofuels and bio-energy and their future importance, explains the problems caused by environmental pollution with methods to control and manage it, and provides an understanding of different energy sources and the use of biotechnology to clean and protect the environment.

Prerequisite

- Basic knowledge of microbiology and environmental science

Course Learning Outcomes

On the successful completion of the course, students will be able to

CLO Number	CLO Statement	Knowledge Level
CLO1	Acquire a complete knowledge about biofuel and bio-energy and its future needs	K1
CLO2	Understand dangerous effects of environmental pollution and its methods of control and management to create more bioremediation methods in future	K2
CLO3	Evaluate the different methods of environmental pollution using biotechnological approaches	K3
CLO4	Determine a comprehensive knowledge about pollution detection methods which help to think about environmental protection	K4

Mapping with Programme Learning Outcomes

CLOs	PLO1	PLO2	PLO3	PLO4	PLO 5
CLO1	M	S	M	S	S
CLO2	M	M	M	M	M
CLO3	S	S	M	S	S
CLO4	S	M	M	S	M

*S- Strong; M-Medium

ENVIRONMENTAL BIOTECHNOLOGY-BT23C10- 73HRS

Unit I: Introduction and Scope

(15 Hrs)

Role and scope of environmental biotechnology; Environmental sustainability. Pollution: types of pollution-Air, Water, Soil thermal, plastic pollution. Environmental degradation-Biodiversity loss, urbanization, ozone layer, global warming and radioactive contamination. Manmade disasters: microplastics, Bhopal gas Tragedy 1989, Atlantic Empress oil Spill 1979. Traditional knowledge in waste management.

Unit II: Environmental remediation

(15 Hrs)

Degradation of lignin, cellulose, pesticides by micro-organisms- degradation of aromatic and chlorinated hydrocarbons and petroleum products. Technologies for remediation- Metals Remediation; Bioleaching and Bioremediation; Bioaccumulation. Biosurfactants. Decontamination of Air Stream- Biofiltration, Trickling Filter, Bioscrubbers.

Unit- III: Waste Management

(14 Hrs)

Solid waste management: Landfills, recycling, incineration and composting, Bio-Gas production. Waste water treatment: Aerobic and anaerobic methods (Primary, Secondary and Tertiary). Biotechnological approach to treat industrial effluent - Tannery, Textile. Bioenergy and SCP from waste. Ex-Situ Remediation of Soil, in-Situ Remediation of Soil; Phytoremediation & Use of aquatic plants in waste water treatment.

Unit- IV: Environmental monitoring

(15 Hrs)

Sampling & Analysis Methods – land (site) sampling, water sampling, air sampling– physical, chemical and biological analysis methods and process. Bioindicators; Biomarkers – biochemical indicators, immunochemistry, genetic indicators; Toxicity testing using biological material, Biosensors – mechanism, principle and working Environment Impact Assessment: EIA complete process, Importance of EIA.

Unit-V: Environmental Legislations

(14 Hrs)

Water Prevention and Pollution. Control Act, The Environment (Protection) Act 1986, The Biological Diversity Act 2002, Forest Conservation Act, Municipal Solid Waste Rules, Biomedical Waste Rules, Hazardous Waste Rules, Environmental Clearance, Environmental Legislation and Pollution Control Acts in India, Central Pollution Control Board, its functions and powers. Green Auditing-ISO 14001 Environmental Management.

Reference Link

S.No	Topics	Links
Unit I: Introduction and Scope		
1.	Environmental degradation- Biodiversity loss, urbanization,	https://www.youtube.com/watch?v=z51cH6DK-iQ
2.	ozone layer, global warming and radioactive contamination	https://www.youtube.com/watch?v=aU6pxSNDPhs
Unit II: Environmental pollutants and remediation		
3.	Metals Remediation; Bioleaching and Biobenificiation; Bioaccumulation. Biosurfactants, Biological Filtration	https://www.youtube.com/watch?v=TlftCd8xtTI
4.	Processes for Decontamination of Air Stream-Biofiltration, Trickling Filter, - Bioscrubbers	https://www.youtube.com/watch?v=ZmjNe5QGKnk
5.	Trickling Filter, -Bioscrubbers	https://www.youtube.com/watch?v=TlftCd8xtTI
Unit III: Waste Management		
6.	Ex-Situ Remediation of Soil, Decontamination	https://www.youtube.com/watch?v=G9B-L8R7oy8
7.	In-Situ Remediation of Soil;	https://www.youtube.com/watch?v=5vsJCMb6QME
8.	Phytoremediation Technology for Soil	https://www.youtube.com/watch?v=SDJhXslhzT8
Unit IV: Environmental monitoring		
9.	Recombinant DNA technology	https://www.youtube.com/watch?v=lrzOGtbmCWs
10.	Proteomics	https://www.youtube.com/watch?v=LvN8f8YuvpU
11.	Monitoring pollution; Bioindicators; Biomarkers – biochemical indicators, immunochemistry, genetic indicators	https://www.youtube.com/watch?v=h9HzZoerqQU
12.	Toxicity testing using biological material Biosensors	https://www.youtube.com/watch?v=j9jIX8Do1Do
Unit V: Environmental Legislations		
13.	Biomedical Waste Rules	https://www.youtube.com/watch?v=fPkkUmNQjXs
14.	Central Pollution Control Board, its functions and powers.	https://www.youtube.com/watch?v=0XJax1NYFDQ
15.	Green Auditing-ISO 14001 Environmental Management.	https://www.youtube.com/watch?v=HH5XJJfVEC M

Text Book

S.No	Authors	Title of the book	Publishers	Year and Edition
1	Sibi, G.	Environmental Biotechnology: Fundamentals to Modern Techniques (Emerging Materials and Technologies)	Taylor & Francis Ltd, CRC Press	2022 1 st Edn
2	Rittmann, B. E., & McCarty, P. L.	Environmental Biotechnology: Principles and Applications	McGraw Hill	2021 2 nd Edn
3	Welker, J.	Water and Wastewater Treatment	Springer	2021 1 st Edn

Books for Reference

S.No	Authors	Title of the book	Publishers	Year and Edition
1	Sharma, N., Sodhi, A. S., & Batra, N.	Basic Concepts in Environmental Biotechnology	CRC Press	2023 1 st Edn
2	Cox, C. B., & Moore, P. D.	Biogeography: An Ecological and Evolutionary Approach	Wiley	2020 10 th Edn

Course Designer

Dr. K. Sabariswaran

Pedagogy

- PowerPoint Presentations, Group Discussion, Seminar, Quiz Assignment, Experience Discussion

