



**PSGR
Krishnammal College for Women**



**DEPARTMENT OF BIOTECHNOLOGY
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)**

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

MSc BIOTECHNOLOGY

SEMESTER I - IV

BATCH 2024-26

PROGRAMME LEARNING OUTCOMES (PLO's)

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

PLO1: Apply the theoretical and practical skills gained in the multidisciplinary field of Biotechnology to solve real world problems, or crack a competitive exam for higher studies or to perform well in a job interview.

PLO2: Gain an in-depth understanding to design and perform experiments, analyze and interpret experimental data in biotechnology and related areas.

PLO3: Acquire the ability to write well-structured reviews, scientific publications and communicate scientific results to the general public and subject experts by oral presentations or posters.

PLO4: Understand the safety procedures in handling chemicals, laboratory equipment, biological materials and genetically modified organisms.

PLO5: Acquire the ability to carry out research independently or in groups in multidisciplinary projects.

PROGRAMME SPECIFIC OUTCOME (PSO's)

The students at the time of graduation will

PSO1: Comprehend Biotechnology and other multidisciplinary areas prescribed in the syllabus.

PSO2: Understand the structure and functions of microbial, animal and plant cells.

PSO3: Develop skills for the design of new products.

PSO4: Acquire higher order thinking skills.

PSO5: Acquire knowledge in the current trends to meet the future challenges in the Biotech, Genomics and Pharmaceutical industries.



DEPARTMENT OF BIOTECHNOLOGY
CHOICE BASED CREDIT SYSTEM (CBCS) & LEARNING OUTCOME BASED
CURRICULAR FRAMEWORK (LOCF)
SYLLABUS & SCHEME OF EXAMINATION
MASTER OF SCIENCE BIOTECHNOLOGY – 2024-2026 BATCH
Applicable to students admitted during the academic year 2024-2025 and onwards

Semester	Course Code	Title of the Course	Instruction hours/week	Contact hours	Tutorial	Duration of Examination	Examination Marks			Credits
							CA	ESE	TOTAL	
I	MBY2301	Cell and Molecular Biology	5	73	2	3	25	75	100	4
	MBY2302	Biochemistry	5	73	2	3	25	75	100	4
	MBY2403	Microbiology	4	58	2	3	25	75	100	4
	MBY2304	Bioinformatics	4	58	2	3	25	75	100	4
	MBY24P1	Practical-I Biochemistry and Microbiology Practical	6	90	-	6	25	75	100	4
	MBY23P2	Practical-II Cell and Molecular Biology and Bioinformatics Practical	6	90	-	6	25	75	100	4
I-III	17MONL1	Online Courses	-	-	-	-	-	-	-	-

CA – Continuous Assessment

ESE - End Semester Examination

Students completing online course through NPTEL, Swayam will get Extra credit of 1, for others completed status will be given.

QUESTION PAPER PATTERN

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)
Seminar/Assignment/Quiz	-	5	
Class Participation	-	5	
Attendance	-	3	

25 + 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

CIA Question Paper Pattern: 1 x 45 = 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 marks

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 marks

Practical (for 25 Marks)

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

ESE Practical 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 CODE	TITLE OF THE COURSE	CATEGORY	L	T	P	CREDITS
MBY2301	CELL AND MOLECULAR BIOLOGY	THEORY	73	2	-	4

Learning Objectives:

- To gain a comprehensive understanding of the cellular and molecular functions of cell organelles, including their role in cell-to-cell interaction, gene regulation, and cellular signalling.
- To acquire the skills of molecular biology and how they are applied in different disciplines.
- To understand the principles and molecular mechanisms involved in cellular differentiation, morphogenesis, growth, and cell potency.

Course Learning Outcomes

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

CLO Number	CLO Statement	Knowledge Level
CLO1	Summarize about the various intracellular organelles.	K2
CLO2	Explain about the mechanism and regulation of intracellular transport in cellular organelles.	K3
CLO3	Outline about DNA damage and evaluate different types of repair mechanisms.	K4
CLO4	Justify the importance of Transcription, Post Transcriptional Modification, Translation and Post Translational modification.	K5
CLO5	Report about proto-oncogenes, oncogenes and tumor suppressor genes.	K6

Mapping with Programme Learning Outcomes

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	S	M	S	S	S
CLO2	S	M	S	S	M
CLO3	S	S	S	S	S
CLO4	S	M	S	S	M
CLO5	S	M	S	S	S

S-Strong M-Medium

MBY2301 - CELL AND MOLECULAR BIOLOGY

Unit I Cell Organization and Cell Cycle

(15 hrs)

Structure of prokaryotic and eukaryotic cells. Structural organization and function of intracellular organelles (Nucleus, Endoplasmic Reticulum, Golgi complex, Mitochondria, Chloroplast, Lysosomes, Peroxisomes and Vacuoles), Cytoskeletons. Chromatin organization and packaging. Cell cycle and its regulation, Prokaryotic and Eukaryotic cell cycle. Cell cycle check points- WEE1, CHK1, CHK2. **Cyclins (D1, D2, B1, A1) and Cyclin Dependent Kinases (CDKA, CDK B) protein kinases-Tyrosine kinase, MAPK Kinase. Phosphatases – CDC25**

Unit II Structure of membrane system, Cellular transport and trafficking

(14 hrs)

Lipid bilayer and membrane protein diffusion, osmosis, ion channels, active transport, and ion pumps. Intracellular protein sorting- Molecular Mechanism and regulation of intracellular transport in mitochondria, chloroplast, endoplasmic reticulum and nucleus. Electrical properties of membranes. **Intracellular vesicular trafficking from endoplasmic reticulum through Golgi apparatus to lysosomes/cell exterior.**

Unit III DNA repair & Recombination

(15 hrs)

DNA damage and repair mechanism (Mismatch correction, Base excision repair, Nucleotide excision repair, Direct repair, Photoreactivation, Error prone Translesion DNA synthesis, SOS repair). **Chemically induced mutation - Base analogs, Nitrous acid, Acridines, Alkylating and hydroxylating agents.** DNA Recombination - Homologous and non-homologous, Site specific recombination. Chi sequences in prokaryotes, Gene targeting, Gene disruption, FLP/FRT and Cre/Lox recombination.

Unit IV Replication, Transcription, Translation and Regulation of gene expression (15 hrs)

DNA Replication-Types, Prokaryotic and Eukaryotic replication. Transcription-Prokaryotic and Eukaryotic. Translation-Prokaryotes and Eukaryotes, Post Translational modifications. Regulation of gene expression - Operon concept, *lac*, *trp*, *ara*, *his*, and *gal* operons. Regulatory proteins, DNA binding Motifs: Zinc fingers, Helix turn Helix, Homeodomain. **Regulation in eukaryotes - Control by promoter, enhancer and silencers. Cis-trans elements, DNA methylation and chromatin remodeling in gene expression.** Environmental regulation of gene expression.

Unit V Oncogenes, Mutations and Transposable elements

(14 hrs)

Mutations, proto-oncogenes, oncogenes and tumor suppressor genes, physical, chemical and biological mutagens, types of mutations, intra-genic and inter-genic suppression, transpositions- transposable genetic elements in prokaryotes and eukaryotes, role of transposons in genome, viral and cellular oncogenes, **tumor suppressor genes: structure, function and mechanism of action, activation and suppression of tumor suppressor genes, oncogenes as transcriptional activators.**

***Link provided for the highlighted content offered in blended mode**

S.No	TOPIC	LINKS
Unit I: Cell Organization and Cell Cycle		
1	Cyclins (D1, D2, B1, A1) and Cyclin Dependent Kinases (CDKA, CDK B).	https://www.youtube.com/watch?v=Lxylidj-3Ts
2	protein kinases-Tyrosine kinase, MAPK Kinase	https://www.youtube.com/watch?v=8-cub2zRQoA https://www.youtube.com/watch?v=thLsxvqDZ04
3	Phosphatases – CDC25	https://www.youtube.com/watch?v=0BqJ58ZiWwA
Unit II: Structure of membrane system, Cellular transport and trafficking		
4	Intracellular vesicular trafficking from endoplasmic reticulum through Golgi apparatus to lysosomes/cell exterior.	https://www.youtube.com/watch?v=MoHEVt9UfkQ
Unit III: DNA repair & Recombination		
5	Chemically induced mutation - Base analogs, Nitrous acid	https://www.youtube.com/watch?v=Qfw4mvGFbNo https://www.ncbi.nlm.nih.gov/pmc/articles/PMC419607/#:~:text=Nitrous%20acid%20is%20a%20mutagenic%20agent%20that%20exhibits%20two%20types,DNA%20(3%2C4).
6	Acridines, Alkylating and hydroxylating agents	https://www.youtube.com/watch?v=B1Ue37BpN3k
Unit IV: Replication, Transcription, Translation and Regulation of gene expression		
7	Regulation in eukaryotes - Control by promoter, enhancer and silencers.	https://www.youtube.com/watch?v=9x6p-r7NNKg
8	Cis-trans elements	https://www.youtube.com/watch?v=AVAmG31xz34
9	DNA methylation and chromatin remodeling in gene expression	https://www.youtube.com/watch?v=OqRt723t33o
Unit V: Oncogenes, Mutations and Transposable elements		
10	Tumor suppressor genes: structure, function and mechanism of action	https://www.youtube.com/watch?v=1mo80kTZgW4
11	activation and suppression of tumor suppressor genes,	https://www.youtube.com/watch?v=2nVm2R2XDiE&t=159s
12	oncogenes as transcriptional activators	https://www.youtube.com/watch?v=EQ9xJE8z65E

TEXT BOOKS

S.No	Authors	Title of the Book	Publishers	Year & Edition
1.	Bruce Alberts , Alexander Johnson , Julian Lewis , David Morgan , Martin Raff, Keith Roberts, Peter Walter	Molecular Biology of the Cell	Garland Science.	2014 & 6 th Edition
2.	Geoffrey M. Cooper, Robert E. Hausman	The Cell: A Molecular Approach	Sinauer Associates is an imprint of Oxford University Press.	2015 & 7 th Edition

REFERENCE BOOKS

S.No	Authors	Title of the Book	Publishers	Year & Edition
1.	Watson, J. D.	Molecular Biology of the Gene	Pearson Education	2017 & 7 th Edition
2.	Krebs, J.C., Goldstein, E.S., and Kilpatrick, S.T	Lewin's Genes XII	Jones and Bartlett Publishers.	2017 & 12 th Edition
3.	Karp, G., Iwasa, J and Marshall, W	Karp's Cell and Molecular Biology	Wiley Plus.	2019 & 9 th Edition

Course Designer:
Dr.Archana G

Module No.	Topic	CLO level	No. of periods	Content delivery method	Student engagement	Participatory Learning / Experiential Learning / Problem based Learning
Unit – I Cell Organization and Cell Cycle						
1	Structure of prokaryotic cells.	CLO1	1	Lecture – Chalk and Talk	Word cloud	Participatory Learning
2	Structure of eukaryotic cells	CLO1	1	Lecture – Chalk and Talk	Quiz (Quizalize/ Socrative)	Participatory Learning
3	Nucleus	CLO1	1	PPT	Diagrams	Experiential Learning
4	Endoplasmic Reticulum	CLO1	1	Chalk and talk/ Picture	Diagrams, Sketchboard	Participatory Learning
5	Golgi complex	CLO1	1	Picture	Diagrams	Experiential Learning
6	Mitochondria	CLO1	1	Lecture – Chalk and Talk	Presentation	Problem-based Learning
7	Chloroplast	CLO1	1	Picture	Sketchboard	Participatory Learning
8	Lysosomes	CLO1	1	PPT	Prototype framing	Experiential Learning
9	Peroxisomes and Vacuoles	CLO1	1	Lecture – Chalk and Talk	Flipped classroom, Poster	Experiential Learning
10	Cytoskeletons	CLO1	1	Picture	Blog	Participatory Learning
11	Chromatin organization and packaging.	CLO1	1	Video	E-portfolio	Experiential Learning
12	Cell cycle and its regulation. Prokaryotic and Eukaryotic cell cycle.	CLO1	1	PPT	Debate	Participatory Learning
13	Cell cycle check points- WEE1, CHK1, CHK2.	CLO1	1	PPT	Quescussion, Pro-con grid	Problem-based Learning
14	Cyclins (D1, D2, B1, A1) and Cyclin Dependent Kinases (CDKA, CDK B)	CLO1	1	Video	Presentation	Problem-based Learning
15	Protein kinases – Tyrosine kinase, MAPK Kinase. Phosphatases – CDC25	CLO1	1	Research article discussion	Presentation	Problem-based Learning

Unit – II Structure of membrane system, Cellular transport and trafficking						
16	Introduction to plasma membrane.	CLO2	1	Lecture – Chalk and Talk	Diagrams, Sketchboard	Participatory Learning
18	Lipid bilayer	CLO2	1	PPT	Diagrams, Sketchboard	Participatory Learning
19	Membrane protein diffusion and Osmosis	CLO2	1	Lecture – Chalk and Talk	Poster	Experiential Learning
20	Active transport and Passive transport	CLO2	1	PPT	Presentation	Problem-based Learning
21	Ion channels and Ion pumps	CLO2	1	PPT	Diagrams, Sketchboard	Participatory Learning
22	Intracellular protein sorting	CLO2	1	Lecture – Chalk and Talk	Think Write and Share	Participatory Learning
23	Mechanism and regulation of intracellular transport in mitochondria.	CLO2	1	Picture	Flipped classroom, Presentation	Participatory Learning
24	Mechanism and regulation of intracellular transport in chloroplast	CLO2	1	Picture	Quescussion, Pro-con grid	Problem-based Learning
25	Mechanism and regulation of intracellular transport in endoplasmic reticulum	CLO2	1	Video	Quescussion, Pro-con grid	Problem-based Learning
26	Mechanism and regulation of intracellular transport in nucleus.	CLO2	1	Video	Debate	Participatory Learning
27	Electrical properties of membranes.	CLO2	1	PPT	Think Write and Share	Participatory Learning
28	Intracellular vesicular trafficking from endoplasmic reticulum through Golgi apparatus to lysosomes/cell exterior.	CLO2	1	Lecture – Chalk and Talk	Presentation	Problem-based Learning
29	Cont. Intracellular vesicular trafficking from endoplasmic reticulum through Golgi apparatus to lysosomes/cell exterior.	CLO2	1	Lecture – Chalk and Talk	Poster	Experiential Learning

Unit – III DNA repair & Recombination						
30	DNA damage and repair mechanism	CLO3	1	Displays	Gallery walk, Post it parade	Experiential Learning
31	Mismatch correction	CLO3	1	Lecture PPT	Peer teaching	Participatory Learning
32	Base excision repair, Nucleotide excision repair	CLO3	1	Lecture PPT	Student seminar	Participatory Learning
33	Direct repair, Photoreactivation	CLO3	1	Seminar / PPT	Flipped classroom	Participatory Learning
34	Error prone Translesion DNA synthesis, SOS repair	CLO3	1	Chalk and talk/ Picture	Debate, Quescussion, Pro-con grid	Problem-based Learning
35	Chemically induced mutation - Base analogs	CLO3	1	Lecture – Chalk and Talk	Poster	Experiential Learning
36	Nitrous acid, Acridines	CLO3	1	Lecture – Chalk and Talk	Poster	Experiential Learning
37	Alkylating and hydroxylating agents	CLO3	1	Displays	Gallery walk, Post it parade	Experiential Learning
38	DNA Recombination	CLO3	1	Research article reading	Case thinking	Problem-based Learning
39	Homologous and non-homologous	CLO3	1	Lecture PPT	Student seminar	Participatory Learning
40	Site specific recombination	CLO3	1	Seminar / PPT	Flipped classroom	Participatory Learning
41	Chi sequences in prokaryotes	CLO3	1	Research article reading	Case thinking	Problem-based Learning
42	Gene targeting	CLO3	1	Displays	Gallery walk, Post it parade	Experiential Learning
43	Gene disruption,	CLO3	1	Displays	Gallery walk, Post it parade	Experiential Learning
44	FLP/FRT and Cre/Lox recombination	CLO3	1	PPT	Word cloud/ Mind map / Think Write and Share	Participatory Learning
Unit – IV Replication, Transcription, Translation and Regulation of gene expression						
45	DNA Replication-Types	CLO4	1	Video	Quescussion	Participatory Learning
46	Prokaryotic and Eukaryotic replication	CLO4	1	Displays	Gallery walk, Post it parade	Experiential Learning

47	Transcription-Prokaryotic and Eukaryotic	CLO4	1	Research article reading	Case thinking	Problem-based Learning
48	Translation-Prokaryotes and Eukaryotes	CLO4	1	Lecture PPT	Peer teaching	Participatory Learning
49	Translation-Prokaryotes and Eukaryotes	CLO4	1	Video / Observation	Group discussion	Experiential Learning
50	Post Translational modifications	CLO4	1	PPT	Review collection, Case study	Problem-based Learning
51	Regulation of gene expression - Operon concept, lac, trp, ara, his, and gal operons	CLO4	1	Lecture – Chalk and Talk	Flipped classroom, Poster	Experiential Learning
52	Regulation of gene expression - Operon concept, lac, trp, ara, his, and gal operons	CLO4	1	Lecture PPT	Student seminar	Participatory Learning
53	Regulatory proteins	CLO4	1	Displays	Gallery walk, Post it parade	Experiential Learning
54	DNA binding Motifs: Zinc fingers, Helix turn Helix, Homeodomain	CLO4	1	Lecture – Chalk and Talk	Poster	Experiential Learning
55	DNA binding Motifs: Zinc fingers, Helix turn Helix, Homeodomain	CLO4	1	Lecture PPT	Student seminar	Participatory Learning
56	Regulation in eukaryotes - Control by promoter	CLO4	1	Lecture/ Virtual lab	Simulation	Experiential Learning
57	enhancer and silencers. Cis-trans elements	CLO4	1	Seminar / PPT	Flipped classroom	Participatory Learning
58	DNA methylation and chromatin remodeling in gene expression.	CLO4	1	Chalk and talk/ Picture	Debate, Quescussion, Pro-con grid	Problem-based Learning
59	Environmental regulation of gene expression.	CLO4	1	Video	Quescussion	Participatory Learning
Unit –V Oncogenes, Mutations and Transposable elements						
60	Mutations, proto-oncogenes	CLO5	1	Video / Observation	Group discussion	Experiential Learning
61	oncogenes and tumor suppressor genes	CLO5	1	Video	Quescussion	Participatory Learning
62	physical, chemical and biological mutagens	CLO5	1	Displays	Gallery walk, Post it parade	Experiential Learning
63	physical, chemical and biological mutagens	CLO5	1	Lecture/ Virtual lab	Simulation	Experiential Learning

64	types of mutations	CLO5	1	Lecture PPT	Student seminar	Experiential Learning
65	intra-genic and inter-genic suppression	CLO5	1	PPT	Review collection, Case study	Experiential Learning
66	transpositions-transposable genetic elements in prokaryotes and eukaryotes	CLO5	1	Lecture – Chalk and Talk	Poster	Experiential Learning
67	transpositions-transposable genetic elements in prokaryotes and eukaryotes	CLO5	1	Displays	Gallery walk, Post it parade	Experiential Learning
68	role of transposons in genome	CLO5	1	Lecture PPT	Peer teaching	Participatory Learning
69	viral and cellular oncogenes	CLO5	1	Lecture	Design thinking	Problem-based Learning
70	tumor suppressor genes: structure, function and mechanism of action	CLO5	1	Lecture – Chalk and Talk	Flipped classroom, Poster	Experiential Learning
71	tumor suppressor genes: structure, function and mechanism of action	CLO5	1	Lecture PPT	Student seminar	Participatory Learning
72	activation and suppression of tumor suppressor genes	CLO5	1	Lecture	Design thinking	Experiential Learning
73	oncogenes as transcriptional activators.	CLO5	1	Seminar / PPT	Flipped classroom	Participatory Learning

Name of the course	MBY2301- Cell & Molecular Biology
Name of the Faculty	Dr. P. Suganya
Participatory Learning	40 %
Experiential Learning	40 %
Problem-based Learning	20 %

COURSE CODE	TITLE OF THE COURSE	CATEGORY	L	T	P	CREDITS
MBY2302	BIOCHEMISTRY	THEORY	73	2	-	4

Learning Objectives

- To learn about the structure of simple sugars and their role in living organisms.
- To understand the different functions of biomolecules, such as sugars, lipids, amino acids, and proteins.
- To analyze the structures of different biomolecules and how they interact with each other.
- To study the pathways involved in sugar utilization and metabolism.

Course Learning Outcomes

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

CLO Number	CLO Statement	Knowledge Level
CLO1	Discuss about the classification and properties of biological macromolecules.	K2
CLO2	Illustrate the structure of different biological macromolecules.	K3
CLO3	Differentiate the biological role of various types of macromolecules.	K4
CLO4	Distinguish the different macromolecular biosynthetic and catabolic pathways.	K5
CLO5	Report about the regulation of metabolic pathways.	K6

Mapping with Programme Learning Outcomes

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	S	S	M	S	S
CLO2	S	S	M	S	M
CLO3	S	S	M	S	S
CLO4	S	S	M	S	M
CLO5	S	S	M	S	S

M-Medium S-Strong

MBY2302-BIOCHEMISTRY

Unit I Carbohydrate and Metabolism

(15 hrs)

Classification, structure & properties of Monosaccharides. Disaccharides – Maltose, Cellobiose, Lactose and Sucrose. **Polysaccharides: Storage homoglycan – Starch, Glycogen & Dextran. Structural homoglycan - Cellulose & Chitin.** Glycosaminoglycans – Proteoglycans, Peptidoglycan, Lectins and Glycoprotein. Carbohydrate metabolism: Glycolysis, TCA cycle & its regulation, Pentose phosphate pathway, Glycogenesis, Glycogenolysis.

Unit II Lipids Classification and Metabolism

(15 hrs)

Classification of lipids – Simple & Complex. Structure, properties and functions of Fatty acids, Triacylglycerols, **Glycerophospholipids, Sphingolipids, Waxes, Steroids**, Cholesterol, Phytosterols and Eicosanoids. Biological role of various types of Glycolipids and Lipoproteins. Self-assembly of lipids, **Micelle formation.** Lipid metabolism: β -oxidation of saturated and unsaturated fatty acids, Biosynthesis of Triacylglycerols, Glycerophospholipids and Cholesterol.

Unit III Amino acids and Proteins

(14 hrs)

Classification, structure and properties of amino acids. Peptide bond - Structure and properties. Ramachandran plot, **Protein structure – Primary, secondary (α -helix, β -sheets, turns & loops), tertiary and quaternary.** Fibrous proteins: Keratin, Collagen & Fibroin. Globular proteins, Protein Denaturation & Renaturation, Protein folding & Stability, Molecular chaperones. Amino acid and Protein metabolism: Biosynthesis of aromatic amino acids, glycine and threonine. Protein metabolism.

Unit IV Enzymes – Kinetics & Specificity

(15 hrs)

Nomenclature and classification of enzymes. **Enzyme catalysis – Specificity of enzymes, Active site, Coenzyme's & cofactors.** Enzyme kinetics – Factors affecting reaction rate, Michaelis-Menten equation, Kinetic constants, Determination of V_{max} & K_m . Enzyme inhibition – Reversible (Competitive, Non-competitive and Uncompetitive), Irreversible enzyme inhibition. Protein & non-protein enzymes (ribozymes, DNazymes), Zymogens, Abzymes, Isoenzymes. Allosteric enzymes and their properties,

Unit V Nucleic acids

(14 hrs)

Structures of Purines & Pyrimidines, Nucleosides, Nucleotides, **Nucleic acids – Classes & Properties. Chemical difference between RNA and DNA structure.** Nucleic acid Metabolism: Biosynthesis of purine and pyrimidine nucleotides - Denovo and Salvage pathways. Catabolism of purines and pyrimidines.