Course Content and Presentation Schedule

Module No.	Topic	CLO level	No. of periods	Content delivery method	Learning methods
Unit I: Introduction and Scope - (15 Hrs)					
1.	Role and scope of environmental biotechnology	CLO1 CLO2	1	Lecture –Chalk and Talk	Participatory Learning
2.	Environmental sustainability.	CLO1 CLO2 CLO3	1	PPT	Participatory Learning
3.	Pollution: types of pollution-	CLO1 CLO2 CLO3	1	PPT	Participatory Learning
4.	Air, Water, Soil thermal, plastic pollution.	CLO2 CLO3	2	Research paper presentation	Problem-based Learning
5.	Environmental degradation- Biodiversity loss	CLO2 CLO4	2	Demonstration	Experiential Learning
6.	urbanization	CLO2 CLO3 CLO4	1	Student Seminar	Experiential Learning
7.	ozone layer	CLO2 CLO3	1	Flipped class room	Experiential Learning
8.	global warming and radioactive contamination	CLO3 CLO4	1	Research Article	Experiential Learning
9.	Manmade disasters: microplastics	CLO3 CLO4	1	Research Article	Experiential Learning
10	Bhopal gas Tragedy 1989	CLO3 CLO4	1	Review Article	Problem-based Learning
11	Atlantic Empress oil Spill 1979	CLO3 CLO4	1	Field observations	Problem-based Learning
12	Indian Knowledge Systems (IKS):	CLO3 CLO4	1	Student seminar Lecture	Participatory Learning
13	Traditional knowledge in waste management.	CLO2 CLO3 CLO4	1	Seminar	Participatory Learning
Unit II: Environmental pollutants and remediation - (15 Hrs)					
14	Degradation of lignin,	CLO1 CLO2 CLO3	1	Lecture – Chalk and Talk	Participatory Learning
15	pesticides by micro-organisms-	CLO1 CLO2 CLO3	1	PPT / OER	Participatory Learning
16	degradation of aromatic and chlorinates	CLO1 CLO2	2	Chalk and talk	Participatory Learning

	hydrocarbons and petroleum products	CLO3			
17	Technologies for remediation	CLO2 CLO3	1	Research paper	Problem-based Learning
18	Metals Remediation;	CLO2 CLO4	1	Research paper	Experiential Learning
19	Bioleaching and Biobenificiation;	CLO2 CLO3 CLO4	2	Research paper	Problem-based Learning
20	Bioaccumulation.	CLO2 CLO3	2	Research paper	Experiential Learning
21	Biosurfactants.	CLO3 CLO4	1	Book/ Article review	Experiential Learning
22	Decontamination of Air Stream-	CLO3 CLO4	1	Virtual lab	Experiential Learning
23	Biofiltration,	CLO3 CLO4	1	Research paper presentation	Problem-based Learning
24	Trickling Filter,	CLO3 CLO4	1	Research paper	Problem-based Learning
25	Bioscrubbers.	CLO3 CLO4	1	Student seminar	Problem-based Learning
Unit III: Waste Management - (14 Hrs)					
26	Solid waste management:	CLO1 CLO2	1	Lecture – Chalk and Talk	Problem-based Learning
27	Landfills,	CLO2 CLO3 CLO4	1	Technical talk	Participatory Learning
28	recycling,	CLO1 CLO2 CLO3	1	PPT / OER	Problem-based Learning
29	incineration and composting,	CLO1 CLO2 CLO3	1	Chalk and talk	Participatory Learning
30	Bio-Gas production.	CLO2 CLO3	1	Lecture and Discussion	Participatory Learning
31	Waste water treatment: Aerobic and anaerobic methods	CLO2 CLO4	1	Demonstration	Experiential Learning
32	(Primary, Secondary and Tertiary).	CLO2 CLO3 CLO4	1	Virtual lab	Experiential Learning
33	Biotechnological approach to treat industrial effluent	CLO3 CLO4 CLO4	1	Book/ Article review	Problem-based Learning
34	Tannery,	CLO3 CLO4	1	Research paper presentation	Problem-based Learning
35	Textile.	CLO3 CLO4	1	Research paper presentation	Problem-based Learning
36	Bioenergy and SCP from waste.	CLO3 CLO4	1	Research Experiments	Problem-based Learning

37	Ex-Situ Remediation of Soil,	CLO3 CLO4	1	Review papers	Participatory Learning
38	in-Situ Remediation of Soil;	CLO3 CLO4	1	Research Experiments	Experiential Learning
39	Phytoremediation & Use of aquatic plants in waste water treatment.	CLO3 CLO4	1	Research Experiments	Participatory Learning
Unit IV: Environmental monitoring - (15 Hrs)					
40	Sampling & Analysis Methods –	CLO1 CLO2	1	Lecture – Chalk and Talk	Participatory Learning
41	land (site) sampling,	CLO3 CLO4	1	Research Experiments	Experiential Learning
42	water sampling,	CLO1 CLO2 CLO3	1	PPT	Problem-based Learning
43	air sampling–	CLO1 CLO2 CLO3	1	Chalk and talk/ Picture	Problem-based Learning
44	physical, chemical and biological analysis methods and process.	CLO2 CLO3	1	Chalk and talk	Participatory Learning
49	Bioindicators;	CLO2 CLO4	1	Demonstration	Problem-based Learning
45	Biomarkers –	CLO2 CLO3 CLO4	1	Student Seminar	Experiential Learning
46	biochemical indicators,	CLO2 CLO3	1	Research paper presentation	Problem-based Learning
47	immunochemistry,	CLO3 CLO4	1	Book/ Article review	Experiential Learning
48	genetic indicators;	CLO3 CLO1 CLO4	1	Virtual lab	Experiential Learning
49	Toxicity testing using biological material,	CLO3 CLO4 CLO2	1	Research paper presentation	Problem-based Learning
50	Biosensors – mechanism,	CLO3 CLO4 CLO2	1	Field observations and observation of renewable organic material	Problem-based Learning
51	principle and working Environment Impact Assessment:	CLO2 CLO3 CLO4	1	Research paper presentation	Participatory Learning
52	EIA complete process,	CLO3 CLO4	1	Research paper presentation	Problem-based Learning
53	Importance of EIA.	CLO3 CLO4	1	Book/ Article review	Problem-based Learning
Unit V: Environmental Legislations - (14 Hrs)					

54	Water Prevention and Pollution.	CLO1 CLO2	1	PPT	Participatory Learning
55	Control Act,	CLO1 CLO2 CLO3	1	PPT / OER	Participatory Learning
56	The Environment (Protection) Act 1986,	CLO1 CLO2 CLO3	1	Chalk and talk/ Picture	Problem-based Learning
57	The Biological Diversity Act 2002,	CLO2 CLO3	1	Video Lecture and Discussion	Problem-based Learning
58	Forest Conservation Act,	CLO2 CLO4	1	Demonstration	Experiential Learning
59	Municipal Solid Waste Rules,	CLO2 CLO3 CLO4	1	Student Seminar	Experiential Learning
60	Biomedical Waste Rules,	CLO2 CLO3	1	Virtual lab	Experiential Learning
61	Hazardous Waste Rules,	CLO3 CLO4	1	Book/ Article review	Experiential Learning
62	Environmental Clearance,	CLO3 CLO4	1	Virtual lab	Experiential Learning
63	Environmental Legislation and Pollution Control Acts in India,	CLO3 CLO4	2	Research paper presentation	Problem-based Learning
64	Central Pollution Control Board,	CLO2 CLO3 CLO4	1	Field observations	Problem-based Learning
65	its functions and powers.	CLO3 CLO4	1	Research Article	Problem-based Learning
66	Green Auditing-ISO 14001 Environmental Management.	CLO2 CLO3 CLO4	1	Research Article	Problem-based Learning

S.NO	LEARNING METHODS	PERCENTAGE
1	Participatory Learning	30 %
2	Experiential Learning	30 %
3	Problem-based Learning	40 %

COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	CREDIT
BT23CP4	GENOMICS AND PROTEOMICS, FERMENTATION TECHNOLOGY AND ENVIRONMENTAL BIOTECHNOLOGY PRACTICAL	PRACTICAL	-	-	105	6

Preamble

- This course enables students to perform protein isolation and DNA marker analysis, carry out enzyme isolation, purification, and immobilization, conduct industrial fermentation and analyze the products, assess environmental parameters for water quality, and prepare microbial formulations for agricultural applications.

Course Learning Outcomes

On the successful completion of the course, students will be able to

CLO Number	CLO Statement	Knowledge Level
CLO1	Perform fundamental laboratory techniques in genomics and proteomics for DNA, RNA, and protein analysis.	K1
CLO2	Design and optimize fermentation processes for producing biotechnological products.	K2
CLO3	Execute environmental biotechnology experiments to analyze and remediate pollutants.	K3
CLO4	Integrate theoretical knowledge with practical skills to address challenges in genomics, proteomics, and biotechnology.	K4

Mapping with Programme Learning Outcomes

CLOs	PLO1	PLO2	PLO3	PLO4	PLO 5
CLO1	M	S	M	M	S
CLO2	M	M	M	M	M
CLO3	S	S	M	S	S
CLO4	S	M	S	S	S

* S-Strong; M-Medium

GENOMICS AND PROTEOMICS, FERMENTATION TECHNOLOGY AND ENVIRONMENTAL BIOTECHNOLOGY PRACTICAL - BT23CP4 – 105 HRS

Genomics and proteomics

1. Isolation of plant/microbial protein
2. Resolving through SDS PAGE
3. RAPD marker analysis
4. RFLP analysis
5. DNA barcoding in bacteria- *In silico Demo*
6. Sequence annotation using BioEdit

Fermentation Technology

1. Isolation of alpha amylase producing bacteria-Iodine method
2. Optimization of medium conditions for bacterial growth and amylase production using Response Surface Methodology (Substrates, pH)
3. Ammonium sulfate precipitation- bacterial amylase
4. Purification through Dialysis
5. Purification - size-exclusion chromatography
6. Immobilization of Enzyme – Gel entrapment
7. Wine production and ethanol estimation
8. Sauerkraut preparation for lactic acid fermentation and analysis.

Environmental Biotechnology

1. Determination of pH, Alkalinity (Titration)
2. Hardness and total dissolved solids in water
3. Estimation of BOD
4. Preparation of Biofertilizers- Azolla/Azospirillum/Rhizobium

Text Book

S.No	Authors	Title of the book	Publishers	Year and Edition
1	Kulandaivel, S., & Janarthanan, S.	Practical Manual on Fermentation Technology	Kindle Edition I K International Publishing House	2012 1 st Edn
2	Simpson, R.	Proteins and proteomics: A laboratory manual	Cold Spring Harbor Laboratory Press.	2002 1 st Edn
3	Alicia, L., Ragout, D. S., & Spencer, J. F. T.	Environmental Microbiology: Methods and Protocols	John M. Walker, John F. T. Spencer, Alicia L. Ragout de Spencer	2023 1 st Edn

Books for Reference

S.No	Authors	Title of the book	Publishers	Year and Edition
1	Green, M. R., & Sambrook, J.	Molecular cloning. A Laboratory Manual	CSH Press	2012 4th Edn
2	Chellapandi, P.	Laboratory Manual in Industrial Biotechnology	Pointer publishers	2007 1 st Edn
3	Mohapatra, P. K.	Textbook of environmental biotechnology.	IK International Pvt Ltd.	2013 1 st Edn
4	Ravi, I., & Saxena, J.	Comprehensive Laboratory Manual of Life Sciences.	Scientific Publishers.	2019 1 st Edn

Course Designers

1. Dr. R. Nirmal Kumar
2. Dr. G. Anbarasi

COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	CREDIT
BT23E04	MARINE BIOTECHNOLOGY	THEORY	73	2	-	4

Preamble

- This course helps students gain knowledge about marine ecosystems and resources, understand bioactive compounds from marine sources, learn about medicinal seaweeds, practice seaweed culture and aquaculture techniques, and evaluate marine biotechnology products.

Course Learning Outcomes

On the successful completion of the course, students will be able to

CLO Number	CLO Statement	Knowledge Level
CLO1	Acquire knowledge about Marine Ecosystems and Resources	K1
CLO2	Understand bioactive compounds from marine sources and medicinal seaweeds	K2
CLO3	Develop skills to practice seaweed culture and aquaculture	K3
CLO4	Learn techniques for evaluation of marine biotechnology products	K4

Mapping with Programme Learning Outcomes

CLOs	PLO1	PLO2	PLO3	PLO4	PLO 5
CLO1	L	S	S	S	L
CLO2	L	M	S	M	M
CLO3	S	S	M	S	S
CLO4	S	S	S	S	S

*S- Strong; M-Medium; L- Low

MARINE BIOTECHNOLOGY- BT23E04- 73HRS

UNIT I: Marine Ecosystems

(15 Hrs)

Marine Ecosystems & Its functioning, Ocean currents, Physical & chemical properties of seawater, Ecological divisions of the Sea- Euphotic- Mesopelagic- Bathopelagic- Benthos-Intertidal, Estuarine- Salt Marsh- Mangrove- Coral Reef.