***Link provided for the highlighted content offered in blended mode**

S.No	TOPIC	LINKS
Unit I - Carbohydrate and Metabolism		
1	Polysaccharides	https://youtu.be/h5x9XCCwjdM?si=cBk6fYtBZZ8COr-x
2	Storage homoglycans - starch and glycogen	https://youtu.be/SLbepigcP38?si=rvkdR76aWkomhwOG
3	Structural homoglycans - cellulose and chitin	https://youtu.be/DN1w7LHn1Fo?si=9GcSVrbnNFxFGdu5
Unit II - Lipids classification and metabolism		
4	Glycerophospholipids	https://youtu.be/Hf_sylfUQZc?si=sZOnhs tjMSEalceR
5	Sphingolipids	https://youtu.be/l5r4oUSojeg?si=6KEE6nAJfoLYNAGo
6	Waxes steroids	https://youtu.be/vKRyJKghu9s?si=yAIykpr--Qs8jNWK
Unit 3: Aminoacids and Proteins		
7	Protein structure - primary	https://youtu.be/qnCZyE_P5-o?si=o2PTkoCFm8ycs7EI
8	Protein structure - secondary	https://youtu.be/tkoZ7xfA2SQ?si=WfgrydclCBM-qstV
9	Protein structure - tertiary and quaternary	https://youtu.be/1peFJ_-N7V8?si=imB6s-4ibWtsLKJW
Unit 4: Enzymes - kinetics and specificity		
10	Enzyme catalysis-specificity of enzymes	https://youtu.be/06jFSnDf-BQ?si=fvAcWl8SPxO9rjJ5
11	Active site	https://youtu.be/Bej5wAsXTYU?si=nw4p_5wOaR4wBGxZ
12	Coenzymes and cofactors	https://youtu.be/NQXmV9w0dXY?si=tHdzSjbaB_AuZoA-
Unit 5: Nucleic acids		
13	Nucleic acid - classes	https://youtu.be/0fypUeSVFpI?si=6UDjcx iHfOdjTjiZ
14	Nucleic acid properties	https://youtu.be/Yy019W99Yac?si=1H7a1N7QTCNE3Ykw
15	DNA and RNA structure - chemical differences	https://youtu.be/GhABWQC3YDs?si=Lejmkz4w1HJs2jNF

TEXT BOOKS

S.No	Authors	Title of the Book	Publishers	Year & Edition
1.	Roger L. Miesfeld Megan M. McEvoy	Biochemistry	W. W. Norton & Company.	2017& 1 st Edition
2.	David L. Nelson, Michael Cox	Lehninger Principles of Biochemistry	WH Freeman.	2017& 7 th Edition

REFERENCE BOOKS

S.No	Authors	Title of the Book	Publishers	Year & Edition
1.	Berg, J.M., Stryer, L., Tymoczko, J and Gatto, G.	Biochemistry	W.H. Freeman and Company, New York. USA.	2019& 9 th Edition
2.	Rodwell, V.W., Bender, D., Botham, K.M., Kennelly, P.J, and Weil, P.A.	Harper's Illustrated Biochemistry	McGraw-Hill Education, New York, USA.	2018& 31 st Edition
3.	Voet, D., Voet, J.G, and Pratt, C.W.	Voet's Principles of Biochemistry	John Wiley & Sons, New York, USA.	2018& 5 th Edition

Course Designer:
Dr. Archana G

Module No.	Topic	CLO level	No. of periods	Content delivery method	Student engagement	Participatory Learning / Experiential Learning / Problem based Learning
UNIT I Carbohydrate and Metabolism						
1.	Carbohydrates: Definition, Introduction	CLO1	1	Lecture – Chalk and Talk / Group reading	Demonstration, Group discussion	Participatory Learning
2.	Carbohydrates: classification	CLO1	1	PPT	Student seminar	Participatory Learning
3.	Monosaccharides- Structure	CLO1 CLO2	1	OER	Model making	Participatory Learning
4.	Monosaccharides – properties and biological functions	CLO2 CLO3	1	Lecture – Chalk and Talk / Group reading	Flipped classroom, quiz	Participatory Learning
5.	Disaccharides – structure and function (Maltose, cellobiose)	CLO2 CLO3	1	Displays	Model making, simulation	Experiential learning
6.	Disaccharides- structure and function (Lactose,Sucrose)	CLO2 CLO3	1	PPT / OER	Group discussion, Quescussion	Participatory learning
7.	Polysaccharides- structure (starch, glycogen,dextran)	CLO2 CLO3	1	Chalk and talk/ OER	Simulation,m odel making	Experiential learning
8.	Polysaccharides- functions (starch,glycogen, dextran)	CLO2 CLO3	1	Lecture – Chalk and Talk / Group reading	Brainstorming, designing thinking	Problem based learning
9.	Homoglycans	CLO2 CLO3	1	Group reading	Research paper,posters	Problem based learning
10.	Glycosaminoglycans – Proteoglycan,peptidoglycan	CLO2 CLO3	1	PPT / OER	Article review, Role play	Experiential Learning
11.	Glycolysis	CLO4 CLO5	1	Virtual lab	Demonstration	Participatory Learning
12.	TCA cycle	CLO4 CLO5	1	Lecture – Chalk and Talk / PPT	Flipped classroom, demonstration	Participatory Learning
13.	Glycogenesis	CLO4 CLO5	1	OER	Student seminar,	Participatory learning

					Group discussion	
14.	Glycogenolysis	CLO4 CLO5	1	PPT / OER	Book/Article review, simulation	Experiential Learning
15.	Pentose phosphate pathway	CLO3 CLO4 CLO5	1	Virtual lab, Demonstration	Simulation	Experiential Learning
Unit – II Lipids Classification and Metabolism						
16.	Lipids – simple and complex	CLO1 CLO2	1	PPT / OER	Peer teaching	Participatory learning
17.	Structure of lipids	CLO1 CLO2	1	Lecture / Seminar	Presentation, posters	Problem based learning
18.	Lipids-properties and functions	CLO2 CLO3	1	PPT	Demonstration, Flipped classroom	Participatory learning
19.	Triacylglycerols	CLO2 CLO3	1	Lecture / Group reading	Article review, simulation	Experiential learning
20.	Glycerophospholipids	CLO2 CLO3	1	PPT	Research paper, Case study	Problem-based Learning
21.	Sphingolipids, waxes	CLO2 CLO3	1	Lecture / Seminar	Quescussion, Pro-con grid	Participatory learning
22.	Steroids, Cholesterol	CLO2 CLO3. CLO4	1	PPT	Designing thinking, Research papers	Problem-based Learning
23.	Phyosterols, Eicosanoids	CLO2 CLO3 CLO4	1	Lecture / OER	Model making	Experiential learning
24.	Glycolipids and lipoproteins	CLO2 CLO3 CLO4	1	Virtual Lab	Simulations	Experiential Learning
25.	Self-assembly of lipids, Micelle formation	CLO2 CLO3 CLO4	1	OER	Designing thinking, case thinking	Problem based learning
26.	Metabolism- oxidation of saturated fats	CLO3 CLO4 CLO5	1	Lecture / OER	Panel discussion, Quiz	Participatory learning
27.	Oxidation of unsaturated fats	CLO3 CLO4 CLO5	1	Lecture / OER	Group discussion	Experiential Learning
28.	Biosynthesis of triacylglycerols	CLO4 CLO5	1	Lecture / Virtual Lab	Simulation	Experiential Learning
29.	Biosynthesis of triglycerophospholipids	CLO4 CLO5	1	Lecture/ Virtual lab	Simulation	Experiential Learning

30.	Biosynthesis of cholesterol	CLO4 CLO5	1	Lecture/OER	Role play, demonstration	Experiential learning
Unit – III Amino acids and Proteins						
31.	Classification of aminoacids – structure and properties	CLO1 CLO2 CLO3	1	OER / PPT	Flipped classroom, Assignment	Participatory Learning
32.	Peptide bond – structure and properties	CLO2 CLO3	1	Lecture PPT	Peer teaching	Participatory Learning
33.	Ramachandran plot	CLO2 CLO3	1	Video / Observation	Group discussion, demonstration	Participatory learning
34.	Protein structure - Primary and secondary	CLO2 CLO3	1	Video / Observation	Model making	Experiential Learning
35.	Protein structure – Tertiary and Quaternary	CLO2 CLO3	1	Lecture PPT , Group reading	Presentation, Brainstorming	Problem based learning
36.	Fibrous proteins - Keratin	CLO2 CLO3 CLO4	1	Lecture PPT	simulation	Experiential Learning
37.	Collagen and Fibroin	CLO2 CLO3 CLO4	1	Seminar / PPT	Flipped classroom	Participatory Learning
38.	Globular proteins	CLO2 CLO3 CLO4	1	Group reading, OER	Article/Book review,model making	Experiential Learning
39.	Protein denaturation	CLO3 CLO4	1	Lecture PPT	Case thinking, Designing thinking	Problem based learning
40.	Protein Renaturation	CLO3 CLO4	1	OER	Case thinking, Designing thinking	Problem based learning
41.	Protein folding and stability	CLO2, CLO3, CLO4	1	Lecture PPT	Group discussion	Participatory Learning
42.	Aminoacid metabolism- Biosynthesis of aromatic aminoacids	CLO3 CLO4 CLO5	1	Video	Quescussion, Group discussion	Participatory Learning
43.	Biosynthesis of glycine, threonine	CLO3 CLO4 CLO5	1	Virtual lab, Demonstration	Flipped classroom	Participatory Learning

60.	Structure of Purines	CLO1 CLO2	1	Research article reading	Group reading and discussion	Experiential Learning
61.	Structure of pyrimidines	CLO1 CLO2	1	PPT	Group reading and discussion	Experiential Learning
62.	Nucleosides, nucleotides	CLO1 CLO2 CLO3	1	Research article reading	Flipped classroom	Participatory Learning
63.	Nucleic acids -classes	CLO2 CLO3	1	Video / Observation	Group discussion, One minute presentations	Participatory learning
64.	Nucleic acids - properties	CLO2 CLO3	1	Video / Observation	Panel discussion, Student seminars	Participatory learning
65.	RNA structure	CLO2 CLO3,	1	PPT, Socrative	Model making	Experiential Learning
66.	DNA structure	CLO2 CLO3,	1	PPT, Socrative	Model making	Experiential learning
67.	Different forms and chemical difference in structure	CLO3 CLO4	1	PPT	Designing thinking, case thinking	Problem-based Learning
68.	Biosynthesis of purine - Denovo	CLO4 CLO5	1	PPT	Demonstrations , group discussions	Participatory learning
69.	Biosynthesis of pyrimidine - Denovo	CLO4 CLO5	1	Lecture	Flipped classroom	Participatory learning
70.	Biosynthesis of purine - Salvage	CLO4 CLO5	1	Lecture	Peer teaching, quiz, group discussion	Participatory learning
71.	Biosynthesis of pyrimidine - Salvage	CLO4 CLO5	1	Lecture	Peer teaching, quiz, group discussion	Participatory learning
72.	Catabolism of purines	CLO4 CLO5	1	Research article reading	Article review, Simulation	Experiential learning
73.	Catabolism of pyrimidines	CLO4 CLO5	1	Research article reading	Article review, Simulation	Experiential Learning

Name of the course	MBY2302-Biochemistry
Name of the Faculty	Dr. D. Subha
Participatory Learning	40 %
Experiential Learning	40 %
Problem-based Learning	20 %

COURSE CODE	TITLE OF THE COURSE	CATEGORY	L	T	P	CREDITS
MBY2403	MICROBIOLOGY	THEORY	58	2	-	4

Learning Objectives

- To learn about the structure and function of microbial cells, including their different parts and how they work together.
- To identify and classify different types of microbes, including bacteria, archaea, fungi, protozoa and viruses.
- To understand the physiology of microbes, such as their growth requirements, metabolism and genetics.
- To assess the use of microbes in different industries, such as food production, bioremediation and biotechnology.

Course Learning Outcomes

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

CLO Number	CLO Statement	Knowledge Level
CLO1	Describe the features of the different groups of microorganisms.	K2
CLO2	Examine the chemical & physical methods of sterilization. Predict the appropriate level of biosafety required for working with different microbes.	K3
CLO3	Distinguish the importance of a diverse group of microorganisms.	K4
CLO4	Evaluate the useful and harmful effects of microorganisms. Recommend control measures for various microbial diseases.	K5
CLO5	Report about the mode of action of various antimicrobial agents.	K6

Mapping with Programme Learning Outcomes

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	S	S	S	M	S
CLO2	S	S	S	M	M
CLO3	S	S	S	M	S
CLO4	S	S	S	S	M
CLO5	S	S	S	S	S

M-Medium S-Strong

MBY2403- MICROBIOLOGY

Unit I Microbial Nutrition and Growth

(12 hrs)

Culture Media: Preparation and its types. ***Nutritional classification of microorganisms. Factors affecting microbial growth – temperature, atmosphere, pH.** Phases of growth and Growth curve measurement techniques. Bacterial culture methods: Pure culture techniques – tube dilution, Culture Plate methods. Anaerobic culture methods – wright's tube, roll tube. ***Types and applications of Microscopy:** Light, Phase contrast, ***Fluorescent**, Confocal and Electron Microscopy. Microscopic identification: Simple & Differential staining (Gram staining, Negative, Acid fast staining).

Unit II Microbial Growth Control

(12 hrs)

Physical ***methods of sterilization – Heat (Dry & Moist), Pasteurization, Filtration, Radiation, Dessication, Low Temperature, High Pressure, Osmotic Pressure & Tyndallization.** ***Chemical methods of sterilization** (Phenols, Halogens, Alcohols, Detergents, Aldehydes, Gaseous agents). ***Phenol coefficient test – Sterility testing.** Biosafety and levels of biosafety, Types of microbiological safety cabinets, GLP.

Unit III Microbial Diversity

(11 hrs)

Bacteria: Acetic acid bacteria, ***Cyanobacteria**, Propionic acid bacteria, Pseudomonads, and Mycoplasma. Archaea: Halophiles, Methanogens, Hyperthermophilic archaea, ***Thermoplasm, Extremophiles** and unculturable microbes. Virus and bacteriophages. Sub-viral particles – Viroids and Prions.

Unit IV Host-Microbes Interaction

(12 hrs)

Normal Microbiome, ***Prebiotics and Probiotics**, Host-pathogen interaction, Microbial communication system (Bacterial Quorum sensing) and biofilm formation. Microbial fuel cells, Pathogenicity islands and their role in bacterial virulence. Types of toxins -Exo-Endo & Entero. Microbial diseases: Causative agent, symptoms and control measures of diseases caused by ***Bacteria infections - Typhoid, Cholera. *Virus - AIDS and Covid-19.** Fungi - Candidiasis & Mucormycosis. Protozoa - Malaria.

Unit V Antimicrobial Agents

(11 hrs)

Minimal inhibitory concentration (MIC), ***Microbial Drug resistance. *Mode of action of Antibacterial drugs – Penicillin, Cephalosporins, Streptomycin, Tetracyclines, Quinolones and Rifampicin.** ***Antifungal drugs – Nystatin, Griseofulvin and Cycloheximide.** Antiviral drugs - Acycloguanosine (acyclic nucleoside), Antiretroviral drugs and Remdesivir. Multi drug resistance and its impact. Strategies to combat multi drug resistance, Phage Therapy.

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

S. No.	Topics	Links
Unit – I Microbial Nutrition and Growth		
1.	Nutritional classification of microorganisms.	https://youtu.be/3A9w_PUGd8Q?si=pDq0i4tTDckzIZpm
2.	Factors affecting microbial growth – temperature, atmosphere	https://youtu.be/gTSuW_iPOzY?si=mlbA32numHF0uwrs
3.	Types and applications of Microscopy- Fluorescent Microscopy	https://youtu.be/PCJ13LjncMc?si=CJqIYj0-_bZdN-NV
Unit – II Microbial Growth Control		
4.	Physical methods of sterilization – Heat (Dry & Moist), Pasteurization, Filtration	https://youtu.be/xjYdOcT6s1Y?si=fAsCe5rljgOl5z2d
5.	Chemical methods of sterilization	https://youtu.be/6YcM4HQ_tWo?si=nWBjFUTB1YrtplqX
6.	Phenol coefficient test – Sterility testing	https://youtu.be/INMIRy59iWY?si=cV3ogxpLe65vuKOD
Unit – III Microbial Diversity		
7.	Cyanobacteria	https://youtu.be/2N0Z0A3Ot44?si=aTy6Lj8dzF5Chw8_
8.	Thermoplasm, Extremophiles	https://youtu.be/yOA5lhdP9-Y?si=t-vPxZTjvUSsJKNg
Unit IV Microbes Interaction		
9.	Prebiotics and Probiotics	https://youtu.be/JOIQezPBi8k?si=edyiyOf9pXjPIId2F
10.	Bacterial infections - Typhoid, Cholera. Virus - AIDS and Covid-19	https://youtu.be/un3e51HhSaM?si=L4fVWxZ6Uc2K-835 https://youtu.be/5ONUK99vL_w?si=gY3_am1cOMoeaWuG https://youtu.be/GQUCCkHNjN8?si=gW2gGY4ZwKxAF6ug
Unit V Antimicrobial Agents		
11.	Microbial Drug resistance.	https://youtu.be/DqfAqIlZDQE?si=ulH4aBidDotWgklm
12.	Mode of action of Antibacterial drugs – Penicillin, Cephalosporin, Streptomycin	https://youtu.be/a81nHSqQuvI?si=w2tkH4aufDOI9ill https://youtu.be/U1aRrqPq-aY?si=lQXcENmROF1iGVjT https://youtu.be/mVAtdAZVUk0?si=d9bSK5P8_w3TvjkY
13.	Antifungal drugs – Nystatin, Griseofulvin	https://youtu.be/I9SiDPFMM3Y?si=v1c_1mQ6f5eGUfoF

TEXT BOOKS

S.No	Authors	Title of the Book	Publishers	Year & Edition
1.	Nina Parker, Mark Schneegurt, Anh-Hue Thi Tu, Brian M. Forster, Philip Lister	Microbiology	ASM Press.	2017& 1 st Edition
2.	Gerard Tortora ,Berdell Funke, Christine Case, Derek Weber, Warner Bair III	Microbiology: An Introduction	Addison-Wesley.	2018& 13 th Edition

REFERENCE BOOKS

S.No	Authors	Title of the Book	Publishers	Year & Edition
1.	Tortora, G., Funke, B., Case, C., Weber, D, and Bair, W.	Microbiology – An Introduction	Pearson Education Inc, London, UK .	2020& 13 th Edition
2.	Murray, P., Rosenthal, K and Pfaller, M.	Medical Microbiology	Elsevier, Netherlands.	2020& 9 th Edition
3.	Pommerville, C.J.	Fundamentals of Microbiology	Jones and Bartlett Publishers Inc, Massachusetts, USA.	2022& 12 th Edition

Course Designer:
Dr.Archana G

Module No.	Topic	CLO level	No. of periods	Content delivery method	Student engagement	Participatory Learning / Experiential Learning / Problem based Learning
Unit – I Microbial Nutrition and Growth						
1.	Culture Media: Preparation and its types.	CLO1, CLO2	1	Lecture – Chalk and Talk / Group reading	Word cloud/ Mind map / Think Write and Share	Participatory Learning
2.	Nutritional classification of microorganisms. Factors affecting microbial growth – temperature, atmosphere, pH, hydrostatic pressure and radiation.	CLO1, CLO2, CLO3	1	PPT / OER	Quiz (Quizalize/ Socrative)	Participatory Learning
3.	Phases of growth curve, Growth measurement techniques.	CLO1, CLO2, CLO3	1	Chalk and talk/ Picture	Diagrams, Sketchboard	Participatory Learning
4.	Bacterial culture methods: Pure culture techniques – tube dilution, pour plate, spread and streak plate methods.	CLO2, CLO3	1	Demonstration	Culturing Techniques	Experiential Learning
5.	Anaerobic culture methods – wright's tube	CLO2, CLO4	1	Demonstration	Culturing Techniques	Experiential Learning
6.	Anaerobic culture methods - roll tube	CLO2, CLO3, CLO4	1	Student Seminar	Debate/Group discussion	Experiential Learning
7.	Microscopy: Types and applications of Light	CLO2, CLO3, CLO5	1	Virtual lab	Flipped classroom, Poster	Experiential Learning
8.	Phase Contrast Microscopy.	CLO3, CLO4, CLO5	1	Book/ Article review	Group discussion	Experiential Learning

9.	Fluorescent Microscopy, Confocal Microscopy and Electron Microscopy	CLO3, CLO4, CLO5	1	Virtual lab	Flipped classroom, Poster	Experiential Learning
10.	Microscopic identification: Simple, Negative & Differential staining	CLO3, CLO4, CLO5	1	Research paper presentation	Debate/Group discussion	Problem-based Learning
11.	Differential staining (Gram staining, Acid fast staining).	CLO3, CLO4, CLO5	1	Demonstration	Diagrams, Sketchboard	Participatory Learning
12.	Differential staining (Gram staining, Acid fast staining).	CLO4, CLO5	1	Student seminar Lecture	Group Discussion/ Debate	Participatory Learning
Unit – II Microbial Growth Control						
13.	Physical methods of sterilization	CLO1, CLO2	1	Lecture – Chalk and Talk / Group reading	Word cloud/ Mind map / Think Write and Share	Participatory Learning
14.	Sterilization Heat (Dry & Moist), Pasteurization, Filtration	CLO1, CLO2, CLO3	1	PPT / OER	Quiz (Quizalize/ Socrative)	Participatory Learning
15.	Radiation, Dessication, Low Temperature	CLO1, CLO2, CLO3	1	Chalk and talk/ Picture	Diagrams, Sketchboard	Participatory Learning
16.	High Pressure	CLO2, CLO3	1	Research paper presentation	Debate/Group discussion	Problem-based Learning
17.	Osmotic Pressure & Tyndallization.	CLO2, CLO4	1	Demonstration	Culturing Techniques	Experiential Learning
18.	Chemical methods of sterilization (Phenols, Halogens)	CLO2, CLO3, CLO4	1	Student Seminar	Debate/Group discussion	Experiential Learning
19.	Chemical methods of sterilization - Alcohols, Detergents,	CLO2, CLO3, CLO5	1	Virtual lab	Flipped classroom, Poster	Experiential Learning
20.	Chemical methods of sterilization - Aldehydes, Gaseous agents).	CLO3, CLO4, CLO5	1	Book/ Article review	Group discussion	Experiential Learning

21.	Phenol coefficient test – Sterility testing.	CLO3, CLO4, CLO5	1	Virtual lab	Flipped classroom, Poster	Experiential Learning
22.	Biosafety and levels of biosafety,	CLO3, CLO4, CLO5	1	Research paper presentation	Debate/Group discussion	Problem-based Learning
23.	Types of microbiological safety cabinets.	CLO3, CLO4, CLO5	1	Field observations 1	Field visit	Problem-based Learning
24.	GLP.	CLO4, CLO5	1	Student seminar Lecture	Group Discussion/ Debate	Participatory Learning
Unit – III Microbial Diversity						
25.	Bacteria: Acetic acid bacteria	CLO1, CLO2	1	Lecture – Chalk and Talk / Group reading	Word cloud/ Mind map / Think Write and Share	Participatory Learning
26.	Cyanobacteria, Propionic acid bacteria,	CLO1, CLO2, CLO3	1	PPT / OER	Quiz (Quizalize/ Socrative)	Participatory Learning
27.	Pseudomonads, and Mycoplasma.	CLO1, CLO2, CLO3	1	Chalk and talk/ Picture	Diagrams, Sketchboard	Participatory Learning
28.	Archaea: Halophiles,	CLO2, CLO3	1	Lecture and Discussion	Just a minute, discussion	Participatory Learning
29.	Methanogens, Hyperthermophilic archaea, Thermoplasm,	CLO2, CLO4	1	Demonstration	Culturing Techniques	Experiential Learning
30.	Extremophiles and unculturable microbes. Virus and bacteriophages. Sub-viral particles – Viroids and Prions Mediasterilization	CLO2, CLO3, CLO4	1	Student Seminar	Debate/Group discussion	Experiential Learning
31.	Extremophiles and unculturable microbes.	CLO2, CLO3, CLO5	1	Virtual lab	Flipped classroom, Poster	Experiential Learning
32.	Virus and bacteriophages.	CLO3, CLO4, CLO5	1	Book/ Article review	Group discussion	Experiential Learning
33.	Virus and bacteriophages.	CLO3, CLO4, CLO5	1	Research paper presentation	Debate/Group discussion	Problem-based Learning

34.	Sub-viral particles – Viroids and Prions	CLO3, CLO4, CLO5	1	Research paper presentation	Debate/Group discussion	Problem-based Learning
35.	Sub-viral particles – Prions.	CLO3, CLO4, CLO5	1	Field observations	Field visit	Problem-based Learning
Unit – IV Host-Microbes Interaction						
36.	Normal Microbiome,	CLO1, CLO2	1	Lecture – Chalk and Talk / Group reading	Word cloud/ Mind map / Think Write and Share	Participatory Learning
37.	Prebiotics and Probiotics,	CLO1, CLO2, CLO3	1	PPT / OER	Quiz (Quizalize/ Socrative)	Participatory Learning
38.	Host-pathogen interaction, Microbial communication system	CLO1, CLO2, CLO3	1	Chalk and talk/ Picture	Diagrams, Sketchboard	Participatory Learning
39.	Bacterial Quorum sensing and biofilm formation.	CLO2, CLO3	1	Chalk and talk/ Picture	Just a minute, discussion	Participatory Learning
40.	Microbial fuel cells	CLO2, CLO4	1	Demonstration	Culturing Techniques	Experiential Learning
41.	Pathogenicity islands and their role in bacterial virulence.	CLO2, CLO3, CLO4	1	Student Seminar	Debate/Group discussion	Experiential Learning
42.	Types of toxins -Exo-Endo &Entero.	CLO2, CLO3, CLO5	1	Research paper presentation	Debate/Group discussion	Problem-based Learning
43.	Microbial diseases: Causative agent, symptoms and control measures of diseases caused by Microbes	CLO3, CLO4, CLO5	1	Book/ Article review	Group discussion	Experiential Learning
44.	Bacterial Infections Typhoid	CLO3, CLO1, CLO5	1	Virtual lab	Flipped classroom, Poster	Experiential Learning
45.	Bacterial Infections Cholera	CLO3, CLO4, CLO5	1	Research paper presentation	Debate/Group discussion	Problem-based Learning
46.	Virus - AIDS, Covid-19	CLO3, CLO4, CLO5	1	Virtual lab	Flipped classroom, Poster	Problem-based Learning