UNIT II: Marine habitats

(15 Hrs)

Marine microbial habitats- Screening for Secondary metabolites from marine microbes (Bacteria, Fungi, Actinomycetes and marine microalgae). Biofouling, Biofilm, Antifouling, Anticorrosion. Probiotic bacteria and their importance in aquaculture.

UNIT III: Medicinal seaweeds

(14 Hrs)

Definitions- Medicinal compounds from flora (Seaweeds, Seagrass and Mangrove) and fauna (Sponges, Sea anemone and Corals)- marine toxins- antiviral and antimicrobial agents.

UNIT IV: Seaweed culture, Aquaculture and fish genetics

(15 Hrs)

Culture aspect-Seaweed (*Kappaphycus alvarezii*), Fish chromosome manipulation in aquaculture- Hybridization- Gynogenesis- Androgenesis- Polyploidy, Artificial Insemination, Eyestalk ablation- Transgenesis and Cryopreservation.

UNIT V: Marine and fishery by-products

(14 Hrs)

Marine algal by-products: Chitin, Chitosan, Agar, Agarose Alginates, Carrageenan and Heparin.

Fishery by-products: Fish oil, Isinglass, Fish glue, Fish silage, Fin rays.

Text Book

S.No	Authors	Title of the book	Publishers	Year and Edition
1	Berg, K.	Marine Biotechnology	Discovery Publishing House (India)	2024 1 st Edn
2	Colwell, R. R.	Biotechnology in the Marine Sciences (Advances in Marine Science & Biotechnology)	Wiley Interscience	1984 1 st Edn
3	Clark, R. B.	Marine Pollution	Oxford University press, New York Inc.	2018 5 th Edn

Books for Reference

S.No	Authors	Title of the book	Publishers	Year and Edition
1	Le Gal, Y., & Ulber, R.	Marine Biotechnology, Advances in Biochemical Engineering/Biotechnology	Springer-Verlag Berlin Heidelberg	2005 1 st Edn
2	Attaway, D. H.	Marine Biotechnology, Volume 1, Pharmaceutical and Bioactive Natural Products.	Plenum Publishing Corporation, Newyork, USA	2001 1 st Edn

Course Designers

Dr. V. Bhuvaneshwari

COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	CREDIT
BT23E05	FOOD TECHNOLOGY AND REGULATION	THEORY	73	2	-	4

Preamble

- This course aims to provide students with a comprehensive understanding of the basic concepts of the food industry and its regulatory framework. It introduces the values and properties of various food products, emphasizes the importance of food preservation, and familiarizes students with modern methods and techniques, including the application of biosensors, for quality assessment and safety monitoring in the food sector.

Course Learning Outcomes

On the successful completion of the course, students will be able to

CLO Number	CLO Statement	Knowledge Level
CLO1	Explain food constituents, natural colorants, and flavors	K1
CLO2	Analyze composition and quality of plant- and animal-based foods	K2
CLO3	Explain and evaluate food preservation and processing methods	K3
CLO4	Understand and interpret food safety regulations and standards	K4

Mapping with Programme Learning Outcomes

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	M	M	M	M	M
CLO2	M	S	S	M	M
CLO3	S	S	M	L	M
CLO4	M	M	M	M	M

*S- Strong; M-Medium;

FOOD TECHNOLOGY AND REGULATION - BT23E05- 73 HRS

UNIT I: Introduction and Chemistry of food Constituents (15 Hrs)

Historical evolution of food biotechnology. Physicochemical properties of Food constituents: Chlorophyll & chlorophyll derivatives, Carotenoids, saffron, turmeric- Stability to pH, temperature and other processing conditions- Techniques for the production of dried colourants - Caramel colour. Ingredients, Taste, Aroma, Undesirable flavors. Classification – flavours – Bittering agents, Fruit flavours.

UNIT II: Standards for food analysis (15 Hrs)

Standards of identity, purity, and methodology for analysis- Cereals, legumes, oil seeds and their products; Fruits, vegetables, tubers, and their products; Tea, coffee, cocoa, chocolate, spices, sugar, condiments.

UNIT III: Meat, Poultry, Egg & Seafood Processing (14 Hrs)

Concept and composition of red meat and white meat, post- mortem changes in meat- rigor mortis, tenderization of meat, ageing of meat. Aquaculture, composition of fish, characteristics of fresh fish, spoilage of fish - microbiological, physiological and biochemical. Composition and nutritive value of egg, characteristics of fresh egg, deterioration of egg quality, difference between broiler and layers. An overview of types of market milk and milk products.

UNIT IV: Principles of food processing (15 Hrs)

Principles of thermal processing; Pasteurization and Sterilization; Principles of food preservation by dehydration, thermal treatments like pasteurization, sterilization, canning, retorting etc., low temperature i.e., chilling and freezing, chemical preservation/ bio-preservation, traditional methods like salting/ syruping, pickling, fermentation etc., non- thermal processes like MAP, irradiation, high pressure processing etc., and hurdle technology.

UNIT V: Food Standards and Safety Regulations: (14 Hrs)

Salient features of Food Safety & Standards Act, 2006, Structure of FSSAI, CODEX. Administrative set up at the State level. Accreditation of Food Laboratory. Hazard analysis and Critical control point (HACCP), Food Laws and Implementing Agencies (National and International), Intellectual Property Rights and Trade Marks, Labelling of GM foods. Regulatory and social aspects of biotechnology in the food industry.

Reference Link

S.No.	Topics	Link
UNIT I: Introduction and Chemistry of food Constituents		
1	Historical evolution of food biotechnology	https://www.youtube.com/watch?v=xLXOrXd5BI4
2	Stability to pH, temperature and other processing conditions	https://www.youtube.com/watch?v=jYRSYfxh8
3	Classification – flavours – Bittering agents	https://www.youtube.com/watch?v=Ft2taKc5RmY
UNIT II: Standards for food analysis		
4	Standards of identity, purity, and methodology for analysis	https://www.youtube.com/watch?v=yKVge46VMRY
UNIT III: Meat, Poultry, Egg & Seafood Processing		
5	Concept and composition of red meat and white meat	https://www.youtube.com/watch?v=bbfyoSdiNA4
6	Aquaculture	https://www.youtube.com/watch?v=YGaFNZzjCXI
7	Composition and nutritive value of egg	https://www.youtube.com/watch?v=EwUtlolBam0
UNIT IV: Principles of food processing		
8	Pasteurization and Sterilization	https://www.youtube.com/watch?v=LH_7EuEfRTc
9	Low temperature i.e., chilling and freezing	https://www.youtube.com/watch?v=nk83WxNE0Zc
10	Non- thermal processes like MAP, irradiation	https://www.youtube.com/watch?v=pe6AKh_tLys
UNIT V: Food Standards and Safety Regulations		
11	Salient features of Food Safety & Standards Act, 2006	https://www.youtube.com/watch?v=kd4eJsgABWA
12	Accreditation of Food Laboratory	https://www.youtube.com/watch?v=oqdS_nSnDno
13	Regulatory and social aspects of biotechnology in the food industry	https://www.youtube.com/watch?v=NWdJQQP_zHM

TEXT BOOKS

S.No	Authors	Title of the book	Publishers	Year and Edition
1	Johnson-Green, P.	Introduction to Food Biotechnology	CRC Press	2018 1 st Edn
2	Bello-Pérez., et al.	Starch and Starchy Food Products Improving Human Health	CRC Press	2022 1 st Edn
3	Paredes-López, O.,	Food Microbial and Molecular Biology from Fundamentals to Applications	CRC Press	2023 1 st Edn

REFERENCE BOOKS

S.No	Authors	Title of the book	Publishers	Year and Edition
1	Islam, S., et al.	Food Microbial and Molecular Biology from Fundamentals to Applications	Apple Academic Press	2023 1 st Edn
2	Attaway, D. H.	Wheat Science-Nutritional and Anti- Nutritional Properties, Processing, Storage, Bioactivity, and Product Development.	CRC Press	2023- 1 st Edn

Course Designer

Dr. Rachana Sharma

Pedagogy

- PowerPoint Presentations, Group Discussion, Seminar, Quiz Assignment, Experience Discussion

Course Content and Presentation Schedule

UNIT I: Introduction and Chemistry of food Constituents - (15 Hrs)					
Module No.	Topic	CLO level	No. of periods	Content delivery method	Learning methods
1.	Historical evolution of food biotechnology.	CLO1 CLO2	1	Lecture – Chalk and Talk / Group reading	Participatory Learning
2.	Physicochemical properties of Food constituents	CLO1 CLO2 CLO3	2	Demonstration	Problem-based Learning
3.	Chlorophyll &	CLO2 CLO3	1	Chalk and talk/ Picture	Participatory Learning
4.	Chlorophyll derivatives	CLO2 CLO3	1	Demonstration and presentation	Experiential Learning
5.	Carotenoids, saffron,	CLO1 CLO2 CLO3	1	Virtual lab	Problem-based Learning
6.	Turmeric- stability to pH, temperature and other processing conditions	CLO1 CLO3	2	Student seminar	Participatory Learning
7.	Techniques for the production of dried colourants	CLO1 CLO2 CLO3	1	Virtual lab	Experiential Learning
8.	Caramel colour	CLO1 CLO2 CLO3	1	Demo	Experiential Learning
9.	Ingredients, Taste, Aroma, Undesirable flavors	CLO1 CLO2 CLO3	2	Field observations	Problem-based Learning
10.	Classification – flavours –	CLO1 CLO2	1	Demo	Experiential Learning
11.	Bittering agents,	CLO1 CLO2	1	Practical session demo	Experiential Learning
12.	Fruit flavours.	CLO1 CLO2 CLO3	1	Practical session demo	Experiential Learning
UNIT II: Standards for food analysis - (15 Hrs)					
13.	Standards of identity, purity, and methodology for analysis-	CLO2 CLO4	2	Lecture – Chalk and Talk	Problem-based Learning
14.	Cereals	CLO1 CLO2	1	Lecture	Participatory Learning

15.	legumes	CLO2 CLO4	1	Chalk and talk/ Picture	Problem- based Learning
16.	oil seeds and their products	CLO2 CLO4	1	Lecture PPT	Participatory Learning
17.	Fruits	CLO1 CLO2	1	Lecture	Problem- based Learning
18.	vegetables	CLO1 CLO2 CLO4	1	PPT	Problem- based Learning
19.	tubers and their products	CLO1 CLO2 CLO4	1	Lecture – Chalk and Talk / Group reading	Participatory Learning
20.	Tea	CLO2 CLO4	1	PPT	Problem- based Learning
21.	coffee	CLO2 CLO4	1	Lecture – Chalk and Talk	Experiential Learning
22.	cocoa	CLO1 CLO2 CLO4	1	Research article reading	Problem- based Learning
23.	chocolate	CLO1 CLO2 CLO4	1	Displays	Experiential Learning
24.	spices.	CLO1 CLO2 CLO4	1	Chalk and talk/ Picture	Problem- based Learning
25.	sugar	CLO2 CLO4	1	Research article reading	Problem- based Learning
26.	Condiments.	CLO2 CLO4	1	Lecture	Problem- based Learning
UNIT III: Meat, Poultry, Egg & Seafood Processing - (14 Hrs)					
27.	Concept and composition of red meat and	CLO2 CLO3	2	Lecture – Chalk and Talk / Group reading	Participatory Learning
28.	white meat	CLO2 CLO3	2	PPT / OER	Experiential Learning
29.	Post- mortem changes in meat	CLO2 CLO4	1	Lecture – Chalk and Talk / Group reading	Problem- based Learning

30.	rigor mortis	CLO2 CLO3 CLO4	1	Book/ Article review	Experiential Learning
31.	Tenderization of meat, ageing of meat	CLO2 CLO3	1	OER	Problem-based Learning
32.	Aquaculture, composition of fish	CLO3 CLO4	1	Lecture – Chalk and Talk / Group reading	Problem-based Learning
33.	Characteristics of fresh fish	CLO2 CLO3 CLO4	1	PPT	Experiential Learning
34.	Spoilage of fish – microbiological, Physiological and biochemical	CLO2 CLO3	1	Lecture	Participatory Learning
35.	Composition and nutritive value of egg, characteristics of fresh egg, deterioration of egg quality	CLO2 CLO3	1	Peer teaching	Participatory Learning
36.	Difference between broiler and layers	CLO2 CLO3	1	Lecture	Experiential Learning
37.	An overview of types of market milk and milk products	CLO2 CLO3 CLO4	2	Peer teaching	Participatory Learning
UNIT IV: Principles of food processing (15 Hrs)					
38.	Principles of thermal processing	CLO2 CLO3 CLO4	1	Chalk and talk/ Picture	Problem-based Learning
39.	Pasteurization and Sterilization	CLO3 CLO4	1	PPT	Problem-based Learning
40.	Principles of food preservation by dehydration	CLO2 CLO3 CLO4	1	Lecture – Chalk and Talk	Experiential Learning
41.	thermal treatments like pasteurization	CLO3 CLO4	1	PPT	Problem-based Learning
42.	sterilization, canning, retorting etc.,	CLO2 CLO3 CLO4	1	Chalk and talk/ Picture	Participatory Learning
43.	low temperature i.e., chilling and freezing	CLO2 CLO4	1	Picture	Experiential Learning
44.	Chemical preservation/ Bio-preservation	CLO2 CLO3 CLO4	1	Research article reading	Problem-based Learning