47.	Fungi - Candidiasis & Mucormycosis. Protozoa - Malaria	CLO4, CLO5	1	Student seminar Lecture	Group Discussion/ Debate	Participatory Learning
Unit – V Antimicrobial Agents						
48.	Minimal inhibitory concentration (MIC)	CLO1, CLO2	1	Lecture – Chalk and Talk / Group reading	Word cloud/ Mind map / Think Write and Share	Participatory Learning
49.	Microbial Drug resistance.	CLO1, CLO2, CLO3	1	PPT / OER	Quiz (Quizalize/ Socrative)	Participatory Learning
50.	Mode of action of Antibacterial drugs – Penicillin	CLO1, CLO2, CLO3	1	Chalk and talk/ Picture	Diagrams, Sketchboard	Participatory Learning
51.	Mode of action of Antibacterial drugs – Cephalosporins, Streptomycin.	CLO2, CLO3	1	Video Lecture and Discussion	Just a minute, discussion	Participatory Learning
52.	Mode of action of Antibacterial drugs – Tetracyclines, Quinolones and Rifampicin.	CLO2, CLO4	1	Research paper presentation	Debate/Group discussion	Experiential Learning
53.	Antifungal drugs – Nystatin	CLO2, CLO3, CLO4	1	Student Seminar	Debate/Group discussion	Experiential Learning
54.	Antifungal drugs – Griseofulvin and Cycloheximide.	CLO2, CLO3, CLO5	1	Virtual lab	Flipped classroom, Poster	Experiential Learning
55.	Antiviral drugs - Acycloguanosine (acyclic nucleoside),	CLO3, CLO4, CLO5	1	Book/ Article review	Group discussion	Experiential Learning
56.	Antiviral drugs - Antiretroviral drugs and Remdesivir.	CLO3, CLO4, CLO5	1	Virtual lab	Flipped classroom, Poster	Experiential Learning
57.	Multi drug resistance and its impact.	CLO3, CLO4, CLO5	1	Research paper presentation	Debate/Group discussion	Problem-based Learning

58.	Cont. Phage Therapy and Strategies to combat multi drug resistance.	CLO3, CLO4, CLO5	1	Field observations and observation of renewable organic material	Field visit	Problem-based Learning
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Name of the course	MBY2403-Microbiology
Name of the Faculty	Dr. Archana G
Participatory Learning	40 %
Experiential Learning	40 %
Problem-based Learning	20 %

COURSE CODE	TITLE OF THE COURSE	CATEGORY	L	T	P	CREDITS
MBY2304	BIOINFORMATICS	THEORY	58	2	-	4

Learning Objectives

- To familiarize students how to use bioinformatics tools to analyze biological data.
- To develop the skills for analyzing protein structures,
- To identify potential druggable sites
- To screen large datasets of compounds for potential drug candidates and ADME studies
- To test the hypothesis statistically using R-program

Course Learning Outcomes

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

CLO Number	CLO Statement	Knowledge Level
CLO1	Understand the principle and application of databases and retrieve data.	K2
CLO2	Acquire the concepts and application of Phylogenetic analysis.	K6
CLO3	Differentiate the various analysis methods for structure prediction and validation.	K4
CLO4	Apply the concept of drug-receptor interactions and ADME studies	K3
CLO5	Test hypothesis statistically for experimental data using R-program	K5

Mapping with Programme Learning Outcomes

CLOs	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
CLO5	S	S	S	M	S

M-Medium S-Strong

MBY2304- BIOINFORMATICS

Unit I Introduction to Bioinformatics

(12 hrs)

Overview of bioinformatics and its applications in biotechnology, Introduction to different types of biological databases, such as Primary - nucleotide databases (GenBank, EMBL, DDBJ), protein sequence databases (UniProt, TrEMBL, PIR), Secondary-structural databases (PDB, MMDB), domain and motif database (Prosite, BLOCKS) and Derived database- Structure database (SCOP, CATH), Gene expression database (GEO), metabolic pathway (KEGG), Specialised database (TGI), Gene prediction tools– GENSCAN, GENEMARK. ***Sequence alignment algorithms: *pairwise (BLAST) and multiple sequence alignment (CLUSTALW).**

Unit II Molecular Phylogenetics and Evolution

(12 hrs)

Introduction to phylogenetic trees and their significance in evolutionary biology, Types of phylogenetic trees: rooted and unrooted trees, Tree-building methods: distance-based, parsimony, and maximum likelihood, Evaluation of tree topologies: bootstrap analysis and support values. ***Phylogenetic reconstruction for different molecular data: DNA sequences, protein sequences, and whole genomes.**

Unit III Proteomics and Systems Biology

(11 hrs)

Protein structure prediction and modeling, function prediction and annotation, ***Protein-protein interactions (STRING)** and networks, Integration of genomics, proteomics, and other -omics data. ***Biological pathway and network analysis**, Systems biology approaches to understanding complex biological processes.

Unit IV Structural Bioinformatics and Drug Discovery

(11 hrs)

Computational drug discovery approaches, including virtual screening and molecular docking, ***Predictive models for drug-target interactions and ADMET** (absorption, distribution, metabolism, excretion, and toxicity) properties. Structure-based drug discovery and molecular dynamics simulations, ADME and Drug likeness, Gene ontology and functional enrichment analysis.

Unit V Computing Using R Programming

(12 hrs)

R programming- Introduction and packages. Basic operations with R programming, Overview – Variable, Data types, Operators, Useful Function, Data frames, working with images and strings, Library functions, Bioconductor, Large datasets, statistics, applications. Case Study: ***Microarray data analysis using Bioconductor package.**

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

S.No.	Topics	Links
Unit – I Introduction to Bioinformatics		
1	Sequence alignment algorithms: pairwise (BLAST)	https://www.youtube.com/watch?v=WRKQGwh_Mw0&t=625s
2	Multiple sequence alignment (CLUSTALW).	https://www.youtube.com/watch?v=dSsyohu9F1c
Unit – II Molecular Phylogenetics and Evolution		
3	Phylogenetic reconstruction for different molecular data:	https://www.youtube.com/watch?v=y5GgkBXmYDk
4	DNA sequences, protein sequences, and whole genomes.	https://www.youtube.com/watch?v=KTstRrDTmWI
5	DNA sequences, protein sequences, and whole genomes.	https://www.youtube.com/watch?v=NdOS8cpuxpg
Unit – III Proteomics and Systems Biology		
6	Protein-protein interactions (STRING) and networks.	https://www.youtube.com/watch?v=8-IPJqXYQ3Q
7	Biological pathway and network analysis	https://www.youtube.com/watch?v=D51vWCuMby4
Unit IV Structural Bioinformatics and Drug Discovery		
8	Predictive models for drug-target interactions and ADMET (absorption, distribution, metabolism, excretion, and toxicity) properties	https://www.youtube.com/watch?v=L1W0q1kEof4
Unit V Computing Using R Programming		
9	Microarray data analysis using Bioconductor package	https://www.youtube.com/watch?v=zxJDusW499k

TEXT BOOKS

S.No	Authors	Title of the Book	Publishers	Year & Edition
1.	Poptsova, M.S	Genome Analysis: Current Procedures and Applications	Caister Academic Press, UK.	2014
2.	Pevsner J	Bioinformatics and Functional Genomics	Wiley-Blackwell, UK.	2015& 3 rd Edition

REFERENCE BOOKS

S.No	Authors	Title of the Book	Publishers	Year & Edition
1.	Andreas D. Baxevanis, Gary D. Bader, David S. Wishart	Bioinformatics	John Wiley & Sons	2020
2.	Namita Mendiratta, Parag Rastogi and S.C. Rastogi	Bioinformatics: Methods and Applications: Genomics, Proteomics and Drug Discovery	PHI Learning	2022
3.	Pevsner J	Bioinformatics and Functional Genomics	Wiley-Blackwell, UK.	2015& 3 rd Edition
4.	Hadley Wickham and Garrett Grolemund	R for Data Science	O'Reilly Media	2016

Course Designer:

Dr. V. Bhuvaneshwari

Dr. G. Shalini

[illegible]

12	Introduction to phylogenetic trees and their significance in evolutionary biology.	CLO2	1	Lecture / OER	Think write and share	Experiential Learning
13	Introduction to phylogenetic trees and their significance in evolutionary biology.	CLO2	1	Lecture / Seminar	Diagrams, Sketchboard	Participatory Learning
14	Introduction to phylogenetic trees and their significance in evolutionary biology.	CLO2	1	Lecture / Seminar	Diagrams, Sketchboard	Participatory Learning
15	Types of phylogenetic trees: rooted	CLO2	1	Lecture / Seminar	Diagrams, Sketchboard	Participatory Learning
16	and unrooted trees.	CLO2	1	Lecture / Seminar	Diagrams, Sketchboard	Participatory Learning
17	Tree-building methods: distance-based, parsimony,	CLO2	1	Lecture / OER	Post it parade	Experiential Learning
18	and maximum likelihood.	CLO2	1	OER	Flipped classroom, Presentation	Participatory Learning
19	Evaluation of tree topologies: bootstrap analysis	CLO2	1	Lecture / OER	Simulation	Experiential Learning
20	and support values.	CLO2	1	Lecture / OER	Simulation	Experiential Learning
21	Phylogenetic reconstruction for different molecular data:	CLO2	1	Lecture and video	Simulation	Experiential Learning
22	DNA sequences, protein sequences, and whole genomes.	CLO2	1	Lecture/ Virtual lab	Simulation	Experiential Learning
23	DNA sequences, protein sequences, and whole genomes.	CLO2	1	Lecture/ Virtual lab	Simulation	Experiential Learning
Unit – III Proteomics and Systems Biology						
23	Protein structure prediction	CLO3	1	ORE / PPT	Flipped classroom, Assignment	Participatory Learning
24	and modelling function prediction	CLO3	1	Lecture PPT	Peer teaching	Participatory Learning
25	annotation.	CLO3	1	Video / Observation	Group discussion	Experiential Learning

26	Protein-protein interactions (STRING) and networks.	CLO3	1	Video / Observation	Student seminar	Experiential Learning
27	Protein-protein interactions (STRING) and networks.	CLO3	1	Lecture PPT	Student seminar	Participatory Learning
28	Integration of genomics, proteomics, and other - omics data.	CLO3	1	Lecture PPT	Student seminar	Participatory Learning
29	Integration of genomics, proteomics, and other - omics data.	CLO3	1	Seminar / PPT	Flipped classroom	Participatory Learning
30	Integration of genomics, proteomics, and other - omics data.	CLO3	1	Demonstration	Discussion	Experiential Learning
31	Biological pathway and network analysis	CLO3	1	Lecture PPT and video	Quiz	Participatory Learning
32	Systems biology approaches to understanding complex biological processes	CLO3	1	Demonstration	Discussion	Experiential Learning
33	Systems biology approaches to understanding complex biological processes	CLO3	1	Lecture PPT	Pro/con grid	Participatory Learning
Unit – IV Structural Bioinformatics and Drug Discovery						
35	Computational drug discovery approaches,	CLO4	1	Research article reading	Group reading and discussion	Experiential Learning
36	including virtual screening	CLO4	1	Research article reading	Group reading and discussion	Experiential Learning
37	and molecular docking	CLO4	1	Research article reading	Group reading and discussion	Experiential Learning
38	Predictive models for drug-target interactions and ADMET (absorption, distribution, metabolism, excretion, and toxicity) properties	CLO4	1	PPT	Review collection, case thinking	Problem-based Learning

39	Predictive models for drug-target interactions and ADMET (absorption, distribution, metabolism, excretion, and toxicity) properties	CLO4	1	PPT	Review collection	Participatory Learning
40	Predictive models for drug-target interactions and ADMET (absorption, distribution, metabolism, excretion, and toxicity) properties	CLO4	1	PPT and video	Review collection, Case study	Problem-based Learning
41	Structure-based drug discovery and molecular dynamics simulations	CLO4	1	PPT	Review collection	Participatory Learning
42	Structure-based drug discovery and molecular dynamics simulations	CLO4	1	Brainstorming	Flipped classroom, Discussion	Participatory Learning
43	Structure-based drug discovery and molecular dynamics simulations	CLO4	1	Brainstorming	Discussion	Participatory Learning
44	ADME and Drug likeness,	CLO4	1	PPT	Case study	Problem-based Learning
45	Gene ontology and functional enrichment analysis.	CLO4	1	Research article reading	Group reading and discussion	Experiential Learning
Unit –V Computing Using R Programming						
47	R programming- Introduction and packages.	CLO5	1	Research article reading	Group reading and discussion	Experiential Learning
48	Basic operations with R programming,	CLO5	1	Discussion	Quiz	Participatory Learning
49	Overview - Variable, Data types, Operators,	CLO5	1	Research article reading	Case thinking	Problem-based Learning
50	Useful Function, Data frames,	CLO5	1	Research article reading	Group reading and discussion	Experiential Learning
51	working with images and strings	CLO5	1	Research article reading	Group reading and discussion	Experiential Learning

52	Library functions.	CLO5	1	Research article reading	Group reading and discussion	Experiential Learning
53	Bioconductor, Large datasets, statistics, applications.	CLO5	1	PPT , Socrative	Case study	Problem-based Learning
54	Statistics	CLO5	1	PPT	Case study	Problem-based Learning
55	Applications	CLO5	1	PPT	Case study	Problem-based Learning
56	Case Study: Microarray data analysis using Bioconductor package.	CLO5	1	Lecture	Flipped classroom and video	Problem-based Learning
57	Case Study: Microarray data analysis using Bioconductor package..	CLO5	1	Lecture	Poster	Problem-based Learning
58	Case Study: Microarray data analysis using Bioconductor package.	CLO5	1	Lecture	Presentation	Problem-based Learning

Name of the course	MBY2304- Bioinformatics
Name of the Faculty	Dr G. Shalini
Participatory Learning	40 %
Experiential Learning	40 %
Problem-based Learning	20 %

COURSE CODE.	TITLE OF THE COURSE	CATEGORY	L	T	P	CREDITS
MBY24P1	PRACTICAL – 1 BIOCHEMISTRY AND MICROBIOLOGY PRACTICAL	PRACTICALS	-	-	90	4

Learning Objectives

- To familiarize students with the basic techniques to estimate and quantify the biomolecules
- To develop students' skills in microbes isolation, identification and analyze its antimicrobial activity
- To inculcate the research attitude in the minds of the students by developing their analytical skills

Course Learning Outcomes

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

CLO Number	CLO Statement	Knowledge Level
CLO1	Identify different microorganisms using basic microbiological techniques, such as Gram staining and biochemical tests.	K2
CLO2	To test the effects of different environmental factors and its effect on growth of microorganisms	K3
CLO3	Evaluate the method for detecting and quantifying a biomolecule in a sample and method for isolating and purifying a microorganism from a sample.	K4
CLO4	Justify the ability to monitor and adjust a processing of bioproduct to give a desired output and optimize kinetic parameters such as temperature, pressure, media composition etc.	K5
CLO5	To solve a real-world problem, such as the development of a new vaccine, new drug or the diagnosis of a disease and prevention of foodborne illness.	K6

Mapping with Programme Learning Outcomes

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	S	S	S	M	S
CLO2	S	S	S	M	M
CLO3	S	S	S	M	S
CLO4	S	S	S	M	M
CLO5	S	S	S	M	S

M-Medium S-Strong

MBY24P1 - BIOCHEMISTRY AND MICROBIOLOGY PRACTICAL

BIOCHEMISTRY

1. Separation of the amino acids - Glycine, Tyrosine and Leucine by Thin Layer Chromatography.
2. Separation of plant pigments and dyes -Paper chromatography.
3. Generation of the titration curve for the amino acid glycine.
4. Colorimetric estimation of maltose by 3,5-dinitrosalicylic acid method and construction of Maltose Standard Curve.
5. Colorimetric estimation of protein by Folin's Lowry method and construction of Protein Standard Curve.
6. Effect of substrate concentration on the activity of alpha amylase and determination of K_m and V_{max} of alpha-amylase.
7. Qualitative analysis of phytochemicals from plants.
8. Quantification of 1. Total phenols 2. Flavonoids.
9. Ferric Reducing Antioxidant Power Assay.

MICROBIOLOGY

1. Isolation and enumeration of bacteria and fungi from sludge/solid waste.
2. Biochemical Characterization of Bacteria-IMVIC test.
3. Hydrolysis test –starch, casein and lipid.
4. Study of bacterial growth curve by turbidimetry.
5. Staining- Simple, Gram and Spore staining.
6. Milk Quality Analysis - MBRT Test.
7. Determination of Minimum Inhibitory Concentration.
8. Determination of the susceptibility of bacteria against different antibiotic agents.
9. Molecular Identification of Bacteria – PCR (Demo).

TEXT BOOKS

S.No	Authors	Title of the Book	Publishers	Year & Edition
1.	R. Saravanan, D. Dhachinamoorthi, CH. MM. Prasada Rao	A Handbook of Practical Microbiology	LAP LAMBERT Academic Publishing.	2019 & 1 st Edition
2.	GyörgyHegyí, JózsefKardos, MihályKovács, AndrásMálnási-Csizmadia, László Nyitray, GáborPál, László Radnai, Attila Reményi, and IstvánVenekei	Introduction to Practical Biochemistry	EötvösLoránd University.	2013 & 1 st Edition

REFERENCE BOOKS

S.No	Authors	Title of the Book	Publishers	Year & Edition
1.	Sadasivam, S. and Manickam, A.	Biochemical methods	New Age International Publishers.	2018 & 3 rd Edition
2.	Pingoud, A and Urbanke, C.	Biochemical Methods: A Concise Guide for Students and Researchers	Wiley-VCH.	2010 & 1 st Edition
3.	Cappuccino, J. G., & Welsh, C.	Microbiology: A Laboratory Manual.	Benjamin-Cummings Publishing Company	2016
4.	Collins, C. H., Lyne, P. M., Grange, J. M., & Falkinham III, J.	Collins and Lyne's Microbiological Methods	Arnolds.	2004 & 8 th Edition

Course Designer:

Dr. V. Bhuvaneshwari

Dr. G. Anbarasi

Dr.R.Kiruba

COURSE CODE	TITLE OF THE COURSE	CATEGORY	L	T	P	CREDIT S
MBY23P2	PRACTICAL- II CELL & MOLECULAR BIOLOGY AND BIOINFORMATICS PRACTICAL	PRACTICALS	-	-	90	4

Learning Objectives

- To isolate and differentiate various cell organelles and to visualize them using staining techniques
- To understand molecular techniques for separating genetic material from organisms
- To develop students' skills in using bioinformatics tools to analyze biological data.
- To use bioinformatics tools to analyze protein structures, to identify potential druggable sites, to screen large datasets of compounds for potential drug candidates.

Course Learning Outcomes

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

CLO Number	CLO Statement	Knowledge Level
CLO1	Identify the basic structure and function of different types of cells using a microscope.	K2
CLO2	Design an experiment to isolate and differentiate different cell organelles	K3
CLO3	Analyze the methods for identifying chemical structure as lead molecules	K4
CLO4	Justify the Application of the principles of bioinformatics to solve a real-world problem in drug discovery and development.	K5
CLO5	Identify basic experimental design principles in solving biological questions.	K6

Mapping with Programme Learning Outcomes

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	S	S	M	M	S
CLO2	S	S	M	M	M
CLO3	S	S	S	S	S
CLO4	S	S	S	S	M
CLO5	S	S	S	S	S

M-Medium S-Strong

MBY23P2-CELL AND MOLECULAR BIOLOGY AND BIOINFORMATICS PRACTICAL

CELL AND MOLECULAR BIOLOGY

1. Visualization of the different stages of Mitosis in Onion Root Tips using light microscope.
2. Visualization of different stages of meiosis in plants.
3. Determination of the number of cells in a suspension, using Hemocytometer.
4. Isolation of Genomic DNA from *E.coli*.
5. Isolation of Genomic DNA from plants-CTAB method
6. Isolation of Plasmid DNA.
7. Isolation of RNA-Trizol method
8. Quantification of DNA –Spectrophotometer/nano drop

BIOINFORMATICS

Biological databases and Sequence alignment

1. Sequence database – NCBI, GenBank, EMBL, Swiss-Prot, ExPASy proteomics tools
2. Structural database – PDB
3. Gene prediction tools – GENSCAN, GENEMARK
4. Primer Designing concepts – Primer3 (tool)
5. Pairwise sequence alignment- BLAST and FASTA
6. Multiple sequence alignment – Omega, MEGABLAST

Macromolecular Structure Prediction and Validation

7. Homology Modeling –SWISS-MODEL
8. Fold recognition and threading
9. Model validation using ProSA, WhatCheck, Errat and ProCheck
10. Structure visualization- RasMol and PyMol

Chemical structure and ADME rules

11. Small molecule building, using CHEMSKETCH
12. Chemical database – PubChem and DrugBank
13. File formats and conversion – Open Babel, SMILES
14. Drug properties, Toxicity, Drug likeness, Lipinski's rule of five- SWISSADME tool

Molecular Docking and analysis

15. Active site prediction (CASP, PDBSum)
16. Structure-based drug design and Ligand based drug design
17. Molecular docking
18. Drug-Receptor interaction - PyMol

TEXT BOOKS

S.No	Authors	Title of the Book	Publishers	Year & Edition
1	Maniatis, T	Molecular Cloning – A Laboratory Manual	Cold Spring Harbor Laboratory.	2001 & 3 rd Edition
2	Michael Agostino	Practical Bioinformatics	Garland Science.	2012 & 1 st Edition
3	Janusz M. Bujnicki	Practical Bioinformatics	Springer.	2004 & 1 st Edition

REFERENCE BOOKS

S. No	Authors	Title of the Book	Publishers	Year & Edition
1.	Cappuccino, J. G., & Welsh, C.	Current Protocols in Cell Biology	Wiley Publication.	2019 & 1 st Edition
2	Carson, S and Miller, H.B.	Molecular Biology Techniques	Academic Press.	2019 & 4 th Edition
3	Rastogi, S.C, Rastogi, P and Mendiratta, N	Bioinformatics: methods and applications - Genomics, Proteomics and Drug discovery.	PHI Learning Pvt Ltd, India.	2022 & 5 th Edition
4	Baxevanis, A. D. & Ouellette, B. F.	Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins.	John Wiley and Sons, USA.	2004 & 3 rd Edition

Course Designer:

Dr. G. Shalini

Mrs. R. Kiruba

Dr. V. Bhuvaneshwari

DEPARTMENT OF BIOTECHNOLOGY
CHOICE BASED CREDIT SYSTEM (CBCS) & LEARNING OUTCOME BASED
CURRICULAR FRAMEWORK (LOCF)
SYLLABUS & SCHEME OF EXAMINATION
MASTER OF SCIENCE BIOTECHNOLOGY – 2024-2026 BATCH

SEMESTER	Course Code	Title of the Course	Course Type	Instruction hours/Week	Contact hours	Tutorial hours	Duration of Examination	Examination Marks			Credits
								CA	ESE	TOTAL	
II	MBY2305	Immunotechnology	CC	4	58	2	3	25	75	100	4
	MBY2406	Animal Biotechnology	CC	3	43	2	3	25	75	100	4
	MBY2307	Environmental Biotechnology	CC	3	43	2	3	25	75	100	3
	MBY2308 /MBY2309	Elective I- Nano Biotechnology/ Food Biotechnology	DSE	3	43	2	3	25	75	100	4
	MTH23A6	Interdisciplinary Course – Statistics for Life Science	GC	4	60	-	3	-	100	100	2
	MBY24P3	Immunotechnology and Animal Biotechnology Practical	CC	5	75	-	6	25	75	100	4
	MBY23P4	Environmental, Nano and Food Biotechnology Practical	CC	5	75	-	6	25	75	100	4
II/III	MBY24CE/ MBY23S1	Advanced Plant Bioinformatics methods / Research Methodology	CC	3	45	-	-/3	100/-	-/100	100	3
I-III	17MONL1	Online Courses	ACC	-	-	-	-	-	-	-	-

CA – Continuous Assessment ESE - End Semester Examination
CC: Core Courses DSE : Discipline Specific Elective
GC : General Courses ACC : Additional Credit Courses

QUESTION PAPER PATTERN

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)
Seminar/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

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

Practical (for 25 Marks)

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

ESE Practical 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 CODE	COURSE NAME	CATEGORY	L	T	P	CREDITS
MBY2305	IMMUNOTECHNOLOGY	THEORY	58	2	-	4

Learning Objectives:

- To gain knowledge on the types of immunity and the structure & functions of immunoglobulins.
- To analyze the methods involved in antibody production
- To understand the various detection methods of antigen-antibody interaction.
- To impart knowledge in vaccine development
- To assess about hypersensitivity and autoimmune disorders

Course Learning Outcomes

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

CLO Number	CLO Statement	Knowledge Level
CLO1	Examine the fundamental concepts of immunology.	K2
CLO2	Compare the major techniques to assess Antigen-Antibody interactions.	K3
CLO3	Assess the different methods involved in antibody production and antibody engineering.	K4
CLO4	Elaborate on the vaccine technology for infectious disease.	K5
CLO5	Explain about the types of hypersensitivity and autoimmune diseases and their treatment.	K6

Mapping with Programme Learning Outcomes

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	M	S	L	M	S
CLO2	S	S	M	S	S
CLO3	M	S	S	S	S
CLO4	S	S	S	S	S
CLO5	L	S	S	S	S

S- Strong; M-Medium; L-Low

MBY2305- IMMUNOTECHNOLOGY

Unit I: Cells and Organs of Immune system (12 hrs)

History and scope of immunology. Types of Immunity: Passive, Active and Acquired immunity. Humoral, Cell Mediated immunity. **Cells and organs of immune response and their functions.** Antigens - Types, haptens, epitopes and Factors influencing antigenicity. Antibody – Structure, types, properties and functions. **Immunoglobulin gene rearrangements.**

Unit II: Antigen Antibody Reactions (11 hrs)

Antigen – Antibody interaction, affinity, cross reactivity, specificity, epitope mapping; **Agglutination reactions-Blood grouping, haemagglutination and Precipitation reactions.** Immunoassays – Immunodiffusion and Immuno electrophoresis, RIA, ELISA, Western blotting, ELISPOT assay, immunofluorescence, Surface plasmon resonance. **Biosensor assays for assessing ligand –receptor interaction.**

Unit III: New Generation Antibodies (12 hrs)

Antibody engineering; Hybridoma and monoclonal antibody (mAb) techniques, Production of murine hybridoma, Production of mAbs in cultures and animal (Ascites), Purification of mAbs. **Characterization of mAbs/ and Labeling of antibodies. Phage display libraries; Antibodies as *in vitro* and *in vivo* probes.**

Unit IV: Vaccine Technology (12 hrs)

Rational vaccine design based on clinical requirements: Active immunization, live, killed, attenuated, Subunit vaccines; Recombinant DNA and protein-based vaccines, plant-based vaccines and reverse vaccinology; Peptide vaccines, conjugate vaccines; Passive Immunization; Antibody, Transfusion of immuno- competent cells, Stem cell therapy, **Cell based vaccines. COVID-19 Vaccines- types, immune response, safety and efficacy. The role of COVID-19 vaccines in preventing COVID-19 and its complications.**

Unit V: Hypersensitivity, Autoimmunity and Transplantation (11 hrs)

Hypersensitivity– Mechanism and Types. Autoimmune disorders - Type I diabetes, Rheumatoid arthritis, Systemic lupus erythematosus, Ulcerative colitis. Tumor immunology: tumor antigens, oncogenes, immune responses, detection of cancers and therapy- chemotherapy and radiation therapy. **Transplantation Immunology.**

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

S.No	Topics	Links
Unit I: Cells and Organs of Immune system		
1.	Cells and organs of immune response and their functions	https://youtu.be/r8r1yNeQcp0?si=DXaIrGCjLuNQqaut
2.	Immunoglobulin gene rearrangements.	https://youtu.be/G0_jHzVf5l8?si=KQVAIAUmojsAuNTk
Unit II: Antigen Antibody Reactions		
3.	Agglutination reactions-Blood grouping, haemagglutination and Precipitation reactions.	https://youtu.be/9n8csriq6e8?si=H32Kug08gBSJ7NNP
4.	Biosensor assays for assessing ligand –receptor interaction.	https://youtu.be/1nzgxcIsais?si=zwdVLboWMWg6630N
Unit III: New Generation Antibodies		
5.	Characterization of mAbs/ and Labeling of antibodies.	https://youtu.be/TLyUu1MndVg?si=inD7onFLbE6Os_S9
6.	Phage display libraries; Antibodies as in vitro and in vivo probes.	https://youtu.be/mczJ3ZbpVW8?si=8rjxZjN8R8M1EVAh
Unit IV: Vaccine Technology		
7.	Cell based vaccines. COVID-19 Vaccines- types, immune response, safety and efficacy.	https://youtu.be/r4-Y81aJhso?si=aMXt4snvnPfv6eIM
8.	The role of COVID-19 vaccines in preventing COVID-19 and its complications.	https://youtu.be/oMXGGmBfkf8?si=-EMVA-bzm-v5g7TH
Unit V: Hypersensitivity, Autoimmunity and Transplantation		
9.	Hypersensitivity– Mechanism and Types.	https://youtu.be/jXTW4F-8jd4?si=ge0wwH6eAnkiP-V3
10.	Transplantation Immunology.	https://youtu.be/EaDDBxgFGfU?si=kU67xjE11KYNxCj5

TEXT BOOKS

S.No.	Authors	Title of the Book	Publishers	Year and Edition
1.	Abbas,A.K., Lichtman, A. H., & Pillai, S.	Basic Immunology: Functions and Disorders of the Immune System	Elsevier Publishers, Amsterdam, Netherlands.	2019 6 th Edition
2.	Janeway CA, Travers P, Walport M, et al.	Immunobiology: the immune system in health and disease	10th ed. New York: Garland Science	2016 6 th Edition
3.	Punt, J., Stranford, S., Jones, P & Owen, J.A.	Kuby Immunology	W. H. Freeman, NY. USA	2018 8 th Edition

REFERENCE BOOKS

S.No.	Authors	Title of the Book	Publishers	Year and Edition
1.	Abbas AK, Lichtman AH, Pillai	Cellular and molecular immunology.	Elsevier Publishers, Amsterdam, Netherlands.	2022 9th ed.
2.	Paul, W. E.	Fundamental Immunology	Lippincott Williams and Wilkins, USA	2012 7 th Edition
3.	Delves, P.J., Martin S.J., Burton, D.R and Roitt I.M.	Roitt's Essential Immunology	Wiley-Blackwell Publishers, USA	2017 13 th Edition

Course Designer:

Mrs. R. Kiruba

Module No.	Topic	CLO level	No. of hours	Content delivery method	Learning Methods
Unit I : Cells and Organs of Immune system					
1	History and scope of immunology.	CLO1	1	Lecture – Chalk and Talk / Group reading	Participatory Learning
2	Types of Immunity: Passive, Active and Acquired immunity.	CLO1,	1	PPT / OER	Problem-based Learning
3	Humoral immunity.	CLO1,	1	Displays	Experiential Learning
4	Cell Mediated immunity.	CLO1	1	Chalk and talk/ Picture	Problem-based Learning
5	Cells and organs of immune response	CLO1	1	Spotters/ Chalk and talk	Experiential Learning
6	immune response and their functions.	CLO1	1	Virtual lab	Problem-based Learning
7	Antigens - Types,	CLO1	1	OER	Problem-based Learning
8	haptens, epitopes and Factors influencing antigenicity.	CLO1	1	Lecture/ Virtual lab	Experiential Learning
9	Antibody – Structure, types	CLO1	1	Virtual lab	Problem-based Learning
10	Antibody properties	CLO1	1	Lecture	Participatory Learning
11	Antibody functions	CLO1	1	Lecture/ Virtual lab	Problem-based Learning
12	Immunoglobulin gene rearrangements.	CLO1	1	Lecture	Participatory Learning
Unit II: Antigen Antibody Reactions					
13	Antigen – Antibody interaction,	CLO2	1	Lecture / OER	Experiential Learning
14	affinity, cross reactivity, specificity	CLO2	1	Lecture / Seminar	Problem-based Learning

15	epitope mapping;	CLO2	1	Lecture / Seminar	Participatory Learning
16	Agglutination reactions	CLO2	1	Lecture / Seminar	Problem-based Learning
17	Blood grouping,	CLO2	1	Lecture / Seminar	Problem-based Learning
18	haemagglutination and Precipitation reactions.	CLO2	1	Lecture / OER	Experiential Learning
19	Immuno assays – Immuno Diffusion and Immunoelectrophoresis,	CLO2	1	OER	Participatory Learning
20	RIA, ELISA, Western blotting,	CLO2	1	Lecture / OER	Problem-based Learning
21	ELISPOT assay, immunofluorescenc, Surface plasmon resonance,	CLO2	1	Lecture / OER	Experiential Learning
22	Biosensor assays	CLO2	1	Lecture / OER	Problem-based Learning
23	Assessing ligand –receptor interaction	CLO2	1	Lecture/ Virtual lab	Experiential Learning
Unit III: New Generation Antibodies					
24	Antibody engineering;	CLO3	1	ORE/ PPT	Participatory Learning
25	Hybridoma technology	CLO3	1	Lecture PPT	Problem-based Learning
26	monoclonal antibody (mAb) techniques,	CLO3	2	Video / Observation	Problem-based Learning
27	Production of murine hybridoma	CLO3	1	Lecture PPT	Participatory Learning
28	Production of mAbs in cultures and animal (Ascites),	CLO3	1	Lecture PPT	Problem-based Learning
29	Production of mAbs in cultures and animal (Ascites),	CLO3	1	Seminar/ PPT	Participatory Learning
30	Purification of mAbs.	CLO3	1	Demonstration	Problem-based Learning
31	Characterization of mAbs.	CLO3	1	Lecture PPT	Participatory Learning
32	Labeling of antibodies.	CLO3	1	Demonstration	Experiential Learning
33	Phage display libraries;	CLO3	1	Lecture PPT	Participatory Learning

34	Antibodies as in vitro and in vivo probes.	CLO3	1	Lecture	Experiential Learning
Unit IV: Vaccine Technology					
35	Rational vaccine design	CLO4	2	Research article reading	Experiential Learning
36	Rational vaccine design based on clinical requirements:	CLO4	1	Research article reading	Experiential Learning
37	Active immunization	CLO4	1	PPT	Problem-based Learning
38	live, killed, attenuated, Subunit vaccines;	CLO4	2	PPT	Participatory Learning
39	Recombinant DNA and protein-based vaccines, plant-based vaccines and reverse vaccinology;	CLO4	1	PPT	Participatory Learning
40	Peptide vaccines, conjugate vaccines; Passive Immunization;	CLO4	1	Brainstorming	Participatory Learning
41	Antibody, Transfusion of immuno-competent cells, Stem cell therapy, Cell based vaccines.	CLO4	1	Brainstorming	Participatory Learning
42	COVID-19 Vaccines	CLO4	1	PPT	Problem-based Learning
43	COVID-19 Vaccines- types	CLO4	1	Research article reading	Experiential Learning
44	immune response, safety and efficacy, the role of COVID-19 vaccines in preventing COVID-19 and its complications	CLO4	1	Lecture	Participatory Learning
Unit V: Hypersensitivity, Autoimmunity and Transplantation					
45	Hypersensitivity– Mechanism and Types.	CLO5	2	Discussion	Participatory Learning
46	Autoimmune disorders - Type I diabetes, Rheumatoid arthritis,	CLO5	1	Research article reading	Problem-based Learning
47	Systemic lupus	CLO5	1	Research article reading	Participatory Learning
48	Erythematosus, Ulcerative colitis.	CLO5	1	Research article reading	Experiential Learning

49	Tumor immunology: tumor antigens, oncogenes,	CLO5	1	Research article reading	Experiential Learning
50	Immune responses,	CLO5	1	PPT	Problem-based Learning
51	detection of cancers and therapy	CLO5	1	PPT	Problem-based Learning
52	Chemotherapy and radiation therapy.	CLO5	1	PPT	Problem-based Learning
53	Transplantation Immunology	CLO5	2	Lecture	Problem-based Learning

Name of the course	MBY2305 - Immunotechnology
Name of the Faculty	Dr R Nirmal Kumar
Participatory Learning	30 %
Experiential Learning	30 %
Problem-based Learning	40 %

COURSE CODE	COURSE NAME	CATEGORY	L	T	P	CREDITS
MBY2406	ANIMAL BIOTECHNOLOGY	CORE THEORY	43	2	-	4

Learning Objectives:

- To make the students understand the basic and Scientific knowledge on the emerging field of Animal Biotechnology
- To provide relevant information about the cell culture requirements,
- To analyze the types and methods of cell culture propagation, growth, maintenance, monitoring analysis and safety precautions
- To gain knowledge in theoretical skills in the maintenance, manipulation and cytotoxic evaluation of animal cell and tissue culture
- To assess transgenic animal, IVF and stem cell technology

Course Learning Outcomes

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

CLO Number	CLO Statement	Knowledge Level
CLO1	Generalize the overall concept about Animal Tissue Culture	K2
CLO2	Compute the Media preparation and types of culture	K3
CLO3	Estimate the Cell types and differentiation portfolio	K4
CLO4	Summarize the recent innovations on IVF and development	K5
CLO5	Manage the concept on Transgenic Animals and applications	K6

Mapping with Programme learning Outcomes

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	S	S	M	M	M
CLO2	S	S	M	S	M
CLO3	S	S	S	S	S
CLO4	S	M	L	S	S
CLO5	M	M	S	S	L

S- Strong; M-Medium; L-Low

MBY2406-ANIMAL BIOTECHNOLOGY

Unit I : Animal cell culture

(8 hrs)

Animal cell culture Laboratory-Design and layout, Equipment and materials. Structure, organization and physiology of animal cells. History, Scope and applications of animal cell culture- Advantages and limitations. Types of animal cell culture. Biology of cultured cells Culture vessels and substrate. **Ethical implications of animal biotechnology, Biosafety and regulatory issues.**

Unit II: Culture media

(8 hrs)

Preparation and sterilization of media and supplements, Physiochemical properties of medium. Balanced salt solution, culture media biochemical ingredients and types of media. Selection of medium and serum. Serum free media. Role of Antibiotics and its types in media **Contaminations in animal cell culture.**

Unit III :Tissue culture and Tissue engineering

(9 hrs)

Basic techniques of animal cell culture *in vitro*, disaggregation of tissue and primary culture, subculture and establishment of cell line, Cloning and selection, Cell separation, Characterization, Differentiation, Transformation and immortalization, Scale-up and cell synchronization, **FACS**. Measurement of cell death – apoptosis and its determination. Introduction and **Applications of 3 D Bioprinting.**

Unit IV: Cytotoxicity and IVF

(9 hrs)

Cytotoxicity: Viability, toxicity and MTT Assay. **Cryopreservation** and Semen banks. Organotypic culture and histotypic culture, tissue engineering and its application. **In vitro fertilization (IVF)**, ICSI, SUZI,PZD ,MESA Embryo transfer and test tube babies. -PGD for (Alzheimer and Huntington disease) . Embryonic Stem Cell method, Microinjection method. Ethical implications of animal biotechnology, Biosafety and regulatory issues.

Unit V: Transgenic animals and Applications

(9 hrs)

Transgenic animals in live- stock improvement. Transgenic Animals: Production Methodology Cell culture-based vaccine. Somatic cell genetics. Genetically humanized animal models for personalized medicine, approaches primary targets **of human gene therapy** (muscular dystrophy, and sickle cell anemia) Stem cell culture and its types Major applications in healthcare industries.

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

S.No	Topics	Links
Unit I: Animal cell culture		
1.	Animal cell culture Laboratory- Design and layout,	https://www.youtube.com/watch?v=CA5fVLK5zAE
2.	Ethical implications of animal biotechnology, Biosafety and regulatory issues.	https://www.youtube.com/watch?v=IbXDOpAfUgk
Unit II: Culture Media		
3.	Preparation and sterilization of media and supplements	https://www.youtube.com/watch?v=o0hHD2yjjNI
4.	Contaminations in animal cell culture.	https://www.youtube.com/watch?v=CGOHvdKBGnA
Unit III: Tissue culture and Tissue engineering		
5.	FACS	https://www.youtube.com/watch?v=7bCZx5xPwt0
6.	Applications of 3 D Bioprinting	https://www.youtube.com/watch?v=DXtsEvcAxxY
Unit IV: Cytotoxicity and IVF		
7.	Cryopreservation	https://www.youtube.com/watch?v=6jx8bD6wWTs
8.	<i>In vitro</i> fertilization (IVF)	https://www.youtube.com/watch?v=pTVtYgSHDtI
Unit V: Transgenic animals and Applications		
9.	Transgenic animals in live- stock improvement	https://www.youtube.com/watch?v=VLGUlyIaqZY
10.	human gene therapy	https://www.youtube.com/watch?v=P3Vypi3ZgOc

TEXT BOOKS

S.No.	Authors	Title of the Book	Publishers	Year and Edition
1	Portner, R	Animal Cell Biotechnology: Methods and Protocols	Humana Publishers, New York, United States	2016 & 3 rd Edition
2.	R. Ian Freshney	Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications.	Wiley-Blackwell	2016 7 th Edition
3.	Satyanarayana U.	Biotechnology	Books and Allied (p) Ltd.	2005 1 st Edition

REFERENCE BOOKS

S.No.	Authors	Title of the Book	Publishers	Year and Edition
1.	Rajesh Kumar Yadav	Animal Biotechnology and Genetic Engineering.	Oxford Book Company	2021 & 1 st Edition
2.	Ranga, M. M	Animal Biotechnology	Agrobios India Publishers, India	2018 & 3 rd Edition
3.	A. K. Srivastava	Animal Biotechnology	Oxford and IBH Publishing Company Pvt. Limited	2018 & 1 st Edition

Course Designer:

Dr. D.S. Ranjith Santhosh Kumar

Module No.	Topic	CLO level	No. of hours	Content delivery methods	Learning Methods
Unit - I: Animal cell culture					
1.	Animal cell culture Laboratory- Design and layout	CLO1	1	Lecture – Chalk and Talk / Group reading	Participatory Learning
2.	Equipment and materials.	CLO1	1	PPT / OER	Problem-based Learning
3.	Structure, organization and physiology of animal cells.	CLO1	1	Displays	Experiential Learning
4.	History, Scope ,Purpose of ATC	CLO1	1	Chalk and talk/ Picture	Problem-based Learning
5.	applications of animal cell culture. Advantages and limitations.	CLO1	1	Spotters/ Chalk and talk	Experiential Learning
6.	Types of animal cell culture and Biology of cultured cells	CLO1	1	Spotters/ Chalk and talk	Experiential Learning
7.	Culture vessels and substrate. Ethical implications of animal biotechnology	CLO1	1	OER	Problem-based Learning
8.	Biosafety and regulatory issues	CLO1	1	Lecture – Chalk and Talk / Group reading	Participatory Learning
Unit – II: Culture media					
9.	Preparation and sterilization of media	CLO2	1	Lecture / Seminar	Problem-based Learning
10.	Supplements Physi ochemical properties of medium	CLO2	1	Lecture / OER	Experiential Learning
11.	Balanced salt solution,	CLO2	1	Spotters/ Chalk and talk	Experiential Learning

12.	culture media biochemical ingredients	CLO2	1	Lecture / Seminar	Problem-based Learning
13.	types and differential of media	CLO2	1	Lecture / Seminar	Problem-based Learning
14.	Selection of medium	CLO2	1	Lecture / Seminar	Problem-based Learning
15.	Serum.- Introduction- Serum free media. Role of Antibiotics	CLO2	1	Lecture / OER	Experiential Learning
16.	Types in media. Contaminations in animal cell culture	CLO2	1	OER	Participatory Learning
Unit – III: Tissue culture and Tissue engineering					
17.	Basic techniques of animal cell culture	CLO3	1	Lecture / Seminar	Problem-based Learning
18.	<i>in vitro</i> , disaggregation of tissue and primary culture,	CLO3	1	Lecture PPT	Problem-based Learning
19.	Subculture, establish ment of cell line,	CLO3	1	Lecture / Seminar	Problem-based Learning
20.	Cloning and selection, Cell separation, Characterization, Differentiation	CLO3	1	Research article reading	Experiential Learning
21.	Transformation and immortalization	CLO3	1	Lecture PPT	Participatory Learning
22.	Scale-up and cell synchronization	CLO3	1	Lecture PPT	Problem-based Learning
23.	FACS	CLO3	1	Seminar / PPT	Participatory Learning
24.	Measurement of cell death – apoptosis and its determination	CLO3	1	Demonstration	Problem-based Learning
25.	Introduction and Applications of 3 D Bioprinting	CLO3	1	Lecture PPT	Participatory Learning
Unit – IV: Cytotoxicity and ART					
26.	Cytotoxicity: Viability, toxicity	CLO4	1	Seminar / PPT	Participatory Learning

27.	MTT Assay	CLO4	1	Research article reading	Experiential Learning
28.	Cryopreservation and cell banks	CLO4	1	Research article reading	Experiential Learning
29.	Organotypic culture, histotypic culture	CLO4	1	PPT	Problem-based Learning
30.	tissue engineering and its application	CLO4	1	Lecture / Seminar	Problem-based Learning
31.	Stem cell culture and its application.	CLO4	1	PPT	Participatory Learning
32.	<i>In vitro</i> fertilization (IVF) SUZI,PZD ,MESA	CLO4	1	PPT	Participatory Learning
33.	PGD for Alzheimer disease	CLO4	1	Brainstorming	Participatory Learning
34.	PGD for Huntington disease	CLO4	1	Brainstorming	Participatory Learning
35.	Embryonic Stem Cell method, Microinjection method. Ethical implications of animal biotechnology, Biosafety and regulatory issues.	CLO4	1	Brainstorming	Participatory Learning
Unit – V: Transgenic animals and Applications					
36.	Transgenic animals in live- stock improvement	CLO5	1	Research article reading	Experiential Learning
37.	Cell culture based vaccine..	CLO5	1	Discussion	Participatory Learning
38.	Somatic cell genetics	CLO5	1	Research article reading	Problem-based Learning
39.	Genetically humanized animal models for personalized medicine	CLO5	1	Lecture / Seminar	Problem-based Learning
40.	approaches primary targets of human gene therapy -sickle cell anemia	CLO5	1	Research article reading	Experiential Learning
41.	approaches primary targets of human gene therapy- muscular dystrophy	CLO5	1	Research article reading	Experiential Learning

42.	Embryonic Stem Cell method, Microinjection method.	CLO5	1	PPT	Problem-based Learning
43.	Stem cell culture and its types Major applications in healthcare industries	CLO5	1	PPT	Problem-based Learning

Name of the course	MBY2406-Animal Biotechnology
Name of the Faculty	Dr. D. S. Ranjith Santhosh Kumar
Participatory Learning	30 %
Experiential Learning	30 %
Problem-based Learning	40 %

COURSE CODE	COURSE NAME	CATEGORY	L	T	P	CREDITS
MBY2307	ENVIRONMENTAL BIOTECHNOLOGY	THEORY	43	2	-	3

Learning Objectives

- To Understand the constitution of biogeography and the effects of environmental stress
- To gain knowledge about environmental hazards and disasters.
- To analyze the methods involved in pollution control.
- To know about pollution detection methods.
- To appreciate the importance of biotechnology in environmental aspects.

Course Learning Outcomes

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

CLO Number	CLO Statement	Knowledge Level
CLO1	Describe about the various types of ecosystems	K2
CLO2	Report about Environmental pollution and its remediation measures.	K3
CLO3	Outline the Environmental hazards and disaster	K4
CLO4	Appraise the pollution detection and control methods	K5
CLO5	Propose the role of biotechnology in environmental measures	K6

Mapping with Programme Learning Outcomes

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	S	S	M	M	S
CLO2	S	S	M	M	S
CLO3	S	S	M	M	M
CLO4	S	S	M	M	M
CLO5	S	S	M	M	S

M-Medium - Strong

MBY2307- ENVIRONMENTAL BIOTECHNOLOGY

Unit I: Biogeography and Environmental problems (9 hrs)

Biogeochemical cycles in ecological systems – Carbon, Phosphorus and Nitrogen cycles. Limiting factors, Energy transfer. Concept of **ecosystems** and ecosystem management. Response of microbes, plants and animals to environmental stresses. Environmental problems- **ozone depletion, greenhouse effect**, Carbon effects, water, air and soil pollution, and land degradation. **environmental impact assessment** and Sustainability.

Unit II: Biofuels Production and environmental hazards (8 hrs)

Biofuels – a general introduction, Plant derived fuels, Biogas, Landfill gas, Biohydrogen. **Composting process** and techniques, Use of composted materials. Types of **environmental hazards and Disasters**. Natural - volcanic eruption, earthquakes, landslides, cyclones, lightning, hailstorms.

Unit III: Pollution and Management Systems (9 hrs)

Sewage and **waste water treatment** and **solid waste management**, Chemical measure of water pollution, Conventional biological treatment, Role of macrophytes and macrophytes in water treatment. **Recent approaches to biological wastewater treatment**. Use of biological techniques in controlling air pollution. Removal of chlorinated hydrocarbons from air. **Hazardous Waste Management** and Waste Handling rules. **Bioremediation**

Unit IV: Pollution Detection Methods (8 hrs)

Pollution Detection Methods-Biotechnological methods of pollution detection: Genotoxicity, Plant test system- **algal bioassay**. **DNA gene probe**, PCR based detection system for Shigella, Salmonella in water. Techniques in pollution detection - Remote sensing, **Bioindicators** and Biosensors for detection of pollution. **Types of Biosensors** – Enzyme electrode, Optical biosensors, H₂O₂ biosensor, Microbial biosensor.