45.	Traditional methods like salting/	CLO2 CLO4	1	Lecture – Chalk and Talk	Problem-based Learning
46.	syruping	CLO3 CLO4	1	Video	Problem-based Learning
47.	pickling	CLO2 CLO3 CLO4	1	Chalk and talk/ Picture	Problem-based Learning
48.	Fermentation etc.,	CLO3 CLO4	1	Video	Problem-based Learning
49.	Non- thermal processes like MAP	CLO2 CLO3 CLO4	1	PPT	Problem-based Learning
50.	Irradiation	CLO2 CLO4	1	Picture	Participatory Learning
51.	High pressure processing etc., and	CLO2 CLO3 CLO4	1	Displays	Experiential Learning
52	Hurdle technology	CLO2 CLO3 CLO4	1	Lecture	Problem-based Learning
UNIT V: Food Standards and Safety Regulations (14 Hrs)					
53.	Salient features of Food Safety & Standards Act, 2006	CLO1 CLO3 CLO4	1	Lecture – Chalk and Talk / Group reading	Participatory Learning
54.	Structure of FSSAI	CLO1 CLO3 CLO4	1	PPT / OER	Participatory Learning
55.	CODEX	CLO1 CLO3 CLO4	1	Chalk and talk/ Picture	Participatory Learning
56	Administrative set up at the State level	CLO3 CLO4	1	Video Lecture and Discussion	Participatory Learning
57.	Accreditation of Food Laboratory	CLO1 CLO3 CLO4	1	Demonstration	Experiential Learning
58.	Hazard analysis and Critical control point (HACCP)	CLO1 CLO3 CLO4	1	Demonstration	Experiential Learning
59.	Food Laws and Implementing Agencies (National and International)	CLO3 CLO4	1	Flipped Class room	Experiential Learning
60.	Intellectual Property Rights and TradeMarks	CLO3 CLO4	2	Virtual lab, Demonstration	Problem-based

					Learning
61.	Labelling of GM foods	CLO3 CLO4	2	Lecture	Participatory Learning
62.	Regulatory and	CLO1 CLO3 CLO4	1	Lecture PPT/OER	Participatory Learning
63.	social aspects of biotechnology in the food industry	CLO1 CLO3 CLO4	2	Book/ Article review	Experiential Learning

S.NO.	LEARNING METHODS	PERCENTAGE
1	Participatory Learning	30%
2	Experiential Learning	30%
3	Problem Based Learning	40%

COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	CREDIT
BT23E06	DRUG DISCOVERY AND DEVELOPMENT	THEORY	73	2	-	4

Preamble

- This course helps students understand the timelines and resources needed for drug discovery and development, the key features of each stage in preclinical drug development, and the comparison of common natural drug sources with modern approaches.

Course Learning Outcomes

On the successful completion of the course, students will be able to

CLO Number	CLO Statement	Knowledge Level
CLO1	Basic science in the discovery and development of new drugs.	K1
CLO2	Understanding the role of natural products as drug candidates.	K2
CLO3	Ability to comprehend the function of medicinal chemistry and imaging in drug discovery.	K3
CLO4	Figuring out the drug development and approval process.	K4

Mapping with Programme Learning Outcomes

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	M	S	M	S	S
CLO2	S	S	M	S	S
CLO3	S	S	S	S	M
CLO4	S	M	S	M	S

S- Strong; M-Medium

DRUG DISCOVERY AND DEVELOPMENT - BT23E06- 73 HRS

Unit I: Foundations of Drug Discovery

(14 Hrs)

Drug Discovery-A Historical Perspective, An Outline in Drug Development Process, time, cost and attrition. Basic science to support new drug ideas and clinical trials. Lead Development and Optimization-Bioesters, Stereochemistry and Lipinski Rule of Five.

Unit II: Natural Products in Drug Discovery

(15 Hrs)

Natural product in drug discovery: Introduction, Historical Perspective, antibiotics. Screening- Whole Organism Screening, Target-Based Screening, Dereplication and Screening Improvements. Optimization of Natural Product Leads- Semisynthesis, Improvements in Natural Products through Total Synthesis, Biosynthetic Modifications and Structure–Activity Relationships.

Unit III: Medicinal Chemistry in Drug Discovery

(15 Hrs)

Drug Discovery and Medicinal Chemistry- Molecular properties and interactions, Bioisosteres and functional groups, Structure activity relationships (SAR) and quantitative SAR (QSAR) techniques. Improving absorption, distribution, metabolism, and excretion (ADME), Toxicology screening, balance clearance and permeability.

Unit IV: *In Vivo* Imaging in Drug Discover

(14 Hrs)

Introduction to *in vivo* imaging in Drug Discovery, *In vivo* imaging with PET: concepts and methods. Positron Emission Tomography (PET) - Basic Principles, General requirements for a PET ligand, Nonspecific and unspecific binding. *In vivo* drug discovery in Zebra fish.

Unit V : Drug Development and Regulatory Approvals

(15 Hrs)

Drug development- Steps involved in drug development, preclinical evaluation clinical evaluation, pharmacology and trials. Drug approval process in India, Europe and United states- a comparison. Investigational New Drug (IND) application, New Drug Application (NDA) and Abbreviated New Drug Application (ANDA).

Text Book

S.No	Authors	Title of the book	Publishers	Year & Edition
1.	Stromgaard, K., Krogsgaard-Larsen, P., & Madsen, U.	Textbook of drug design and discovery	CRC Press- Taylor & Francis group	2017 5 th Edn
2.	Gad, S. C.	Drug discovery-Handbook	Wiley	2005 1 st Edn
3.	Schoenwald, R. D.	Pharmacokinetics in Drug Discovery Development	CRC Press	2002

Books for Reference

S.No	Authors	Title of the book	Publishers	Year & Edition
1.	Poduri, R.	Drug Discovery and Development from Targets and Molecules to Medicines	Springer Singapore	2021 1 st Edn
2.	Blass, B. E.	Basic Principles of Drug Discovery and Development	Academic Press	2021 2 nd Edn

Course designers:

Dr. Shalini G

Dr. V. Bhuvaneshwari

COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	CREDIT
BT22SB02	COMPUTATIONAL BIO-NETWORKING	THEORY	43	2	-	3

Preamble

- To apply computational tools for predicting immunological data, evaluate and design effective immunotherapeutic targets and it focuses on understanding the fundamentals of molecular dynamics force fields, alongside applying simulation algorithms to study protein-ligand interactions.