Unit V: Bioresources and Environmental Management (9 hrs)

Genetically Engineered Microorganisms (GEMs) in environment, Role of Environmental Biotechnology in management of environmental problems, Bioremediation: Advantages and Disadvantages, **In situ and ex-situ bioremediation**, slurry bioremediation. Bioremediation of contaminated ground water and **phytoremediation of soil metals**. Microbiology of degradation of xenobiotics. **Biofertilizers, Biomining** and Soil enzymes. agencies for pollution control. Case Study- any two relevant studies.

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

S.No.	Topics	Weblink(s)
Unit I: Biogeography and Environmental problems		
1	Biogeochemical cycles	https://www.youtube.com/watch?v=ccWUDIKC3dE
2	Ecosystems	https://www.youtube.com/watch?v=KQF9WdZrH_c
3	Ozone depletion	https://www.youtube.com/watch?v=aU6pxSNDPhs
4	Greenhouse effect	https://www.youtube.com/watch?v=gVfgkFaswn4
5	Pollution (ex. microplastics)	https://www.youtube.com/watch?v=1RDc2opwg0I
6	Environmental impact assessment	https://www.youtube.com/watch?v=RWtT0EfhNsE
Unit II: Biofuels Production and environmental hazards		
7	Biofuels	https://www.youtube.com/watch?v=I9arI2e5bkw
8	Composting process	https://www.youtube.com/watch?v=Tg2qWjk9AD4
9	Environmental hazards and Disasters	https://www.youtube.com/watch?v=gfqJZmb3pG4
Unit III: Pollution and Management Systems		
10	Waste water treatment	https://www.youtube.com/watch?v=KsVfshmK0Ak
11	Solid waste management	https://www.youtube.com/watch?v=tZEM5K72aVs
12	Recent approaches to biological wastewater treatment	https://www.youtube.com/watch?v=TNR0BEqxy7I
13	Hazardous Waste Management	https://www.youtube.com/watch?v=pZ62gSUdYqw
14	Bioleaching	https://www.youtube.com/watch?v=5dU82XTU31s
Unit IV: Pollution Detection Methods		
15	Algal bioassay	https://www.youtube.com/watch?v=kNL99XVJjQo
16	DNA gene probe	https://www.youtube.com/watch?v=Hv5fIUOsEOs
17	Bioindicators	https://www.youtube.com/watch?v=mdLnmoykpkQ
18	Types of biosensors	https://www.youtube.com/watch?v=dSgyOkEqRb8
Unit V: Bioresources and Environmental Management		
19	In situ and ex-situ bioremediation	https://www.youtube.com/watch?v=Tgwh8PiMO7M
20	Phytoremediation of soil metals	https://www.youtube.com/watch?v=L89sLg4H4BA
21	Biofertilizers	https://www.youtube.com/watch?v=ExqbV5O1lFU
22	Biomining	https://www.youtube.com/watch?v=mKgflNAXwO4

TEXT BOOKS

S.No	Authors	Title of the Book	Publishers	Year and Edition
1.	Davis, M. L and Masten, S.J.	Principles of Environmental Engineering & Science.	McGraw Hill, UK.	2019 4 th Edition
2.	Mihelcic, J.R and Zimmerman, J.B.	Environmental Engineering: Fundamentals, Sustainability, and Design.	Wiley-Blackwell, UK.	2021 3 rd Edition
3.	Wright, R and Boorse, D	Environmental Science: Toward a Sustainable Future.	Pearson, USA.	2016 13 th Edition

REFERENCE BOOKS

S.No	Authors	Title of the Book	Publishers	Year of Publication
1.	Roger WrubelP, SheldonKrimsky	Agricultural Biotechnology and the Environment	University of Illinois Press.	1996 1st Edition
2.	P. Bajpai , R. Kondo	Biotechnology for Environmental Protection in the Pulp and Paper Industry	Springer.	2011 2nd Edition

Course Designer:

Dr. P. Suganya

Module No.	Topic	CLO level	No. of hours	Content delivery methods	Learning Methods
Unit I: Biogeography and Environmental problems					
1	Biogeochemical cycles in ecological systems – Carbon, Phosphorus and Nitrogen cycles.	CLO2 CLO4	1	Lecture – Chalk and Talk	Participatory Learning
2	Limiting factors	CLO2 CLO4	1	Video	Problem-based Learning
3	Energy transfer	CLO2 CLO4	1	Chalk and talk/ Picture	Participatory Learning
4	Concept of ecosystems and ecosystem management	CLO2 CLO4	1	Research article discussion	Problem-based Learning
5	Response of microbes, plants and animals to environmental stresses.	CLO2 CLO4	1	PPT	Experiential Learning
6	Environmental problems- ozone depletion	CLO2 CLO4	1	Lecture – Chalk and Talk	Problem-based Learning
7	Greenhouse effect, Carbon effects	CLO2 CLO4	1	Picture	Participatory Learning
8	Water, air and soil pollution, and land degradation.	CLO2 CLO4	1	PPT	Problem-based Learning
9	Environmental impact assessment and Sustainability.	CLO2 CLO	1	Video / Observation	Experiential Learning
Unit II: Biofuels Production and environmental hazards					
10	Biofuels – a general introduction	CLO2 CLO4	1	Lecture – Chalk and Talk	Participatory Learning
11	Plant derived fuels	CLO2 CLO4	1	Chalk and talk/ Picture	Problem-based Learning
12	Biogas, Landfill gas and Biohydrogen	CLO2 CLO5	1	Video	Participatory Learning
13	Composting process and techniques	CLO3 CLO4	1	Picture	Problem-based Learning
14	Use of composted materials	CLO2 CLO	1	Video	Participatory Learning
15	Types of environmental hazards and Disasters.	CLO2 CLO4	1	Lecture – Chalk and Talk	Participatory Learning
16	Natural - volcanic eruption, earthquakes, landslides, cyclones	CLO2 CLO5	1	Video / Observation	Experiential Learning

17	Lightning, hailstorms.	CLO2 CLO5	1	PPT	Participatory Learning
Unit III: Pollution and Management Systems					
18	Sewage and waste water treatment	CLO2 CLO4	1	Chalk and talk/ Picture	Problem-based Learning
19	Solid waste management	CLO2 CLO4	1	Lecture PPT	Participatory Learning
20	Chemical measure of water pollution	CLO2 CLO5	1	PPT	Experiential Learning
21	Conventional biological treatment, Role of macrophytes and macrophytes in water treatment	CLO3 CLO4	1	PPT	Problem-based Learning
22	Recent approaches to biological wastewater treatment.	CLO2 CLO4	1	Displays	Experiential Learning
23	Use of biological techniques in controlling air pollution	CLO2 CLO3	1	Research article reading	Problem-based Learning
24	Removal of chlorinated hydrocarbons from air.	CLO2 CLO5	1	Lecture – Chalk and Talk	Experiential Learning
25	Hazardous Waste Management and Waste Handling rules.	CLO3 CLO4	1	Seminar / PPT	Participatory Learning
26	Bioleaching	CLO3 CLO5	1	Research article reading	Problem-based Learning
Unit IV: Pollution Detection Methods					
27	Pollution Detection Methods- Biotechnological methods of pollution detection: Genotoxicity	CLO2 CLO4	1	Lecture – Chalk and Talk	Problem-based Learning
28	Plant test system- algal bioassay.	CLO2 CLO4	1	Lecture – Chalk and Talk	Experiential Learning
29	DNA gene probe	CLO2 CLO5	1	Video / Observation	Experiential Learning
30	PCR based detection system for Shigella, Salmonella in water.	CLO3 CLO4	1	PPT	Problem-based Learning
31	Techniques in pollution detection - Remote sensing	CLO2 CLO4	1	Lecture PPT	Participatory Learning
32	Bioindicators and Biosensors for detection of pollution.	CLO3 CLO5	1	Lecture – Chalk and Talk	Experiential Learning
33	Types of Biosensors – Enzyme electrode, Optical biosensors	CLO3 CLO5	1	Video	Participatory Learning
34	H ₂ O ₂ biosensor, Microbial biosensor.	CLO3 CLO5	1	PPT	Participatory Learning
Unit V: Bioresources and Environmental Management					
35	Genetically Engineered Microorganisms (GEMs) in environment	CLO2 CLO4	1	Video / Observation	Experiential Learning

36	Role of Environmental Biotechnology in management of environmental problems	CLO3 CLO5	1	Video	Problem-based Learning
37	Bioremediation: Advantages and Disadvantages	CLO2 CLO4	1	Picture	Experiential Learning
38	In situ and ex-situ bioremediation, slurry bioremediation.	CLO2 CLO5	1	Displays	Experiential Learning
39	Bioremediation of contaminated ground water and phytoremediation of soil metals.	CLO3 CLO4	1	PPT	Problem-based Learning
40	Microbiology of degradation of xenobiotics.	CLO3 CLO4	1	Lecture/ Virtual lab	Experiential Learning
41	Biofertilizers, Biomining and Soil enzymes.	CLO3 CLO5	1	Video	Problem-based Learning
42	Agencies for pollution control.	CLO3 CLO5	1	Video	Problem-based Learning
43	Case Study- any two relevant studies.	CLO3 CLO5	1	Research article reading	Problem-based Learning

Name of the course	MBY2307 - Environmental Biotechnology
Name of the Faculty	Dr. Prabhu Thangadurai
Participatory Learning	30 %
Experiential Learning	30 %
Problem-based Learning	40 %

COURSE CODE	COURSE NAME	CATEGORY	L	T	P	CREDITS
MBY2308	NANO BIOTECHNOLOGY	THEORY	43	2	-	4

Learning Objectives:

- To apply the basics of nanobiology, able to differentiate particles at macro, micro and nano level
- To know how to synthesize nanoparticles on a laboratory scale
- To understand the characterization techniques involved in nanotechnology
- To assess the properties of biological nano-objects
- To apply the nanomaterials for various biological applications

Course Learning Outcomes

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

CLO Number	CLO Statement	Knowledge Level
CLO1	Describe about the various types of nanoparticles and able to differentiate particles at macro, micro and nano level	K2
CLO2	Synthesis the nanoparticles on a laboratory scale	K3
CLO3	Outline the characterization techniques involved in nanotechnology	K4
CLO4	Distinguish the properties of different biological nano-objects	K5
CLO5	Apply the nanomaterials for various biological applications	K6

Mapping with Programme Learning Outcomes

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	S	M	M	M	L
CLO2	M	M	M	M	S
CLO3	M	L	S	M	S
CLO4	S	S	S	M	M
CLO5	S	S	S	M	S

M-Medium S- Strong L-Low

MBY2308-NANO BIOTECHNOLOGY

Unit I: Introduction to Nanobiology and Nanomaterials

(9 hrs)

Nanobiology: Concepts. **Classification of Nanostructures**, Bionanoparticles and nanocomposites, Types of biomaterials and biodegradable polymers, Nano-thin films: Chitosan thin film, Nanodevices (nanorobots), **Nanotubes: Microtubules assembly and its importance**, Nano shells- Dendrimers: Liposomes, Nanofibers: Collagen, nanocomposites

Unit II: Synthesis of Nanomaterials

(8 hrs)

Synthesis of nanomaterials - Physical approaches, Chemical approaches, Biological approaches-plant, bacteria, fungi mediated method. **Bottom-up approach**- Sol-Gel synthesis, **Physical vapor deposition**, **top-down approach** -ball milling, microfabrication.

Unit III: Characterization Techniques for Nanomaterials

(9 hrs)

Physical and chemical properties of nanoparticles. **Characterization– UV-Vis spectroscopy, particle size analyzer, Zeta potential, FTIR, XRD, EDS**, Differential Thermal Analysis (DTA) and Differential Scanning Calorimetry (DSC). Electron Microscopy-**Scanning Electron Microscopy (SEM), HRTransmission Electron Microscopy (TEM)**. Scanning Probe Microscopy (SPM), Atomic Force Microscopy (AFM).

Unit IV: Biological Nano-objects

(8 hrs)

DNA-based Nanostructures, Mastering the complex DNA nanostructure, DNA tweezers, DNA actuators, DNA scissors, Protein-based Nanostructures, Lipid-based Nanostructures, Self-assembly, Micelles, Application of biological nano-objects.

Unit V: Applications of nanomaterials in various fields

(9 hrs)

Nanobiotechnology in medicine Surgical supplements, Application in Diagnostic equipment, **Tissue engineering with a focus on wound healing, Cancer treatment**, Drug designing, **Drug delivery**, Photocatalysis of dye and heavy metal removal, Application in Cosmetics, food and agriculture. Biosensors.

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

S.No	Topics	Links
Unit I: Introduction to Nanobiology and Nanomaterials		
1.	Classification of Nanostructures	https://www.youtube.com/watch?v=xEd4NYpc5OU
2.	Nanotubes: Microtubules assembly and its importance	https://www.youtube.com/watch?v=ZpEKOH4LBAC&t=32s
Unit II: Synthesis of Nanomaterials		
3.	Synthesis of nanomaterials-Top down approach and Bottom up approach	https://www.youtube.com/watch?v=bLKsHAtxDrM
4.	Ball milling	https://www.youtube.com/watch?v=6pSkixSwIZY&t=103s
5.	Physical Vapour Deposition	https://www.youtube.com/watch?v=JR1EMIE15nQ&t=10s
Unit III: Characterization Techniques for Nanomaterials		
6.	Characterization- FT-IR, UV Spectroscopy,	https://www.youtube.com/watch?v=IFYs3XD4fQ
7.	Nanoparticle track analyzer, Zeta potential,	https://www.youtube.com/watch?v=IFYs3XD4fQ
8.	SEM, TEM	https://www.youtube.com/watch?v=qvIWpLSzRhs
9.	EDS and XRD	https://www.youtube.com/watch?v=sYxWedz273s&list=PLbc81v3FNszodghMOUCpkJIZbzNLwyivd&index=7 https://www.youtube.com/watch?v=vMv1118CEeg&list=PLbc81v3FNszodghMOUCpkJIZbzNLwyivd&index=12
Unit IV: Biological Nano-objects		
10.	DNA-based Nanostructures	https://www.youtube.com/watch?v=hSYOaKYeDI4
11.	Mastering the complex DNA nanostructure	https://www.youtube.com/watch?v=QtgB6iApaHA
12.	DNA tweezers	https://www.youtube.com/watch?v=x3GgdqKC9WI
13.	DNA actuators	https://www.youtube.com/shorts/f5v5UQQRZwI
14.	DNA scissors	https://www.youtube.com/watch?v=ZQf7ewZGZXg
Unit V: Applications of nanomaterials in various fields		
15.	Tissue engineering with a focus on wound healing	https://www.youtube.com/watch?v=oUc_5RpGJWk
16.	Drug delivery	https://www.youtube.com/watch?v=f7hMhL_N4k8
17.	Cancer treatment	https://www.youtube.com/watch?v=6kmfDNVjRdw

TEXT BOOKS

S.No	Authors	Title of the Book	Publishers	Year and Edition
1.	Parthasarathy BK	Introduction to Nanotechnology	Isha Publication, India	2007 1 st Edition
2.	Elisabeth Papazoglou, Aravind Parthasarathy,	Bionanotechnology	Morgan and Claypool Publishers, United States	2007 1 st Edition

REFERENCE BOOKS

S.No.	Authors	Title of the Book	Publishers	Year and Edition
1.	Kulkarni	Nanotechnology: Principles and Practice	Springer	2015 & 3 rd edition,
2.	Ehud Gazit	Plenty of Room for Biology at the Bottom: An Introduction to Bionanotechnology	Imperial College Press, London, United Kingdom	2006 & 2 nd Edition
3.	David E Reisner, Joseph D Bronzino	Bionanotechnology: Global Prospects	CRC Press, Florida, United States	2019 & 1 st Edition

Course Designer:**Dr. V. Bhuvaneshwari**

Module No.	Topic	CLO level	No. of hours	Content delivery methods	Learning Methods
Unit I: Introduction to Nanobiology and Nanomaterials					
1.	Introduction to Nanobiology and Nanomaterials	CLO1	1	PPT / OER	Participatory Learning
2.	Concepts of nanobiology, Classification of Nanostructures	CLO1	1	Lecture – Chalk and Talk / Group reading	Participatory Learning
3.	Bionanoparticles and nanocomposites	CLO1	1	PPT / OER	Participatory Learning
4.	Types of biomaterials and biodegradable polymers	CLO1	1	Chalk and talk/ Picture	Problem-based Learning
5.	Nano-thin films, Chitosan thin film	CLO1	1	Research paper presentation	Experiential Learning
6.	Nanodevices (nanorobots)	CLO1	1	OER/PPT	Experiential Learning
7.	Nanotubes: Microtubules assembly and its importance	CLO1	1	OER/PPT	Experiential Learning
8.	Nano shells- Dendrimers: Liposomes	CLO1	1	OER/PPT	Experiential Learning
9.	Nanofibers: Collagen, Nanocomposites	CLO1	1	Book/ Article review	Experiential Learning
UNIT II: Synthesis of Nanomaterials					
10.	Synthesis of nanomaterials - Physical and Chemical approaches	CLO2	1	Lecture – Chalk and Talk / Group reading	Participatory Learning
11.	Biological approaches	CLO2	1	Review article presentation	Experiential Learning
12.	Plant mediated method	CLO2	1	Demonstration	Experiential Learning
13.	Bacteria mediated method	CLO2	1	Research paper presentation	Problem-based Learning
14.	Fungi mediated method	CLO2	1	Student Seminar	Problem-based Learning
15.	Bottom-up approach, Sol-Gel synthesis, Physical vapor deposition	CLO2	1	PPT / OER	Problem-based Learning
16.	Top-down approach -ball milling	CLO2	1	Research paper presentation	Problem-based Learning
17.	Microfabrication	CLO2	1	Book/ Article review	Problem-based Learning
UNIT III: Characterization Techniques for Nanomaterials					

18.	Physical and chemical properties of nanoparticles	CLO3	1	Lecture – Chalk and Talk / Group reading	Participatory Learning
19.	Characterization: UV-Vis spectroscopy	CLO3	1	PPT / OER	Participatory Learning
20.	Particle size analyzer, Zeta potential	CLO3	1	Demonstration	Experimental Learning
21.	FTIR	CLO3	1	Demonstration	Experimental Learning
22.	XRD, EDS	CLO3	1	Lecture and Discussion	Experiential Learning
23.	Differential Thermal Analysis (DTA), Differential Scanning Calorimetry (DSC)	CLO3	1	Virtual lab	Problem-based Learning
24.	Electron Microscopy- Scanning Electron Microscopy (SEM)	CLO3	1	Research paper presentation	Problem-based Learning
25.	HRTransmission Electron Microscopy (TEM)	CLO3	1	Research paper presentation	Problem-based Learning
26.	Scanning Probe Microscopy (SPM), Atomic Force Microscopy (AFM)	CLO3	1	Lecture and Discussion	Problem-based Learning
UNIT IV: Biological Nano-objects					
27.	Biological Nano-objects, DNA-based Nanostructures	CLO4	1	PPT / OER	Participatory Learning
28.	Mastering the complex DNA nanostructure	CLO4	1	Chalk and talk/ Picture	Participatory Learning
29.	DNA tweezers	CLO4	1	PPT / OER	Participatory Learning
30.	DNA actuators, DNA scissors	CLO4	1	Student Seminar	Experiential Learning
31.	Protein-based Nanostructures	CLO4	1	Research paper presentation	Participatory Learning
32.	Lipid-based Nanostructures	CLO4	1	Book/ Article review	Problem-based Learning
33.	Self assembly, Micelles	CLO4	1	Virtual lab	Problem-based Learning
34.	Application of biological nano-objects	CLO4	1	Research paper presentation	Problem-based Learning
Unit V: Applications of nanomaterials in various fields					
35.	Nanobiotechnology in medicine Surgical supplements	CLO5	1	PPT / OER	Participatory Learning
36.	Application in Diagnostic equipment	CLO5	1	Chalk and talk/ Picture	Participatory Learning

37.	Tissue engineering with a focus on wound healing	CLO5	1	Video Lecture and Discussion	Participatory Learning
38.	Cancer treatment	CLO5	1	Book/ Article review	Experiential Learning
39.	Drug designing, Drug delivery	CLO5	1	Student Seminar	Experiential Learning
40.	Photocatalysis of dye, Heavy metal removal	CLO5	1	Demonstration	Problem-based Learning
41.	Application in Cosmetics	CLO5	1	Research paper presentation	Problem-based Learning
42.	Application in food and agriculture	CLO5	1	Research paper presentation	Problem-based Learning
43.	Biosensors	CLO5	1	Research paper presentation	Problem-based Learning

Name of the course	MBY2308- Nano Biotechnology
Name of the Faculty	Dr. V. Bhuvaneshwari
Participatory Learning	30%
Experiential Learning	30%
Problem-based Learning	40%

COURSE CODE	COURSE NAME	CATEGORY	L	T	P	CREDITS
MBY2309	FOOD BIOTECHNOLOGY	THEORY	43	2	-	4

Learning Objectives

- To gain knowledge on the basic principles of food science and technology,
- To analyze the various detection methods of microbes in food samples
- To apply the techniques used in food processing and preservation.

Course Learning Outcomes

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

CLO Number	CLO Statement	Knowledge Level
CLO1	Distinguish the basic constituents of food.	K2
CLO2	Elaborate on the standards of identity, purity and methodology for analysis of different categories of food.	K3
CLO3	Evaluate the various food preservation methods.	K4
CLO4	Explain about the role of enzymes used in the food industry.	K5
CLO5	Examine the methods of detecting different bacteria in food samples.	K6

Mapping with Programme Learning Outcomes

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	S	S	M	S	S
CLO2	S	S	M	S	S
CLO3	S	S	M	S	S
CLO4	S	S	M	S	S
CLO5	S	S	M	S	S

S- Strong; M-Medium

MBY2309- FOOD BIOTECHNOLOGY

Unit I: Introduction to Food Science and technology (8 hrs)

Basics of chemistry of food constituents- carbohydrates, proteins, lipids, vitamins, minerals, water (different forms of water present in foods and their effect on quality and preservation of foods). Minor constituents affecting texture, colour, taste and odour. **Food allergens and mechanism. Strain improvement for flavour.** Food microbiology, Food biochemistry. Food additives, General food composition and effect of food constituents on food quality.

Unit II: Standards for food analysis (8 hrs)

Standards of identity, purity and methodology for analysis of Cereals, legumes, oil seeds and their products. Fruits, vegetables, tubers and their products. Tea, coffee, cocoa, chocolate, spices, and condiments. Milk and milk products. Meat, fish and poultry products. Miscellaneous foods e.g. fermented products. Food constituents in grains like gluten.

Unit III: Food processing and preservation (9 hrs)

Introduction to food processing of various foods - dairy, bakery, brewing, fruit and vegetable products, plantation products, and nutraceuticals. 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/ syruling, pickling, and fermentation. Non thermal processes like MAP, irradiation, high pressure processing, Hurdle technology.

Unit IV: Industrial Food Products (9 hrs)

Fermentative production of enzymes used in the food industry, solid state fermentation, recovery of enzymes from natural sources, cheese making and whey processing, **impact of enzyme technology (bioethanol, protein hydrolysates, bioactive peptides), enzymatic processing of fruit juices.** Role of enzymes in baking, meat and meat processing, comparative methods of toxicity test in (novel) foods, biosensors, enzymatic approach to tailor made fats, catabolic processes and oxygen-dependent reactions in food, use of lipases and reactions in organic solvents and two phases.

Unit V: Fermented foods and Regulations 9 hrs)

Applications of immunological techniques in the food industry. **Detection methods for *E. coli*, Staphylococci, Yersinia, Campylobacter, B. cereus, Clostridium botulinum & Salmonella from food samples.** Newer processing technology, Pesticide residues, Newer sources of ingredients, Nutraceuticals. Use of Antibiotics & Hormones in Food Processing & Agricultural Practices. Farmers producers Organisation (FPO), Quality analysis of food products, Hazard analysis and Critical control point (HACCP), Food biotechnology Government regulatory agency.