Course Learning Outcomes

On the successful completion of the course, students will be able to

CLO Number	CLO Statement	Knowledge Level
CLO1	Identify computational tools used to predict immunological data.	K1
CLO2	Explain the novel approaches for disease intervention using network theory.	K2
CLO3	Demonstrate the application of molecular dynamics and force field concepts.	K3
CLO4	Analyze protein-ligand interactions using simulation algorithms.	K4

Mapping with Programme Learning Outcomes

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	S	S	S	M	M
CLO2	S	M	S	M	M
CLO3	S	S	M	M	M
CLO4	S	M	M	M	M

* S- Strong; M-Medium

COMPUTATIONAL BIO- NETWORKING - BT22SB02- 43 HRS

Unit I: Underpinnings of Immunoinformatics

(8 Hrs)

Introduction to immunology and computational biology, Tools for sequence analysis and epitope prediction, Data mining and analysis in immunological studies, Applications in vaccine design and immunotherapy.

Unit II : Network Pharmacology in Biomedical Sciences

(9 Hrs)

Network theory and its applications in pharmacology, Construction and analysis of biological networks. Drug-target interactions and network-based drug discovery, Network-based approaches for disease modeling and drug repurposing.

Unit III : Principles of Molecular Dynamics Simulation

(8 Hrs)

Basics of molecular dynamics and force fields, Simulation algorithms and methodologies, understanding protein-ligand interactions through simulations, Practical use of molecular dynamics in drug design and protein dynamics.

Unit IV: Biodegradation Pathways in Waste Cleanup

(9 Hrs)

Introduction to toxicology and biodegradation, computational toxicology, toxicological databases and data interpretation, computational analysis of biodegradation pathways, genomic analysis in biodegradation prediction.

Unit V: Next-generation sequencing

(9 Hrs)

Introduction to NGS, preprocessing and quality control of NGS data, alignment and assembly. Software commonly used in NGS data analysis - BWA, Bowtie, SAMtools and GATK. Galaxy-workflow, data integration, and analysis.

Reference Link

S.No	Topic	Video Link
Unit I: Underpinnings of Immunoinformatics		
1	Tools for sequence analysis	https://www.youtube.com/watch?v=QLcmEqBayr0
2	Data mining	https://www.youtube.com/watch?v=Hb8oWM-NQLE
Unit II: Network Pharmacology in Biomedical Sciences		
3	Drug-target interactions	https://www.youtube.com/watch?v=_LPQw5Hjo1o
Unit III : Principles of Molecular Dynamics Simulation		
4	Basics of force fields	https://www.youtube.com/watch?v=uNvF9ZBufTk
5	Understanding protein-ligand interactions through simulations	https://www.youtube.com/watch?v=qZ8P_6Mwtc4
Unit IV: Biodegradation Pathways in Waste Cleanup		
6	Computational toxicology	https://youtu.be/8TAFKzmvjal
7	Genomic analysis	https://youtu.be/2JUu1WqidC4
Unit V: Next-generation sequencing		
8	Software commonly used in NGS data analysis	https://youtu.be/l4BAfRekohk
9	Galaxy	https://youtu.be/yxauG_pj2CI

Course Content and Presentation Schedule

Module No.	Topic	CLO level	No. of Hours	Content delivery method	Learning methods
UNIT I: Underpinnings of Immunoinformatics – (8 Hrs)					
1	Introduction to immunology and computational biology,	CLO1 CLO2	1	Lecture – Chalk and Talk	Participatory Learning
2	Tools for sequence analysis and	CLO1 CLO4	1	PPT and Video	Participatory Learning
3	epitope prediction,	CLO1 CLO3	1	Virtual lab	Experiential Learning
4	Data mining and	CLO1 CLO2	1	PPT and Video	Participatory Learning
5	analysis in immunological studies,	CLO1 CLO3	1	Virtual lab, Demonstration	Experiential zLearning
6	Applications	CLO1 CLO4	1	Virtual lab	Problem-based Learning
7	in vaccine design and	CLO1 CLO4	1	Demonstration and Lecture	Experiential Learning
8	Immunotherapy.	CLO1 CLO3	1	Virtual lab, Demonstration	Experiential Learning
UNIT II: Network Pharmacology in Biomedical Sciences – (9 Hrs)					
9	Network theory and its applications in pharmacology,	CLO2 CLO1	1	Lecture	Participatory Learning
10	Construction and	CLO2 CLO3	1	PPT and Discussion	Experiential Learning
11	analysis of biological networks.	CLO2 CLO3	1	Virtual lab and Demonstration	Problem-based Learning
12	Drug-target interactions and	CLO2 CLO3	1	Lecture and video	Participatory Learning
13	network-based,	CLO1 CLO2	1	PPT	Participatory Learning
14	drug discovery,	CLO1 CLO2	1	PPT and Virtual lab	Experiential Learning
15	Network-based approaches for	CLO2 CLO3	1	Lecture	Participatory Learning
16	disease modeling and	CLO2 CLO4	1	Lecture	Participatory Learning
17	drug repurposing	CLO1 CLO2	1	Lecture and PPT	Problem-based Learning
UNIT III: Principles of Molecular Dynamics Simulation - (8 Hrs)					
18	Basics of molecular dynamics and	CLO3 CLO4	1	Lecture and PPT	Problem-based Learning
19	force fields,	CLO3 CLO1	1	Video	Experiential Learning
20	Simulation algorithms and	CLO2	1	Virtual lab	Problem-based