TEXT BOOKS

S.No.	Authors	Title of the Book	Publishers	Year and Edition
1.	Keith H. Steinkraus	Industrialization of Indigenous Fermented Foods.	CRC Press, USA	2004 2 nd Edition
2.	ByongH.Lee.	Fundamentals of Food Biotechnology.	Wiley-Blackwell, UK	2015 2 nd Edition
3.	Smith, J.S; and Hui. Y.H	Food Processing Principles & Applications	Wiley-Blackwell, UK	2013 1 st Edition

REFERENCE BOOKS

S.No.	Authors	Title of the Book	Publishers	Year and Edition
1.	Frazier, W.C., Westhoff, D.C; and Vanitha, N. M.	Food Microbiology	McGraw Hill Education, New York, USA.	2017 5 th Edition
2.	Srilakshmi, B.	Food Science	New Age International Private Limited, New Delhi	2015 6 th Edition
3.	Sun, D.W.	Emerging Technologies for Food Processing	Academic Press, USA	2014 2 nd Edition

Course Designer:

Dr. P. Suganya

COURSE CODE	COURSE NAME	CATEGORY	L	T	P	CREDITS
MBY24P3	IMMUNOTECHNOLOGY AND ANIMAL BIOTECHNOLOGY PRACTICAL	PRACTICAL	-	-	75	4

Learning Objectives

- To familiarize students with the basic principles of immunotechnological methods, animal cell culture and biostatistics.
- To develop students' skills to perform immunotechnological methods, animal cell culture, and biostatistics.
- To evaluate the method for detect and quantify the antigen, antibody concentration, toxicity analysis and analyze it using biostatistics method
- To design and perform immunological experiments, animal cell culture techniques and biostatistics to test specific hypotheses.

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 principles of immunotechnological methods, animal cell culture and biostatistics.	K2
CLO2	Test and apply the immunotechnological methods, animal cell culture, and biostatistics.	K3
CLO3	Evaluate the method for detecting and quantifying the antigen	K4
CLO4	Justify the principles and applications of immunological techniques	K5
CLO5	Understand the real-world problem and solve using immunological experiments	K6

Mapping with Programme Learning Outcomes

CLOs	PLO1	PLO 2	PLO 3	PLO 4	PLO 5
CLO1	M	S	S	M	S
CLO2	S	S	M	S	S
CLO3	S	S	M	S	S
CLO4	S	S	S	S	S
CLO5	S	S	M	S	S

S-Strong M-Medium

MBY24P3 -IMMUNOTECHNOLOGY AND ANIMAL BIOTECHNOLOGY PRACTICAL

IMMUNOTECHNOLOGY

1. Determination of the blood group of the given sample.
2. Preparation of serum from blood.
3. Blood smear staining by using Leishman stain
4. Single radial immunodiffusion.
5. Ouchterlony double diffusion.
6. Rocket Immunelectrophoresis for determination of concentration of antigen in unknown sample.
7. Micro-hemagglutination test.
8. WIDAL test for typhoid
9. ELISA test (demo)
10. Western blotting (demo)

ANIMAL BIOTECHNOLOGY

1. Isolation of animal DNA from liver
2. Preparation of reagents and media for cell culture.
3. Primary culture technique chicken embryo fibroblasts.
4. Qualification of cells by trypan blue exclusion dye.
5. Isolation and cultivation of lymphocytes.
6. Cryopreservation of cell primary cultures and Revival of cells (Demo)
7. Demonstration and observation Zebra fish Cytotoxicity

TEXT BOOKS

S.No	Authors	Title of the Book	Publishers	Year and Edition
1.	Frank C. Hay	Practical Immunology	Garland Science	2018 5th Edition
2.	R. Ian Freshney	Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications.	Wiley-Blackwell 7th edition	2016 7 th Edition

REFERENCE BOOKS

S.No.	Authors	Title of the Book	Publishers	Year and Edition
1.	Jenkins, N	Animal Cell Biotechnology: Methods and Protocols.	Humana press, New Jersey	2010 Standard
2.	Vashist, S.K. & Luong, J.H.T.	Handbook of Immunoassay Technologies: Approaches, Performances, and Applications	Academic Press	2018 1 st Edition

Course Designer:

Dr. R. Nirmal Kumar

Dr. D.S. Ranjith Santhosh Kumar

COURSE CODE	COURSE NAME	CATEGORY	L	T	P	CREDITS
MBY23P4	ENVIRONMENTAL, NANO AND FOOD BIOTECHNOLOGY PRACTICAL	PRACTICALS	-	-	75	4

Learning Objectives

- To identify the basic methods involved in environmental, nano and food products
- To design an experiment to assess the environmental, nano and food samples
- To analyze the methods for identifying the quality of environmental, nano and food sample
- To justify the application of environmental, nano and food biotechnology
- To identify basic experimental design principles in preparation of environmental, nano and food products

Course Learning Outcomes

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

CLO Number	CLO Statement	Knowledge Level
CLO1	Identify the basic methods involved in environmental, nano and food products	K2
CLO2	Design an experiment to assess the environmental, nano and food samples	K3
CLO3	Analyze the methods for identifying the quality of environmental, nano and food samples	K4
CLO4	Justify the application of environmental, nano and food biotechnology	K5
CLO5	Identify basic experimental design principles in preparation of environmental, nano and food products	K6

Mapping with Programme Learning Outcomes

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	S	S	M	M	L
CLO2	S	S	M	M	M
CLO3	S	S	S	S	S
CLO4	S	S	S	S	M
CLO5	S	S	S	S	S

S- Strong M-Medium; L-Low

MBY23P4 ENVIRONMENTAL, NANO AND FOOD BIOTECHNOLOGY PRACTICAL

ENVIRONMENTAL BIOTECHNOLOGY

1. Water quality testing:
 - a) pH b) Turbidity c) TDS d) Residual chlorine e) Hardness f) free CO₂
2. MPN method of water analysis
3. Estimation of biological oxygen demand in water/sewage samples
4. Determination of optimum concentration of coagulant in water using Jar test.
5. Preparation of Biofertilizer

NANO BIOTECHNOLOGY

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. Preparation of Nano emulsion using magnetic stirrer and Ultra sonicator
5. Determination of surface plasmon resonance using UV-visible spectroscopy
6. Photocatalysis of dye by Nanoparticles
7. Determination of average size and charge of nanoparticles using Particle Size Analyzer (Demo)

FOOD BIOTECHNOLOGY

1. Detection of Food adulteration
2. Determination of moisture content from food sample
3. Application of enzymes in Fruit processing
4. Determination of peroxide value of oil
5. Determination of ascorbic acid content from fruits
6. Microbiological analysis of food
7. Detection of pesticides using HPLC method (Demo)

TEXT BOOKS

S.No	Authors	Title of the Book	Publishers	Year and Edition
1.	Hauser, B	Drinking water chemistry: a laboratory manual.	CRC Press	2018 & 1 st Edition
2.	Poinern, G.E.J	A Laboratory Course in Nanoscience and Nanotechnology	CRC Press	2014 & 1 st Edition
3	Nielsen, S.S	Food analysis laboratory manual	New York, NY, USA: Kluwer Academic/Plenum Publishers.	2024 & 4 th Edition

REFERENCE BOOKS

S. No	Authors	Title of the Book	Publishers	Year and Edition
1.	Winkelmann, Kurt	Practical Aspects of Creating an Interdisciplinary Nanotechnology Laboratory Course for Freshmen	Journal of Nano Education 1.1	2009
2.	Patra, J.K., Das, G., Das, S.K. and Thatoi, H	A Practical Guide to Environmental Biotechnology	Springer	2020 1 st Edition
3.	Pomeranz & Meloan	Food analysis: theory and practice.	Springer Science & Business Media.	2018 4 th Edition

Course Designer:

Dr. V. Bhuvaneshwari

COURSE NO	COURSE NAME	CATEGORY	L	T	P	CREDITS
MBY23S1	RESEARCH METHODOLOGY	THEORY	45	-	-	3

Learning Objectives

To facilitate the students to

- Gain the skill in selecting appropriate research project, design of experiments, methods, and techniques that align with the research objectives.
- To understand the concepts in Bioethics
- To examine the biosafety and risk assessment of products derived from recombinant DNA research
- To distinguish National and International biosafety regulations.
- To justify the concept of research ethics and responsible conduct in research

Course Learning Outcomes

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

CLO Number	CLO Statement	Knowledge Level
CLO1	Summarize the components of a research review, report and manuscript.	K5
CLO2	Understand the Concepts in Bioethics	K3
CLO3	Examine the biosafety and risk assessment of products derived from recombinant DNA research	K4
CLO4	Distinguish National and International biosafety regulations.	K2
CLO5	Justify the concept of research ethics.	K6

Mapping with Programme Learning Outcomes

CLOs	PLO1	PLO 2	PLO 3	PLO 4	PLO 5
CLO1	S	S	S	S	S
CLO2	S	S	S	S	M
CLO3	S	S	S	S	S
CLO4	S	S	M	S	M
CLO5	S	S	M	S	S

M-Medium S- Strong

MBY23S1- RESEARCH METHODOLOGY

UNIT I: Introduction to Research

(9 hrs)

Definition, Basic and Applied research, Interdisciplinary research. Literature Review – Research reading, Discriminative reading, consulting source material, Reference cards. Primary and Secondary literature. Literature citation, Components of a research report, Use of tables and figures, Preparation of photographs and microphotographs, Formatting and requirements for manuscript preparation, Biological abstract, Review, Monographs, Peer reviewed journals, Plagiarism software, e-resources, Digital library, Electronic research tools, Bibliography software. Internet - Worldwide Web - Search Engines - their functions. Boolean searching - File formats.

UNIT II: Bioethics

(9 hrs)

Introduction, ethical conflicts in biological sciences - interference with nature. Bioethics in health care - patient confidentiality, informed consent, euthanasia, artificial reproductive technologies, prenatal diagnosis, genetic screening, gene therapy, transplantation. Bioethics in research – cloning and stem cell research, Human and animal experimentation, animal rights/welfare, Agricultural biotechnology - Genetically engineered food, environmental risk, labeling and public opinion. Sharing benefits and protecting future generations - Protection of environment and biodiversity – biopiracy

UNIT III: Biosafety

(9 hrs)

Biosafety and Biosecurity - introduction; historical background; primary containment for biohazards, GRAS organisms, Definition of GMOs & LMOs, principles of safety assessment of transgenic plants – sequential steps in risk assessment. Environmental risk assessment and food and feed safety assessment, risk assessment of transgenic crops Vs cisgenic plants or products derived from RNAi, genome editing tools.

UNIT IV: National & International biosafety regulations

(9 hrs)

International regulations – Cartagena protocol, OECD consensus documents and Codex Alimentarius, Indian regulations – EPA act and rules, guidance documents, regulatory framework – RCGM, GEAC, IBSC and other regulatory bodies; Draft bill of Biotechnology Regulatory authority of India - containments – Biosafety levels and category of rDNA experiments; field trials –biosafety research trials – standard operating procedures - guidelines of state governments; GM labeling – Food Safety and Standards Authority of India (FSSAI).

UNIT V: Research Ethics and Responsible Conduct in Research

(9 hrs)

Brief history and analytical basis of research ethics, responsible conduct in research (Honesty in Science: Integrity, Authorship, Conflicts of Interest, Privacy and Confidentiality, Informed Consent, Risk/Benefit Assessment), The legal regulation of research ethics in India (From UGC, MHRD and other governing agencies), Regulatory requirements relevant to international research.

TEXT BOOKS

S.No	Authors	Title of the Book	Publishers	Year and Editon
1.	Sibi, G.	Intellectual property rights, Bioethics, Biosafety and Entrepreneurship in Biotechnology.	Wiley India Pvt Ltd	2021 1 st Edition
2.	Uzochukwu, S.	Biosafety and Bioethics in Biotechnology.	Taylor and Francis Ltd, UK	2022 1 st Edition
3.	Gurumani, N.	Research Methodology: for Biological Science	MJP Publishers, India	2019 1 st Edition

REFERENCE BOOKS

S.No	Authors	Title of the Book	Publishers	Year and Edition
1.	Campbell, A.V.	Bioethics -The basics.	Routledge	2018 2 nd Edition
2.	John W. Creswell, J. David Creswell	Research Design: Qualitative, Quantitative, and Mixed Methods Approaches	SAGE Publications	2018 5 th Edition

Course Designer:

Dr. V. Bhuvaneshwari

MASTER OF SCIENCE IN BIOTECHNOLOGY
CHOICE BASED CREDIT SYSTEM (CBCS) & LEARNING OUTCOME BASED CURRICULAR
FRAMEWORK (LOCF)

SYLLABUS & SCHEME OF EXAMINATION
MASTER OF SCIENCE IN BIOTECHNOLOGY- 2024-2026 BATCH

Semester	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	MBY2410	Plant Biotechnology	CC	4	58	2	3	25	75	100	4
	MBY2311	Bioprocess Technology	CC	4	58	2	3	25	75	100	4
	MBY2312	Genetic Engineering and Omics concept	CC	4	58	2	3	25	75	100	4
	MBY2313/ MBY2314	Elective II – Marine Biotechnology/ Lead Molecule Discovery and Preclinical Development	DSE	3	43	2	3	25	75	100	3
	MBY23P5	Plant Biotechnology & Genetic Engineering and Omics concept Practical	CC	5	75	-	6	25	75	100	4
	MBY23P6	Bioprocess technology and Marine Biotechnology Practical	CC	5	75	-	6	25	75	100	4
III	MBY23S1	Research Methodology	CC	3	45	-	3	-	100	100	3
	MNM22CS2	Cyber Security II	AECC	2	30	-	-	100	-	100	Gr .
	MBY24COM	Comprehensive Examination	GC	-			2	100	-	100	Gr .
	MBY23IST	Summer Internship	DSE	Minimum one month						50	Gr .
I-III	17MONL1	Online Courses #	ACC	-						-	-

CC: Core Courses

AECC: Ability Enhancement Compulsory Course

ACC: Additional Credit Courses

ESE - End Semester Examination

#Students completing online course through NPTEL, Swayam will get Extra credit of 1, For others completed status will be given

DSE: Discipline Specific Elective

GC: General Course

CA – Continuous Assessment

#: Self study

COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	CREDITS
MBY2410	PLANT BIOTECHNOLOGY	THEORY	58	2	-	4

Preamble

- To learn about the principles of molecular biology and genetics, as they apply to plants.
- To introduce the techniques of plant tissue culture, including micropropagation, somatic embryogenesis, and plant regeneration.
- To introduce students to genetic transformation techniques for trait improvement in crops.
- To explore the ethical, social, and environmental implications of plant biotechnology.

Course Learning Outcomes

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

CLO Number	CLO Statement	Knowledge Level
CLO1	Explain conventional and molecular-assisted breeding techniques in plant biotechnology	K2
CLO2	Demonstrate techniques in plant tissue culture, including media preparation and aseptic handling.	K3
CLO3	Analyze in vitro culture methods and gene transformation techniques for crop improvement.	K4
CLO4	Evaluate the role of secondary metabolites in pharmaceutical and biofuel industries	K5
CLO5	Design strategies for developing transgenic plants with enhanced traits.	K6

Mapping with Programme Learning Outcomes

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	S	S	M	M	M
CLO2	S	S	S	S	M
CLO3	S	S	M	M	M
CLO4	S	S	M	M	S
CLO5	S	M	S	S	M

S- Strong; M-Medium;

MBY2410 - PLANT BIOTECHNOLOGY (58 hrs)

Unit I Conventional Breeding and Molecular Assisted Breeding (12 hrs)

Introduction to Plant Breeding: Overview and significance. Conventional Breeding Techniques: Selection, hybridization, mutation and polyploidy. DNA fingerprinting – principles and applications in plant genetic diversity, cultivar identification, and marker-assisted selection (excluding forensic applications). Introduction to molecular markers, Types of molecular markers (e.g., SSRs, SNPs, AFLPs) Introduction to mapping of genes /QTLs, Principles and applications of marker-assisted selection. (MAS)

Unit II *In vitro* culture for plants (12 hrs)

Design of Plant tissue culture laboratory. Nutritional requirements of plant tissue culture. Composition of MS media, Gamborgs media, Nitch's media, Whites media and their preparation. Plant growth regulators. Sterilization techniques. In Vitro Culture Techniques: Micropropagation, Hairy root culture, Cell suspension culture, Callus culture, Organogenesis, somatic embryogenesis, suspension culture, embryo culture, haploid culture, protoplast culture and fusion; Somaclonal variation; Artificial seeds: Acclimatization of Tissue Culture Plants: Greenhouse conditions, hardening, and adaptation strategies. Quality Control in Micropropagation: Virus indexing and genetic fidelity of micro propagated crops.

Unit III Gene Transfer Methods (12 hrs)

Agrobacterium mediated gene transfer, Agrobacterium based vectors (Ti plasmids and Ri plasmids), viral vectors and their applications. **Direct gene transfer methods** - electroporation, microinjection and particle bombardment. Characterization of transgenics, screenable and selectable markers. Marker free methodologies: Cre-lox, recombinase-mediated cassette exchange, and gene targeting strategies: Homologous recombination and site-specific integration (CRISPR, TALENs and ZFNs).

Unit IV Secondary metabolites in plants (11 hrs)

Industrial phytochemical products from plants - Alkaloids, Biodegradable Plastics, Therapeutic proteins, antibodies, plant vaccines, herbal drugs, bioethanol and biodiesel. Metabolic engineering, **Production and processes for enhancing secondary metabolites from cell suspension cultures**. Elicitor, Precursor treatment for production, product recovery, scaleup process and products.

Unit V Application of gene transformation in plants (11 hrs)

Molecular basis of host-pathogen interaction in plants, Resistance Traits in Transgenic Plants: Insect Resistance, Fungal Resistance, Viral Resistance. **Abiotic Stress Tolerance**: Drought, cold, and salt resistance mechanisms. **Nutritional and Functional Enhancements**: Biofortification, Gene Silencing in Crops, **Reproductive and Growth Modifications**: Terminator Seed Technology, Male Sterility Systems, Heat Shock Proteins (HSPs). **Biopharmaceutical and Industrial Applications**: Production of Therapeutic Antibodies (plant-made pharmaceuticals). Edible Vaccines: Enhanced Shelf Life of Fruits and Flowers. Nitrogen Fixation. Biosafety of Transgenic Plants

TEXT BOOKS

S.No.	Authors	Title of the Book	Publishers	Year & Edn
1.	Chawla, H.S.	Introduction to Plant Biotechnology	CRC Press, Florida, United States.	2018 & 3 rd Edn
2.	Glick, B.R. & Patten,C.L.	Molecular Biotechnology	Taylor & Francis Publishers, bingdon, United Kingdom. (5 th Edn)	2017 & 5 th Edn
3.	Jason Angstrom	Principles of Plant Biotechnology	Callisto Reference. (1 st Edn)	2019 & 1 st Edn

REFERENCE BOOKS

S.No.	Authors	Title of the Book	Publishers	Year & Edn
1	Ranzoni, M and Cvejic, A	Single-cell biology: resolving biological complexity, one cell at a time.	The Company of Biologists	2018
2	Primrose, B. and Twyman, R. M.	Principles of Gene Manipulation and Genomics	John Wiley and Sons Ltd, United Kingdom	2016 & 8 th Edn
3	P.S. Srivastava, Alka Narula, Sheela Srivastava	Plant Biotechnology and Molecular Markers	Springer Dordrecht	2005

Course Designer:

Mrs. R Kiruba

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

S.No	TOPIC	Links
Unit I Conventional Breeding and Molecular Assisted Breeding		
1	Introduction to mapping of genes /QTLs	https://www.youtube.com/watch?v=JN0B6AeAsZY https://www.youtube.com/watch?v=17NtnnFsqs https://www.youtube.com/watch?v=14wBGrGaa4A https://www.youtube.com/watch?v=gcc88urP9xI
Unit II <i>In vitro</i> culture for plants		
2	Protoplast culture and fusion	https://www.youtube.com/watch?v=QZ9S5HvfpmA https://www.youtube.com/watch?v=O4VHRGFWIzk
3.	Somaclonal variation	https://www.youtube.com/watch?v=3ldYQRmuqtE https://www.youtube.com/watch?v=JvaPueOWprs
4.	Green house conditions,	https://www.youtube.com/watch?v=BpaZjnQnLcM https://www.youtube.com/watch?v=QnSZBO7zhIE https://www.youtube.com/watch?v=eQSNKrigiOM&t=15s
Unit III Gene Transfer Methods		
5	Agrobacterium mediated gene transfer	https://www.youtube.com/watch?v=1GF-T3TRcHc https://www.youtube.com/watch?v=NXNFR4cj68U
6	Direct gene transfer methods	https://www.youtube.com/watch?v=MVK6AEOX_dQ
7	Introduction to gene editing (CRISPR, TALENs and ZFNs)	https://www.youtube.com/watch?v=2pp17E4E-O8&t=208s https://www.youtube.com/watch?v=JArlDYv0Qw4 https://www.youtube.com/watch?v=YkVVkzA7QpA&t=348s
Unit IV Secondary metabolites in plants		
8	Industrial phytochemical products from plants	https://www.youtube.com/watch?v=AYIE039NAH0 https://www.youtube.com/watch?v=vBxDnojqkxA https://www.youtube.com/watch?v=1YbDwKSPTKA
9	Production and processes for enhancing secondary metabolites from cell suspension cultures	https://www.youtube.com/watch?v=nqucidxRolM https://www.youtube.com/watch?v=aOlUNSiT0Qk
Unit V Application of gene transformation in plants		
10	Insect resistance	https://www.youtube.com/watch?v=1eulFA4Oj60 https://www.youtube.com/watch?v=Bzhro2AyKs0
11	virus resistance	https://www.youtube.com/watch?v=B82UmkOAgd8 https://www.youtube.com/watch?v=Nj9ZQhbX0tI

Module No.	Topic	CLO level	No. of periods	Content delivery method	Learning methods
Unit – I Conventional Breeding and Molecular Assisted Breeding					
1.	Introduction to Plant Breeding: Overview and significance	CLO1	1	Lecture – Chalk and Talk	Participatory Learning
2.	Conventional Breeding Techniques: Selection, hybridization, mutation and polyploidy	CLO1	1	Brainstorming	Problem-based Learning
3.	Cont. Conventional Breeding Techniques: Selection, hybridization, mutation and polyploidy	CLO1	1	PPT	Experiential Learning
4.	DNA fingerprinting – principles and applications in plant genetic diversity, cultivar identification,	CLO1	1	Chalk and talk/ Picture	Participatory Learning
5.	DNA fingerprinting – principles and applications in plant genetic diversity, cultivar identification,	CLO1	1	Picture	Experiential Learning
6.	and marker-assisted selection (excluding forensic applications).	CLO1, CLO2	1	Lecture – Chalk and Talk	Problem-based Learning
7.	Introduction to molecular markers	CLO1, CLO2	1	Research paper presentation	Problem-based Learning
8.	Types of molecular markers (e.g., SSRs, SNPs, AFLPs)	CLO1, CLO2	1	PPT	Problem-based Learning
9.	Cont. Types of molecular markers (e.g., SSRs, SNPs, AFLPs)	CLO1, CLO2	1	Lecture – Chalk and Talk	Experiential Learning
10.	Cont. Types of molecular markers (e.g., SSRs, SNPs, AFLPs)	CLO1, CLO2	1	Picture	Participatory Learning
11.	Introduction to mapping of genes /QTLs	CLO1, CLO2	1	Video	Problem-based Learning
12.	Principles of marker-assisted selection	CLO1, CLO2	1	Research paper presentation	Problem-based Learning
Unit II <i>In vitro</i> culture for plants					
13.	Design of Plant tissue culture laboratory	CLO2, CLO3	1	Brainstorming	Problem-based Learning
14.	Nutritional requirements of plant tissue culture	CLO2, CLO3	1	PPT	Participatory Learning
15.	Composition of MS media, Gamborgs media, Nitch's media, Whites media	CLO2, CLO3	1	Lecture – Chalk and Talk	Experiential Learning

	and their preparation				
16.	Plant growth regulators.	CLO2, CLO3	1	PPT	Problem-based Learning
17.	Sterilization techniques	CLO2, CLO3	1	Virtual lab	Problem-based Learning
18.	In Vitro Culture Techniques: Micropropagation, Hairy root culture, Cell suspension culture	CLO2, CLO3	1	Lecture – Chalk and Talk	Participatory Learning
19.	Callus culture, Organogenesis, somatic embryogenesis	CLO2, CLO3	1	Picture	Participatory Learning
20.	suspension culture, embryo culture, haploid culture	CLO2, CLO3	1	Picture	Problem-based Learning
21.	protoplast culture and fusion;	CLO2, CLO3	1	Video	Problem-based Learning
22.	Somaclonal variation; Artificial seeds	CLO2, CLO3	1	Video	Participatory Learning
23.	Acclimatization of Tissue Culture Plants: Green house conditions,	CLO2, CLO3	1	Virtual lab	Problem-based Learning
24.	hardening, Virus indexing and genetic fidelity of micro propagated crops	CLO2, CLO3	1	Lecture – Chalk and Talk	Problem-based Learning
Unit III Gene Transfer Methods					
25.	Agrobacterium mediated gene transfer	CLO2, CLO3	1	Displays	Experiential Learning
26.	Agrobacterium based vectors (Ti plasmids and Ri plasmids)	CLO2, CLO3	1	Lecture PPT	Participatory Learning
27.	viral vectors and their applications	CLO2, CLO3	1	Lecture PPT	Participatory Learning
28.	Direct gene transfer methods – electroporation	CLO2, CLO3, CLO4	1	Virtual lab	Problem-based Learning
29.	Electroporation microinjection and	CLO2, CLO3, CLO4	1	Chalk and talk/ Picture	Problem-based Learning
30.	particle bombardment	CLO2, CLO3, CLO4	1	Lecture/ Virtual lab	Experiential Learning
31.	Characterization of transgenics	CLO2, CLO3, CLO4	1	Lecture – Chalk and Talk	Experiential Learning

32.	screenable and selectable markers	CLO2, CLO3, CLO4	1	Displays	Experiential Learning
33.	Marker free methodologies and gene targeting	CLO2, CLO3, CLO4	1	Research article reading	Problem-based Learning
34.	Cre-lox, recombinase-mediated cassette exchange, and gene targeting strategies:	CLO2, CLO3, CLO4	1	Displays	Experiential Learning
35.	Cre-lox, recombinase-mediated cassette exchange, and gene targeting strategies:	CLO2, CLO3, CLO4	1	Research paper presentation	Problem-based Learning
36.	Homologous recombination and site-specific integration (CRISPR, TALENs and ZFNs).	CLO2, CLO3, CLO4	1	Chalk and talk/ Picture	Participatory Learning
Unit IV Secondary metabolites in plants					
37.	Industrial phytochemical products from plants-	CLO2, CLO3, CLO4	1	Displays	Experiential Learning
38.	Cont. Industrial phytochemical products from plants	CLO2, CLO3, CLO4	1	Lecture PPT	Participatory Learning
39.	Alkaloids, Biodegradable Plastics	CLO3, CLO4	1	Lecture PPT	Participatory Learning
40.	Therapeutic proteins, antibodies	CLO3, CLO4	1	Seminar / PPT	Participatory Learning
41.	plant vaccines, herbal drugs	CLO3, CLO4	1	Chalk and talk/ Picture	Problem-based Learning
42.	bioethanol and biodiesel	CLO3, CLO4	1	Seminar / PPT	Participatory Learning
43.	Metabolic engineering	CLO3, CLO4	1	Lecture – Chalk and Talk	Experiential Learning
44.	Production and processes for enhancing secondary metabolites from cell suspension cultures	CLO3, CLO4	1	Displays	Experiential Learning
45.	Cont. Production and processes for enhancing secondary metabolites from cell suspension cultures	CLO3, CLO4	1	Research article reading	Problem-based Learning
46.	Elicitor, Precursor treatment for production, product recovery, scaleup process and products	CLO3, CLO4	1	Lecture PPT	Participatory Learning

47.	Cont. Elicitor, Precursor treatment for production, product recovery, scaleup process and products	CLO3, CLO4	1	Lecture PPT	Problem-based Learning
Unit V Application of gene transformation in plants					
48.	Molecular basis of host-pathogen interaction in plants	CLO3, CLO4, CLO5		Research article reading	Problem-based Learning
49.	Resistance Traits in Transgenic Plants: Insect resistance, fungus resistance	CLO3, CLO4, CLO5	1	Video / Observation	Experiential Learning
50.	virus resistance	CLO3, CLO4, CLO5	1	Video	Participatory Learning
51.	Abiotic Stress Tolerance: drought, cold resistance, salt resistance mechanisms.	CLO3, CLO4, CLO5	1	Displays	Experiential Learning
52.	Nutritional and Functional Enhancements: Biofortification, Gene Silencing in Crops	CLO3, CLO4, CLO5	1	Lecture/ Virtual lab	Experiential Learning
53.	Nutritional and Functional Enhancements: Biofortification, Gene Silencing in Crops	CLO3, CLO4, CLO5	1	Lecture PPT	Participatory Learning
54.	Reproductive and Growth Modifications: Terminator seed technology	CLO3, CLO4, CLO5	1	PPT	Problem-based Learning
55.	Reproductive and Growth Modifications: Terminator seed technology	CLO4, CLO5	1	Lecture – Chalk and Talk	Experiential Learning
56.	Male Sterility Systems, Heat Shock Proteins (HSPs).	CLO4, CLO5	1	Chalk and talk/ Picture	Experiential Learning
57.	Biopharmaceutical and Industrial Applications: Production of Therapeutic Antibodies (plant-made pharmaceuticals).	CLO4, CLO5	1	Lecture	Problem-based Learning
58.	Edible Vaccines: Enhanced Shelf Life of Fruits and Flowers. Nitrogen Fixation. Biosafety of Transgenic Plants	CLO4, CLO5	1	Lecture – Chalk and Talk	Experiential Learning

Name of the course	MBY2410 Plant Biotechnology
Name of the Faculty	Mrs. R. Kiruba
Participatory Learning	30 %
Experiential Learning	30 %
Problem-based Learning	40 %

COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	CREDITS
MBY2311	BIOPROCESS TECHNOLOGY	THEORY	58	2	-	4

Preamble

- To learn the techniques of optimizing the conversion of renewable biomass into usable energy sources.
- To study the efficient and scalable processes for the production of high-quality pharmaceutical products.
- To acquire the knowledge about efficient production of enzymes with desired properties, such as high activity and stability.

Course Learning Outcomes

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

CLO Number	CLO Statement	Knowledge Level
CLO1	Explain factors influencing enhancement of microbial cell growth and product formation in fermentation.	K2
CLO2	Analyze cell and product kinetics in batch, continuous, and fed-batch fermentation systems.	K3
CLO3	Summarize rheological properties and changes during fermentation.	K4
CLO4	Evaluate scale-up strategies from lab-scale to bench-top fermentation systems	K5
CLO5	Formulate approaches integrating bioprocess simulation and economic evaluation for biomanufacturing.	K6

Mapping with Programme Learning Outcomes

CLOs	PLO1	PLO 2	PLO 3	PLO 4	PLO 5
CLO1	S	S	S	S	S
CLO2	S	S	S	S	M
CLO3	S	M	M	S	S
CLO4	S	M	M	S	M
CLO5	S	M	M	S	S

S-Strong M-Medium

MBY2311 - BIOPROCESS TECHNOLOGY (58 hrs)

Unit I Introduction to Bioprocess technology (11 hrs)

History and Scope of Bioprocess Technology: Isolation and screening of industrially important strains- primary and secondary screening. Strain improvement, mutation, selection of mutant and transformation processes. Significance and Types of Microbial biomass, microbial enzymes, **recombinant products**.

Unit II Bioreactor types and upstream essentials (12 hrs)

Bioreactors: Introduction to bioreactors - Aerobic and anaerobic fermentation; solid state and submerged fermentation; **Types of Bioreactors**: Batch, continuous and fed-batch (variants), Specialized bioreactors (fluidized bioreactors, photo bioreactors, **immobilized cell reactors**, airlift bioreactor, **packed bed bioreactor**); Gas fermentation. **Design and construction of Bioreactors**: Monitoring and control of bioreactor: Online and offline control, controlling systems: Temperature, flow rate, pressure, pH.

Unit III Upstream process (12 hrs)

Media formulation – sterilization – Air and media sterilization. Microbial kinetics: **batch, fed- batch** and continuous cultures, phases of batch growth. Kinetics of cell growth - Kinetics of mass and heat transfer. Product formation, **substrate utilization**, product inhibition kinetics, yield concept and productivity.

Unit IV Downstream processing (12 hrs)

Introduction, Cell distribution methods for intracellular products: foam separation, precipitation. Filtration – micro and ultrafiltration, Solvent extraction, **Chromatographic separation - FPLC, HPLC, Gel-filtration chromatography**, dialysis, centrifugation, distillation, drying, crystallization. Turbidity analysis and cell yield determination.

Unit V Microbial products in pharmaceutical, food and agriculture industry (11 hrs)

Whole cell immobilization, Protein immobilization and their industrial application. **Industrial production of chemicals: Alcohol, Acids (citric acid), Solvents (glycerol), Antibiotics (streptomycin), Amino acids (Lysine), Single cell protein**, Use of microbes in mineral beneficiation and oil recovery, Bioconversion to food waste to useful products. Bacteriocins from lactic acid bacteria –production and applications in food preservation. Fermentation products available in market Effective Microorganisms- Dr Bacto's EM Effluent treatment plants (ETP), NEMIX® C.

TEXT BOOKS

S.No.	Authors	Title of the Book	Publishers	Year & Edn
1.	Clemens Posten	Integrated Bioprocess Engineering	De Gruyter	2018 & 1 st Edn
2.	Michael L.Shuler, Fikret Kargi,MatthewDeLisa	Bioprocess Engineering: Basic Concepts	Pearson	2017 & 3rd Edn

REFERENCE BOOKS

S.No.	Authors	Title of the Book	Publishers	Year & Edn
1.	Bailey, J.S. &Ollis, D.F.	Biochemical Engineering Fundamentals.	McGraw - Hill, UK.	2017 & 2 nd Edn
2.	Panchal, C. J.	Yeast Strain Selection.	CRC Press, USA.	2020 & 1 st Edn
3.	Kalaichelvan. P.T and Arul Pandi, I	Bioprocess Technology	MJP Publishers, India.	2021 & 1 st Edn

Course Designer:

Dr. Archana G

***Link provided for the highlighted content offered in blended mode**

S.No	TOPIC	LINKS
Unit I: Introduction to Bioprocess technology		
1	Recombinant products.	https://youtu.be/Av_-ys-LK2o?si=vVXFyhLjLgWT8Rp6
Unit II: Bioreactor types and upstream essentials		
2	Types of Bioreactors	https://youtu.be/fQOzHC828aM?si=coYVRrwZQ1oG62ja
3	Immobilized cell reactors	https://youtu.be/34KnTEf75aM?si=-NyK_nGQ70T2EDcJ
4	Packed bed bioreactor	https://youtu.be/PBXYl_EY5vc?si=jm_hMOs_e-XFCd1K
5	Design and construction of Bioreactors	https://youtu.be/NAhfgJoZV_E?si=WNkedXqkc534tdDf
Unit III: Upstream process		
6	Media formulation	https://youtu.be/_4EtUIcO2Q8?si=YbL_sDGeCZumnPDg
7	Batch, fed- batch	https://youtu.be/mUDXupn2Dhk?si=hT0vwNMREpJjOA2ZD
8	Substrate utilization	https://youtu.be/SLw7yOVogls?si=pOmDcT3emV16EcBF
Unit IV: Downstream processing		
9	Introduction: Cell distribution methods for intracellular products	https://youtu.be/DFe-AyB0vc8?si=JCtjAQIfKbLFvcfG
10	Chromatographic separation - FPLC	https://youtu.be/ohQKaTeAhzQ?si=YWISzmy9i8Egow_T
11	HPLC	https://youtu.be/ZN7euA1fS4Y?si=48wVSp2HTOtDqsuj
12	Gel-filtration chromatography	https://youtu.be/L-xIHihOGKs?si=mT2uRceA2MjR0fwN
Unit V: Microbial products in pharmaceutical, food and agriculture industry		
13	Industrial production of chemicals: Alcohol	https://youtu.be/bKunpGA2r7U?si=uxYUHAZvxcor0TNz
14	Acids (citric acid)	https://youtu.be/od4oeUUFHw?si=KYm3EwoqlSvVnhGZ
15	Solvents (glycerol)	https://youtu.be/pk1W23Mvojo?si=pp4Zl4BdaRbFxDix
16	Antibiotics (streptomycin)	https://youtu.be/30hqY_RKgxA?si=_IAOePSTKfaMkPKD
17	Amino acids (Lysine)	https://youtu.be/7bzwmbnfww0?si=BjFmoBbqfXtCJjcJ
18	Single cell protein	https://youtu.be/Z1EudFO3b6w?si=XJcMD48AdYp4tEwa

Module No.	Topic	CLO level	No. of periods	Content delivery method	Learning methods
Unit I Introduction to Bioprocess technology					
1.	Bioprocess Technology	CLO1	1	Lecture – Chalk and Talk	Participatory Learning
2.	History and scope of bioprocess technology	CLO1	1	Brainstorming	Problem-based Learning
3.	Isolation and screening of industrially important strains	CLO1	1	PPT	Experiential Learning
4.	Strain improvement	CLO1	1	Chalk and talk/ Picture	Participatory Learning
5.	Mutation	CLO1	1	Picture	Participatory Learning
6.	Selection of mutant	CLO1, CLO2	1	Lecture – Chalk and Talk	Problem-based Learning
7.	Transformation processes.	CLO1, CLO2	1	Research paper presentation	Problem-based Learning
8.	Significance of microbial biomass	CLO1, CLO2	1	PPT	Problem-based Learning
9.	Types of microbial biomass	CLO1, CLO2	1	Lecture – Chalk and Talk	Experiential Learning
10.	Microbial enzymes	CLO1, CLO2	1	Picture	Participatory Learning
11.	Recombinant products	CLO1, CLO2	1	Video	Problem-based Learning
Unit II Bioreactor types and upstream essentials					
12.	Bioreactors	CLO2, CLO3	1	Brainstorming	Problem-based Learning
13.	Introduction to bioreactors	CLO2, CLO3	1	PPT	Participatory Learning
14.	Aerobic and anaerobic fermentation	CLO2, CLO3	1	Lecture – Chalk and Talk	Experiential Learning

15.	Solid state and submerged fermentation	CLO2, CLO3	1	PPT	Problem-based Learning
16.	Types of bioreactors	CLO2, CLO3	1	Virtual lab	Problem-based Learning
17.	Batch, continuous and fed-batch (variants)	CLO2, CLO3	1	Lecture – Chalk and Talk	Participatory Learning
18.	Specialized bioreactors	CLO2, CLO3	1	Picture	Participatory Learning
19.	Fluidized bioreactors, photo bioreactors	CLO2, CLO3	1	Picture	Problem-based Learning
20.	Immobilized cell reactors, airlift bioreactor	CLO2, CLO3	1	Video	Problem-based Learning
21.	Packed bed bioreactor; gas fermentation	CLO2, CLO3	1	Video	Participatory Learning
22.	Design and construction of bioreactors: monitoring and control of bioreactor	CLO2, CLO3	1	Virtual lab	Problem-based Learning
23.	Online and offline control, controlling systems: temperature, flow rate, pressure, pH.	CLO2, CLO3	1	Lecture – Chalk and Talk	Problem-based Learning
Unit III Upstream process					
24.	Media formulation	CLO2, CLO3	1	Displays	Experiential Learning
25.	Sterilization – air and media sterilization	CLO2, CLO3	1	Lecture PPT	Participatory Learning
26.	Microbial kinetics	CLO2, CLO3	1	Lecture PPT	Participatory Learning
27.	Batch, fed- batch	CLO2, CLO3, CLO4	1	Virtual lab	Problem-based Learning

28.	Continuous cultures	CLO2, CLO3, CLO4	1	Chalk and talk/ Picture	Experiential Learning
29.	Phases of batch growth	CLO2, CLO3, CLO4	1	Lecture/ Virtual lab	Experiential Learning
30.	Kinetics of cell growth	CLO2, CLO3, CLO4	1	Lecture – Chalk and Talk	Experiential Learning
31.	Kinetics of mass and heat transfer	CLO2, CLO3, CLO4	1	Displays	Experiential Learning
32.	Product formation	CLO2, CLO3, CLO4	1	Research article reading	Problem-based Learning
33.	Substrate utilization	CLO2, CLO3, CLO4	1	Displays	Experiential Learning
34.	Product inhibition kinetics	CLO2, CLO3, CLO4	1	Research paper presentation	Problem-based Learning
35.	Yield concept and productivity	CLO2, CLO3, CLO4	1	Chalk and talk/ Picture	Participatory Learning
Unit IV Downstream processing					
36.	Downstream processing	CLO2, CLO3, CLO4	1	Displays	Experiential Learning
37.	Introduction	CLO2, CLO3, CLO4	1	Lecture PPT	Participatory Learning
38.	Cell distribution methods for intracellular products	CLO3, CLO4	1	Lecture PPT	Participatory Learning
39.	Foam separation	CLO3, CLO4	1	Seminar / PPT	Participatory Learning
40.	Precipitation	CLO3, CLO4	1	Chalk and talk/ Picture	Problem-based Learning
41.	Filtration – micro and ultrafiltration	CLO3, CLO4	1	Seminar / PPT	Participatory Learning

42.	Solvent extraction	CLO3, CLO4	1	Lecture – Chalk and Talk	Experiential Learning
43.	Chromatographic separation - fplc, hplc, gel-filtration chromatography	CLO3, CLO4	1	Displays	Experiential Learning
44.	Dialysis, centrifugation, distillation, drying	CLO3, CLO4	1	Research article reading	Problem-based Learning
45.	Crystallization	CLO3, CLO4	1	Lecture PPT	Problem-based Learning
46.	Turbidity analysis	CLO3, CLO4	1	Lecture PPT	Problem-based Learning
47.	Cell yield determination	CLO3, CLO4	1	Lecture PPT	Problem-based Learning
Unit V Microbial products in pharmaceutical, food and agriculture industry					
48.	Whole cell immobilization, protein immobilization and their industrial application	CLO3, CLO4, CLO5	1	Research article reading	Problem-based Learning
49.	Industrial production of chemicals	CLO3, CLO4, CLO5	1	Video / Observation	Experiential Learning
50.	Alcohol, acids (citric acid), solvents (glycerol)	CLO3, CLO4, CLO5	1	Video	Participatory Learning
51.	Antibiotics (streptomycin), amino acids (lysine), single cell protein	CLO3, CLO4, CLO5	1	Displays	Experiential Learning
52.	Use of microbes in mineral beneficiation and oil recovery	CLO3, CLO4, CLO5	1	Lecture/ Virtual lab	Experiential Learning

53.	Bioconversion to food waste to useful products	CLO3, CLO4, CLO5	1	Lecture PPT	Participatory Learning
54.	Bacteriocins from lactic acid bacteria	CLO3, CLO4, CLO5	1	PPT	Problem-based Learning
55.	Production and applications in food preservation.	CLO4, CLO5	1	Lecture – Chalk and Talk	Experiential Learning
56.	Fermentation products	CLO4, CLO5	1	Chalk and talk/ Picture	Experiential Learning
57.	Fermentation products available in market effective microorganisms	CLO4, CLO5	1	Lecture	Problem-based Learning
58.	Dr Bacto's em effluent treatment plants (ETP) nemix® c	CLO4, CLO5	1	Lecture – Chalk and Talk	Experiential Learning

Name of the course	MBY2311 Bioprocess Technology
Name of the Faculty	Dr. K. Sabariswaran
Participatory Learning	30 %
Experiential Learning	30 %
Problem-based Learning	40 %

COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	CREDITS
MBY2312	GENETIC ENGINEERING AND OMICS CONCEPT	THEORY	58	2	-	4

Preamble

- To gain knowledge of vectors used for gene delivery.
- To understand the principles and applications of real-time PCR and quantitative PCR,
- To learn cloning strategies and methods for creating gene libraries.
- To explore the applications of functional proteomics in areas like drug discovery, biomarker identification, and understanding disease processes.

Course Learning Outcomes

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

CLO Number	CLO Statement	Knowledge Level
CLO1	Describe essential tools and prerequisites for conducting genetic engineering experiments	K2
CLO2	Compare vector systems and cloning techniques used in genetic manipulation.	K3
CLO3	Distinguish gene amplification and sequencing techniques for molecular screening.	K4
CLO4	Examine omics approaches for studying gene expression at the genomic, transcriptomic, and proteomic level	K5
CLO5	Justify the application of omics technologies for societal and biomedical advancement.	K6

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	M	M	S	S
CLO5	S	M	M	S	S

S- Strong; M-Medium

MBY2312 - GENETIC ENGINEERING AND OMICS CONCEPT (58 hrs)

Unit I Tools for Genetic engineering (11 hrs)

General requirements for performing a genetic engineering experiment. Restriction endonucleases and Methylases, DNA ligase, Klenow enzyme, DNA polymerases, Polynucleotide kinase, Alkaline phosphatase. Cohesive and blunt end ligation, linkers, adaptors, homopolymeric tailing. Labeling of DNA: Nick translation, Random priming, Radioactive and Non-radioactive probes. Protein tags: His, GST, CBP, MBP, Myc, FLAG and GFP tags. ***Hybridization techniques: Northern, Southern, Western, and Colony hybridization, Fluorescence *in situ* hybridization.**

Unit II Vector system and amplification techniques (12 hrs)

Plasmids-pUC19, Bacteriophages-M13 vectors, Lambda vectors, Insertion and Replacement vectors, Phagemids- pBluescript vectors, Cosmids-pJB8, Artificial chromosome vectors (YACs, BACs). Expression vectors: pMal, pET-based vectors. Intein-based vectors. Baculovirus vector and Pichia vector system, yeast vectors, and shuttle vectors. ***Types of PCR – Multiplex, Nested; Reverse-transcription PCR, Real time PCR, Touchdown PCR, Hot start PCR, Colony PCR, and Asymmetric PCR.**

Unit III Gene transfer and library construction (12 hrs)

Insertion of foreign DNA into host cells - Transformation, Electroporation, Transfection. Construction of libraries. Reverse transcriptase and cDNA synthesis, cDNA and Genomic libraries. ***Construction of microarrays – genomic arrays, cDNA arrays and oligo arrays.** Study of protein-DNA interactions: electrophoretic mobility shift assay, CHIP-Assay, DNase footprinting, methyl interference assay, yeast one-hybrid system, phage display.

Unit IV Omics approaches (12 hrs)

DNA Sequencing: Sanger sequencing, Maxam Gilbert, ***Whole genome sequencing, Genome-wide association studies (GWAS), 454, Solexa, Illumina, PacBIO and Oxford Nanopore sequencing.** Introduction to omics and types. Emerging Omics technologies. Clinical application of genomics. Transcriptomics approaches: Single cell transcriptomics, RNA-sequencing. Proteomics technologies: Two-dimensional gel electrophoresis (2D-PAGE), Isoelectric focusing, Two-dimensional fluorescence difference in-gel electrophoresis (DIGE). Tryptic digestion of protein and peptide fingerprinting, post-translational modification analysis using MALDI-TOF Mass spectrometry, LC/MS-MS- Identification of proteins and modified proteins.

Unit V Functional proteomics and Applications (11 hrs)

Protein Sequencing- Edman degradation. ***Protein-protein interactions using Yeast two hybrid systems. Protein microarray-Types: Antibody arrays, Antigen arrays, Peptide arrays.** Protein expression profiling-SAGE and differential display proteomics. Quantitative proteomics - Stable isotope labeling by amino acids in cell culture (SILAC), Isotope-coded affinity tag (ICAT), Isobaric tagging for relative and absolute quantitation (iTRAQ). Label-free proteomics. Clinical and biomedical applications of Proteomics.