		CLO3			Learning
21	methodologies	CLO3 CLO4	1	Lecture	Experiential Learning
22	understanding protein-ligand interactions	CLO1 CLO3	1	Lecture and demonstration	Experiential Learning
23	through simulations,	CLO1 CLO3	1	PPTs and video	Experiential Learning
24	Practical use of molecular dynamics in	CLO2 CLO3	1	Virtual lab	Experiential Learning
25	drug design and protein dynamics.	CLO3 CLO4	1	Demonstration	Experiential Learning
UNIT IV: Biodegradation Pathways in Waste Cleanup (9 Hrs)					
26	Introduction to toxicology and biodegradation,	CLO1 CLO4	1	Lecture and discussion	Participatory Learning
27	computational toxicology,	CLO CLO4	1	PPTs and demonstration	Experiential Learning
28	toxicological databases	CLO1 CLO3	1	Brainstorming	Participatory Learning
29	data interpretation,	CLO2 CLO4	1	PPT	Experiential Learning
30	computational analysis of biodegradation pathways,	CLO2 CLO4	1	Demonstration	Experiential Learning
31	genomic analysis in	CLO1 CLO4	2	PPT and virtual lab	Problem-based Learning
32	biodegradation prediction.	CLO1 CLO2 CLO4	2	Virtual lab	Problem-based Learning
UNIT V: Next-generation sequencing – (9 Hrs)					
33	Introduction to NGS,	CLO2 CLO4	1	Research article reading	Participatory Learning
34	preprocessing and quality control of NGS data.	CLO1 CLO3 CLO4	1	Discussion	Participatory Learning
35	alignment and assembly.	CLO3 CLO4	1	Research article reading	Experiential Learning
36	Software commonly used in NGS data analysis-	CLO2 CLO4	1	Virtual lab	Experiential Learning
37	BWA, Bowtie, SAMtools, GATK.	CLO3 CLO4	1	Demonstration	Experiential Learning
38	Galaxy-	CLO2 CLO3 CLO4	1	PPT	Problem-based Learning
39	Workflow,	CLO3 CLO4	1	PPT and discussion	Experiential Learning
40	data integration, and	CLO2 CLO3 CLO4	1	Brainstorming	Problem-based Learning
41	analysis.	CLO1 CLO2 CLO4	1	Brainstorming	Problem-based Learning

SNO	LEARNING METHODS	PERCENTAGE
1	Participatory Learning	27 %
2	Experiential Learning	47 %
3	Problem-based Learning	26 %

COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	CREDIT
BT22AC3	FORENSIC BIOTECHNOLOGY	THEORY	-	-	-	5

Preamble

- This course helps students understand the timelines and resources needed for drug discovery and development, the key features of each stage in preclinical drug development, and the comparison of common natural drug sources with modern approaches to drug design and development.

FORENSIC BIOTECHNOLOGY - BT22AC3

UNIT I: Introduction to Forensic Biotechnology

Definition and scope of Forensic Biotechnology, History and development, Forensic genetics, Forensic agriculture.

UNIT II: Crime scene investigation

Crime scene investigation; collection, preservation, packing and forwarding of physical and trace evidence. Questioned documents – identification of handwriting, signature and detection of forgery.

UNIT III: Serology

Serology - Fresh blood grouping and typing, stains of bloods. Identification of blood stains, collection and storage of allied body fluids (semen, saliva and blood).

UNIT IV: Biochemical and Molecular techniques in Forensic investigation

Molecular techniques, Microscopy (Electron, Fluorescent) and Chromatography (Paper, TLC & HPLC) in forensic investigation. Odontology

UNIT V: DNA fingerprinting

DNA Profiling--RAPD, RFLP, AFLP, VNTR, SNP. Isolation of DNA from blood samples, DNA testing in cases of disputed paternity and maternity. Case studies: N.D. Tiwari and Tandoor Murder Case (1995).

Text Book

S.No	Authors	Title of the book	Publishers	Year and Edition
1	Rao, N. G.	Textbook of Forensic Medicine & Toxicology	Jaypee	2013 2 nd Edn
2	Reddy, K. S. N., & Murty, O. P.	The Essentials of Forensic Medicine & Toxicology	Jaypee	2022 35 th Edn
3	Stuart, B. H.	Forensic Analytical Techniques	Wiley, UK	2013 1 st Edn

Books for Reference

S.No	Authors	Title of the book	Publishers	Year and Edition
1	Fraser, J.	Forensic Science: A very short introduction	Oxford university press	2010 2 nd Edn
2	Goodwin, W., Linacre, A., & Hadi, S.	An introduction to Forensic Genetics	John Wiley & Sons Ltd	2007 2 nd Edn

Course Designers

Dr. V. Bhuvaneshwari

COURS CODE	COURSE TITLE	CATEGORY	L	T	P	CREDIT
BT23AC4	HUMAN ANATOMY AND PHYSIOLOGY	THEORY	-	-	-	5

Preamble

- This course provides fundamental knowledge of the structure and functions of the human body, helps students understand homeostatic mechanisms, and offers the basic foundation needed to study various disciplines of pharmacy.

HUMAN ANATOMY AND PHYSIOLOGY - BT23AC4

Unit I - Introduction to human body

Definition and scope of anatomy and physiology, levels of structural organization and body systems, basic life processes, homeostasis, basic anatomical terminology. Cellular level of organization Structure and functions of cell. General principles of cell communication, Forms of intracellular signaling: Contact-dependent, Paracrine, Synaptic, Endocrine.

Unit II – Integumentary and Skeletal system

Structure and functions of skin. Skeletal system- Divisions of skeletal system, types of bone, salient features and functions of bones of axial and appendicular skeletal system. Organization of skeletal muscle, physiology of muscle contraction, neuromuscular junction.

Unit III - Blood Lymphatic system

Body fluids, composition and functions of blood, formation of hemoglobin, anemia, mechanisms of coagulation, blood grouping, Rh factors, transfusion, its significance and disorders of blood.

Unit IV - Peripheral nervous system

Classification of peripheral nervous system: Structure and functions of sympathetic and parasympathetic nervous system. Origin and functions of spinal and cranial nerves. Special senses Structure and functions of eye, ear, nose and tongue and their disorders.

Unit V - Cardiovascular system

Heart– anatomy of heart, blood circulation, blood vessels, structure and functions of artery, vein and capillaries, elements of conduction system of heart and heartbeat, its regulation by autonomic nervous system, cardiac output, cardiac cycle. Regulation of blood pressure, pulse, electrocardiogram and disorders of heart.

Text Book

S.No	Authors	Title of the book	Publishers	Year and Edition
1	Sembulingam, K., & Sembulingam, P.	Essentials of Medical Physiology	Jaypee brothers medical publishers, New Delhi	2012 6 th Edn
2	Waugh, A., & Grant, A.	Anatomy And Physiology in Health and Illness	Churchill Livingstone	2010 11 th Edn
3.	Tandon, O. P., & Tripathi.	Best & Taylor's Physiological Basis of Medical Practice	Wolters Kluwer Company	2011 13 th Edn

Books for Reference

S.No	Authors	Title of the book	Publishers	Year and Edition
1	Hall, J. E., & Guyton, A. C.	Text book of Medical Physiology	Miamisburg, OH, U.S.A	2020 3 rd Edn
2	John, N. A.	Human Physiology	Academic Publishers Kolkatta.	2005 1 st Edn

Course Designers

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2. Dr. G. Anbarasi