TEXT BOOKS

S.No.	Authors	Title of the Book	Publishers	Year & Edn
1.	Green, M. R., & Sambrook, J.	Molecular Cloning: A Laboratory Manual.	Cold Spring Harbor Laboratory Press, USA.	2012 & 4 th Edn
2.	Brown, T. A.	Gene cloning and DNA Analysis an Introduction	Blackwell Publishers, USA.	2016 & 7 th Edn
3.	Desmond S.T. Nicholl	An introduction to Genetic Engineering	Cambridge University Press, UK	2012 & 3 rd Edn

REFERENCE BOOKS

S.No.	Authors	Title of the Book	Publishers	Year & Edn
1.	Glick, B. R., & Patten, C. L.	Molecular biotechnology: Principles and applications of recombinant DNA.	John Wiley & Sons, UK.	2017 & 5 th Edn
2.	Primrose, S.B., and Twyman, R.	Principles of Gene manipulation and Genomics.	Wiley-Blackwell Publishers, USA	2014 & 7 th Edn
3.	Veenstra, T.D., and Yates, J.R.	Proteomics for Biological discovery	Wiley-Blackwell Publishers, USA	2019 & 2 nd Edn
4.	Rastogi, S., and Pathak, N.	Genetic Engineering (Oxford Higher Education)	Oxford University Press, UK	2009 & 1 st Edn

Course Designer:

Dr R Nirmal Kumar

Dr. V. Bhuvaneshwari

***Link provided for the highlighted content offered in blended mode**

S.No	TOPIC	LINKS
Unit I Tools for genetic engineering		
1	Hybridization techniques: Northern, Southern, Western, and	https://www.youtube.com/watch?v=Pt_NaNExy8
2	Colony hybridization	https://www.youtube.com/watch?v=FtNreXY7poA
3	Fluorescence in situ hybridization	https://www.youtube.com/watch?v=qkLsMOMRlhk&t=8s
Unit II Vector system and amplification techniques		
4	Types of PCR – Multiplex, Nested; Reverse-transcription PCR, Real time PCR, Touchdown PCR, Hot start PCR, Colony PCR, and Asymmetric PCR.	https://www.youtube.com/watch?v=9jz-9w_vtsY
Unit III Gene transfer and library construction		
6	Construction of microarrays – genomic arrays, cDNA arrays and oligo arrays.	https://www.youtube.com/watch?v=HHWA_uwfjBE https://www.youtube.com/watch?v=Hv5flUOsE0s
Unit IV Omics approaches		
9	Whole genome sequencing, Genome-wide association studies (GWAS), 454, Solexa, Illumina, PacBIO and Oxford Nanopore sequencing.	https://www.youtube.com/watch?v=1mByG5rZw1I https://www.youtube.com/watch?v=zst2IHwGZ3U https://www.youtube.com/watch?v=XRkD9nqka4Q https://www.youtube.com/watch?v=--_lMjOPwZ8 https://www.youtube.com/watch?v=TDD6bExnR38 https://www.youtube.com/watch?v=CZ6FPF1cOOc https://www.youtube.com/watch?v=bS3NiFLwPqE
Unit V Functional proteomics and Applications		
13	Protein-protein interactions using Yeast two hybrid systems.	https://www.youtube.com/watch?v=s7qbnxXBS7k
14	Protein microarray-Types: Antibody arrays, Antigen arrays, Peptide arrays.	https://www.youtube.com/watch?v=9TYgNWyENRE https://www.youtube.com/watch?v=inv1Lq3fXAk https://www.youtube.com/watch?v=3FJ-2kqRBbY https://www.youtube.com/watch?v=kYhMZOGmdVU

Module No	Topic	CLO level	No. of periods	Content delivery method	Learning methods
Unit I Tools for Genetic engineering					
1.	General requirements for performing a genetic engineering experiment. Restriction endonucleases and Methylases	CLO1	1	PPT / OER	Participatory Learning
2.	DNA ligase, Klenow enzyme, DNA polymerases,	CLO1	1	Lecture – Chalk and Talk / Group reading	Participatory Learning
3.	Polynucleotide kinase, Alkaline phosphatase.	CLO1	1	Chalk and talk/ Picture	Participatory Learning
4.	Cohesive and blunt end ligation, linkers, adaptors, homopolymeric tailing	CLO1	1	PPT / OER	Participatory Learning
5.	Labeling of DNA: Nick translation, Random priming,	CLO1	1	Chalk and talk/ Picture	Problem-based Learning
6.	Radioactive and Non-radioactive probes.	CLO1	1	Research paper presentation	Problem-based Learning
7.	Protein tags: His, GST, CBP	CLO1	1	OER/PPT	Experiential Learning
8.	MBP, Myc, FLAG and GFP tags.	CLO1	1	OER/PPT	Experiential Learning
9.	Hybridization techniques: Northern, Southern,	CLO1	1	OER/PPT	Experiential Learning
10.	Western, and Colony hybridization	CLO1	1	Book/ Article review	Experiential Learning
11.	Fluorescence in situ hybridization	CLO1	1	Research paper presentation	Experiential Learning
Unit II Vector system and amplification techniques					
12.	Plasmids- pUC19	CLO2	1	Lecture – Chalk and Talk / Group reading	Participatory Learning
13.	Bacteriophages-M13 vectors, Lambda vectors, Insertion and Replacement vectors,	CLO2	1	PPT / OER	Participatory Learning

14.	Phagemids -pBluescript vectors,	CLO2	1	Chalk and talk/ Picture	Participatory Learning
15.	Cosmids-pJB8	CLO2	1	Research paper presentation	Problem-based Learning
16.	Artificial chromosome vectors (YACs, BACs).	CLO2	1	Demonstration	Problem-based Learning
17.	Expression vectors: pMal, pET-based vectors.	CLO2	1	Student Seminar	Problem-based Learning
18.	Intein-based vectors. Baculovirus vector	CLO2	1	Virtual lab	Experiential Learning
19.	Pichia vector system, yeast vectors, and shuttle vectors	CLO2	1	Book/ Article review	Experiential Learning
20.	Types of PCR – Multiplex, Nested	CLO2	1	Virtual lab	Experiential Learning
21.	Reverse-transcription PCR	CLO2	1	Research paper presentation	Problem-based Learning
22.	Real time PCR	CLO2	1	OER/PPT	Problem-based Learning
23.	Touchdown PCR, Hot start PCR, Colony PCR, and Asymmetric PCR.	CLO2	1	Book/ Article review	Problem-based Learning
Unit III Gene transfer and library construction					
24.	Insertion of foreign DNA into host cells	CLO3	1	Lecture – Chalk and Talk / Group reading	Participatory Learning
25.	Transformation, Electroporation, Transfection.	CLO3	1	PPT / OER	Problem-based Learning
26.	Construction of libraries.	CLO3	1	Chalk and talk/ Picture	Problem-based Learning
27.	Reverse transcriptase and cDNA synthesis	CLO3	1	Lecture and Discussion	Experiential Learning
28.	cDNA library.	CLO3	1	Lecture and Discussion	Participatory Learning
29.	Genomic libraries	CLO3	1	PPT / OER	Participatory Learning

30.	Construction of microarrays – genomic arrays	CLO3	1	Virtual lab	Experiential Learning
31.	cDNA arrays	CLO3	1	Chalk and talk/ Picture	Participatory Learning
32.	oligo arrays.	CLO3	1	Research paper presentation	Problem-based Learning
33.	Study of protein-DNA interactions: electrophoretic mobility shift assay	CLO3	1	Research paper presentation	Problem-based Learning
34.	CHIP-Assay, DNase footprinting, methyl interference assay	CLO3	1	Student Seminar	Experiential Learning
35.	yeast one-hybrid system, phage display.	CLO3	1	Demonstration	Experiential Learning
Unit IV Omics approaches					
36.	DNA Sequencing: Sanger sequencing, Maxam Gilbert,	CLO4	1	Lecture – Chalk and Talk / Group reading	Participatory Learning
37.	Whole genome sequencing, Genome wide association studies (GWAS),	CLO4	1	PPT / OER	Participatory Learning
38.	454, Solexa, Illumina, PacBIO and Oxford Nanopore sequencing.	CLO4	1	Chalk and talk/ Picture	Participatory Learning
39.	Introduction to omics and types. Emerging Omics technologies.	CLO4	1	Chalk and talk/ Picture	Participatory Learning
40.	Clinical application of genomics.	CLO4	1	Demonstration	Experiential Learning
41.	Transcriptomics approaches: Single cell transcriptomics,	CLO4	1	Student Seminar	Experiential Learning
42.	RNA-sequencing.	CLO4	1	Book/ Article review	Problem-based Learning
43.	Proteomics technologies: Two-dimensional gel electrophoresis (2D-PAGE), Isoelectric focusing,	CLO4	1	Virtual lab	Problem-based Learning
44.	Two-dimensional fluorescence difference in-gel electrophoresis (DIGE).	CLO4	1	Research paper presentation	Problem-based Learning

45.	Tryptic digestion of protein and peptide fingerprinting,	CLO4	1	Research paper presentation	Problem-based Learning
46.	Post-translational modification analysis using MALDI-TOF Mass spectrometry,	CLO4	1	Field observations	Problem-based Learning
47.	LC/MS-MS- Identification of proteins and modified proteins.	CLO4		Chalk and talk/ Picture	Problem-based Learning
Unit V Functional proteomics and Applications					
48.	Protein Sequencing- Edman degradation.	CLO5	1	Lecture – Chalk and Talk / Group reading	Participatory Learning
49.	Protein-protein interactions using Yeast two hybrid systems.	CLO5	1	Chalk and talk/ Picture	Participatory Learning
50.	Protein microarray-Types: Antibody arrays,	CLO5	1	Video Lecture and Discussion	Problem-based Learning
51.	Antigen arrays.	CLO5	1	Virtual lab	Experiential Learning
52.	Peptide arrays.	CLO5	1	Student Seminar	Experiential Learning
53.	Protein expression profiling- SAGE and differential display proteomics.	CLO5	1	Virtual lab	Experiential Learning
54.	Quantitative proteomics - Stable isotope labeling by amino acids in cell culture (SILAC),	CLO5	1	Book/ Article review	Problem-based Learning
55.	Isotope-coded affinity tag (ICAT),	CLO5	1	Virtual lab	Problem-based Learning
56.	Isobaric tagging for relative and absolute quantitation (iTRAQ).	CLO5	1	Research paper presentation	Problem-based Learning
57.	Label-free proteomics.	CLO5	1	Field observations and observation of renewable organic material	Problem-based Learning
58.	Clinical and biomedical applications of Proteomics	CLO5	1	Research paper presentation	Problem-based Learning

Name of the course	MBY2312- Genetic engineering and omics concept
Name of the Faculty	Mrs. R. Kiruba
Participatory Learning	29.3 %
Experiential Learning	29.3 %
Problem-based Learning	41.4 %

COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	CREDITS
MBY2313	MARINE BIOTECHNOLOGY	THEORY	43	2	-	3

Preamble

- To gain knowledge about Marine Ecosystem and Resources.
- To study the principles of marine microbial diversity.
- To realize the bioactive compounds from Marine sources
- To practice culture of seaweeds and Aquaculture
- To evaluate the Marine biotech products

Course Learning Outcomes

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

CLO Number	CLO Statement	Knowledge Level
CLO1	Assess the structure and dynamics of marine ecosystems and associated resources	K6
CLO2	Explain microbial diversity in marine habitats and their ecological significance.	K2
CLO3	Identify marine bioactive compounds and evaluate their potential applications.	K3
CLO4	Analyze aquaculture methods, seaweed cultivation, and fish genetics tools.	K4
CLO5	Evaluate value-added products from marine organisms and their industrial relevance.	K5

Mapping with Programme Learning Outcomes

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	M	S	S	S	M
CLO2	M	M	S	M	M
CLO3	S	S	M	S	S
CLO4	S	S	S	S	S
CLO5	S	S	S	S	S

S- Strong; M-Medium;

MBY2313 - MARINE BIOTECHNOLOGY (43 hrs)

Unit I Marine Ecosystems

(9 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. Biofouling, Biofilm, ***Antifouling, Anticorrosion**.

Unit II Marine habitats

(8 hrs)

Marine microbial habitats, ***Diversity of Marine microorganisms: Archaea, Bacteria, Cyanobacteria, Algae, Fungi, viruses, viroids and prions**. Specialized microorganisms: Extremophiles: barophiles, thermophiles, psychrophiles, halophiles ***actinomycetes, polyextremophiles, anaerobes**.

Unit III Analytical Techniques in Marine Biotechnology

(9 hrs)

Screening for Secondary metabolites from marine microbes (Bacteria, Fungi, Actinomycetes and marine microalgae). Probiotic bacteria and their importance in aquaculture. Medicinal compounds from flora (Seaweeds, Seagrass and Mangrove) and fauna (Sponges, Sea anemone and Corals)- **marine toxins- antiviral and antimicrobial agents**. Culture aspect-Seaweed (*Kappaphycu salvarezii*). ***Practical works in the sampling collection, cell isolation and purification, preparation of culture media with emphasize on nutrient and environmental requirement for growth or marine microalgae**.

Unit IV Aquaculture and fish genetics

(9 hrs)

Importance of coastal aquaculture; Aqua farms; Design and construction; ***Criteria for selecting cultivable species**; Culture systems and management practices – extensive, semi-intensive and intensive culture practices. Seed production in controlled condition; Types; Design and management of hatchery –induced spawning; Mass production of seeds; feed formulation; ***Artificial insemination - *in vitro* fertilization**. Fish chromosome manipulation in aquaculture- Hybridization- Gynogenesis- Androgenesis- Polyploidy, ***Eyestalk ablation- Transgenesis and Cryopreservation**.

Unit V Marine and fishery by-products

(8 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. Development of novel pharmaceutical drugs like Bryostatin and keyhole limpet hemocyanin (KLH), **bio active chemicals (AMP), enzymes like amylase, protease**.

TEXT BOOKS

S.No	Authors	Title of the book	Publishers	Year & Edn
1	Song Qin, W.E.G. Muller and Edwin L. Cooper.	Marine Biotechnology	Hindawi Publishing Corporation	2011
2	Se-Kwon Kim	Springer Handbook of Marine Biotechnology	Springer Dordrecht Heidelberg London New York	2015
3	Clark, R. B.	Marine Pollution	Oxford University press, New York Inc.	2001

REFERENCE BOOKS

S.No	Authors	Title of the book	Publishers	Year & Edn
1	Le Gal Y., Ulber R. (Series editor: T. Scheper)	Marine Biotechnology, Advances in Biochemical Engineering/Biotechnology	Springer-Verlag Berlin Heidelberg	2005
2	David H. Attaway	Marine Biotechnology, Volume 1, Pharmaceutical and Bioactive Natural Products.	Plenum Publishing Corporation, Newyork, USA	2001
3	Felix,S	Handbook of Marine and Aquaculture Biotechnology.	AGROBIOS INDIA	2010
4	Munn, C.	Marine microbiology: Ecology & applications.	CRC press	2011

Course designers:

Dr. P. Suganya

Dr. V. Bhuvaneshwari

***Link provided for the highlighted content offered in blended mode**

S.No	TOPIC	LINKS
Unit I: Marine Ecosystems		
1	Ocean currents	https://www.youtube.com/watch?v=ygI1B7h2j_0
2	Antifouling	https://www.mdpi.com/2076-2607/11/6/1568
3	Anticorrosion	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6513773/
Unit II: Marine habitats		
4	Diversity of Marine microorganisms: Archaea, Bacteria, Cyanobacteria, Algae, Fungi, viruses, viroids and prions.	https://www.youtube.com/watch?v=Avrg6SMFtWk https://www.youtube.com/watch?v=WSbTiWDwdM
5	actinomycetes, polyextremophiles, anaerobes.	https://www.youtube.com/watch?v=vtbEcSM3KP4 https://www.researchgate.net/publication/279948825_Polyextremophiles https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5488096/
Unit III: Analytical Techniques in Marine Biotechnology		
6	marine toxins- antiviral and antimicrobial agents	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3153220/
Unit IV: Aquaculture and fish genetics		
7	Criteria for selecting cultivable species	https://sist.sathyabama.ac.in/sist_coursematerial/uploads/GBT1608.pdf
9	Artificial insemination - <i>in vitro</i> fertilization	https://www.researchgate.net/publication/348280490_Artificial_Insemination_and_its_Importance_in_Marine_Crustaceans_A_Review
10	Eyestalk ablation- Transgenesis and Cryopreservation	https://www.slideshare.net/slideshow/eyestalk-ablation-technique/251367855 https://www.slideshare.net/slideshow/cryopreservation-and-its-application-to-aquaculturepptx/251667353 https://www.researchgate.net/publication/271272142_Transgenic_Technology_in_Marine_Organisms#:~:text=Marine%20organisms%20into%20which%20a,are%20termed%20transgenic%20marine%20organisms.
Unit V: Marine and fishery by-products		
11	Marine algal by-products: Chitin, Chitosan, Agar, Agarose Alginates, Carrageenan and Heparin	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3674937/
12	bio active chemicals (AMP),	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4881601/
13	enzymes like amylase, protease.	https://www.youtube.com/watch?v=rXeCdDslmU

Module No.	Topic	CLO level	No. of periods	Content delivery method	Learning methods
Unit I Marine Ecosystems					
1	Marine Ecosystems & Its functioning	CLO2 CLO4	1	Lecture – Chalk and Talk	Participatory Learning
2	Ocean currents	CLO2 CLO4	1	Video	Problem-based Learning
3	Physical properties of seawater	CLO2 CLO4	1	Chalk and talk/ Picture	Participatory Learning
4	Chemical properties of seawater,	CLO2 CLO4	1	Research article discussion	Problem-based Learning
5	Ecological divisions of the Sea- Euphotic- Mesopelagic- Bathopelagic	CLO2 CLO4	1	PPT	Experiential Learning
6	Ecological divisions of the Sea- Euphotic- Mesopelagic- Bathopelagic- Conc	CLO2 CLO4	1	Lecture – Chalk and Talk	Problem-based Learning
7	Benthos-Intertidal, Estuarine- Salt Marsh- Mangrove- Coral Reef.	CLO2 CLO4	1	Picture	Participatory Learning
8	Biofouling, Biofilm	CLO2 CLO4	1	PPT	Problem-based Learning
9	Antifouling, Anticorrosion.	CLO2 CLO4	1	Video / Observation	Experiential Learning
Unit II Marine habitats					
10	Marine microbial habitats	CLO2 CLO4	1	Lecture – Chalk and Talk	Participatory Learning
11	Diversity of Marine microorganisms: Archaea, Bacteria, Cyanobacteria, Algae, Fungi, viruses, viroids and prions.	CLO2 CLO4	1	Chalk and talk/ Picture	Problem-based Learning
12	Diversity of Marine microorganisms: Archaea, Bacteria, Cyanobacteria, Algae, Fungi, viruses, viroids and prions. Conc	CLO2 CLO5	1	Video	Participatory Learning
13	Diversity of Marine microorganisms: Archaea, Bacteria, Cyanobacteria, Algae, Fungi, viruses, viroids and prions. Conc	CLO3 CLO4	1	Picture	Problem-based Learning
14	Specialized microorganisms: Extremophiles: barophiles, thermophiles, psychrophiles, halophiles actinomycetes, polyextremophiles	CLO2 CLO4	1	Video	Participatory Learning

15	Specialized microorganisms: Extremophiles: barophiles, thermophiles, psychrophiles, halophiles actinomycetes, polyextremophiles. Conc	CLO2 CLO4	1	Lecture – Chalk and Talk	Participatory Learning
16	Specialized microorganisms: Extremophiles: barophiles, thermophiles, psychrophiles, halophiles actinomycetes, polyextremophiles. Conc	CLO2 CLO5	1	Video / Observation	Experiential Learning
17	Anaerobes.	CLO2 CLO5	1	PPT	Participatory Learning
Unit III: Analytical Techniques in Marine Biotechnology					
18	Screening for Secondary metabolites from marine microbes (Bacteria, Fungi, Actinomycetes and marine microalgae).	CLO2 CLO4	1	Chalk and talk/ Picture	Problem-based Learning
19	Probiotic bacteria and their importance in aquaculture.	CLO2 CLO4	1	Lecture PPT	Participatory Learning
20	Medicinal compounds from flora (Seaweeds, Seagrass and Mangrove)	CLO2 CLO5	1	PPT	Experiential Learning
21	Fauna (Sponges, Sea anemone and Corals)	CLO3 CLO4	1	PPT	Problem-based Learning
22	Marine toxins	CLO2 CLO4	1	Displays	Experiential Learning
23	Antiviral and antimicrobial agents.	CLO2 CLO3	1	Research article reading	Problem-based Learning
24	Culture aspect-Seaweed (<i>Kappaphycus alvarezii</i>).	CLO2 CLO5	1	Lecture – Chalk and Talk	Experiential Learning
25	Practical works in the sampling collection, cell isolation and purification,	CLO3 CLO4	1	Seminar / PPT	Participatory Learning
26	Preparation of culture media with emphasize on nutrient and environmental requirement for growth or marine microalgae	CLO3 CLO5	1	Research article reading	Problem-based Learning
Unit IV Aquaculture and fish genetics					
27	Importance of coastal aquaculture;	CLO2 CLO4	1	Lecture – Chalk and Talk	Problem-based Learning
28	Aqua farms; Design and construction;	CLO2 CLO4	1	Lecture – Chalk and Talk	Experiential Learning
29	Criteria for selecting cultivable species;	CLO2 CLO5	1	Video / Observation	Experiential Learning
30	Culture systems and management practices – extensive, semi-intensive and intensive culture practices.	CLO3 CLO4	1	PPT	Problem-based Learning

31	Seed production in controlled condition; Types; Design and management of hatchery –induced spawning;	CLO2 CLO4	1	Lecture PPT	Participatory Learning
32	Mass production of seeds; feed formulation	CLO3 CLO5	1	Lecture – Chalk and Talk	Experiential Learning
33	Artificial insemination - <i>in vitro</i> fertilization.	CLO3 CLO5	1	Video	Participatory Learning
34	Fish chromosome manipulation in aquaculture- Hybridization- Gynogenesis -Androgenesis- Polyploidy	CLO3 CLO5	1	PPT	Participatory Learning
35	Eyestalk ablation- Transgenesis and Cryopreservation.	CLO2 CLO4	1	Video / Observation	Experiential Learning
Unit V Marine and fishery by-products					
36	Marine algal by-products: Chitin, Chitosan, Agar, Agarose Alginates, Carrageenan and Heparin.	CLO3 CLO5	1	Video	Problem-based Learning
37	Marine algal by-products: Chitin, Chitosan, Agar, Agarose Alginates, Carrageenan and Heparin. Conc	CLO2 CLO4	1	Picture	Experiential Learning
38	Fishery by-products: Fish oil, Isinglass, Fish glue, Fish silage, Fin rays.	CLO2 CLO5	1	Displays	Experiential Learning
39	Fishery by-products: Fish oil, Isinglass, Fish glue, Fish silage, Fin rays. Conc	CLO3 CLO4	1	PPT	Problem-based Learning
40	Development of novel pharmaceutical drugs like Bryostatin and keyhole limpet hemocyanin (KLH),	CLO3 CLO4	1	Lecture/ Virtual lab	Experiential Learning
41	Development of novel pharmaceutical drugs like Bryostatin and keyhole limpet hemocyanin (KLH). Conc	CLO3 CLO5	1	Video	Problem-based Learning
42	Bio active chemicals (AMP), enzymes like amylase, protease.	CLO3 CLO5	1	Video	Problem-based Learning
43	Bio active chemicals (AMP), enzymes like amylase, protease. Conc	CLO3 CLO5	1	Research article reading	Problem-based Learning

Name of the course	MBY2313- Marine Biotechnology
Name of the Faculty	Dr. D S Ranjith Santhosh Kumar
Participatory Learning	30 %
Experiential Learning	30 %
Problem-based Learning	40 %

COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	CREDITS
MBY2314	LEAD MOLECULE DISCOVERY AND PRECLINICAL DEVELOPMENT	THEORY	43	2	-	3

Preamble

- To know about the process of drug discovery and development.
- To provide an overview about identifying drug targets and strategies to develop drugs.
- To learn about basic and essential qualities of a candidate drug and testing methods.
- To understand the prerequisites of obtaining drug approval and to know about clinical trials, regulatory approval process.

Course Learning Outcomes

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

CLO Number	CLO Statement	Knowledge Level
CLO1	Outline stages and processes involved in drug discovery and development.	K2
CLO2	Identify potential drug targets and propose development strategies	K3
CLO3	Illustrate characteristics and testing methods for a potential drug candidate	K4
CLO4	Apply drug screening techniques in preclinical settings.	K5
CLO5	Formulate steps for drug approval including clinical trials and regulatory processes.	K6

Mapping with Programme Learning Outcomes

CLOs	PLO1	PLO 2	PLO 3	PLO 4	PLO 5
CLO1	S	S	S	M	S
CLO2	S	S	S	M	M
CLO3	S	S	S	M	S
CLO4	S	S	S	M	M
CLO5	S	S	S	M	S

S-Strong; M-Medium

MBY2314 - LEAD MOLECULE DISCOVERY AND PRECLINICAL DEVELOPMENT (43 hrs)

Unit I Introduction to drug discovery and development (9 hrs)

General introduction to drug discovery research and development, Different stages of drug discovery and development, pre-clinical studies, non-clinical activities, clinical studies, Innovator and generics, Concept of generics, Generic drug product development.

Unit II Target identification and validation (9 hrs)

Concept of target, different approaches to identify drug targets, Target validation, Single target versus multi-targets approaches, Off target and adverse effects, Drug repurposing. Concept of target, different approaches to identify drug targets, Target validation, Single target versus multi-targets approaches, Off target and adverse effects, Drug repurposing.

Unit III *In-silico* drug designing (8 hrs)

Basics of structural bioinformatics, Role of Bioinformatics in drug design, Target understanding at molecular level, lead optimization and in-silico validation, Structure- and ligand-based drug design, Molecular docking and docking algorithms, de-novo ligand design and molecular dynamics simulation.

Unit IV Drug Screening (8 hrs)

Understanding protein-protein, protein-small molecule interaction study, Role of Structural Biology in Drug Discovery, Cell-free and cell-based assays, exploiting cell biology to design assay platforms, High-throughput screening, Introduction to High Content Screening, Designing and development of disease model.

Unit V Medicinal Chemistry, Pharmacology and Drug Development (9hrs)

Small molecules as drugs, Lipinski rule five, hit identification to lead development process, Chemistry Manufacturing and Control (CMC), Pre-clinical study, Clinical study, Approval processes and timelines involved in Investigational New Drug (IND), New Drug Application (NDA), Abbreviated New Drug Application (ANDA). Changes to an approved NDA / ANDA.

TEXT BOOKS

S. No	Authors	Title of the Book	Publishers	Year & Edn
1.	Patwaradhan B	Drug discovery and development.	New India publishing agency, New Delhi	2007
2.	Kristian Stromgaard, Povl Krogsgaard- Larsen, Ulf Madsen	Textbook of Drug Design and Discovery	CRC Press.	2017 & 5 th Edn
3.	James J. O'Donnell, John Somberg, Vincent Idemyor, James T. O'Donnell	Drug Discovery and Development	CRC Press.	2020 & 3 rd Edn.

REFERENCE BOOKS

S. No	Authors	Title of the Book	Publishers	Year & Edn
1.	Benjamin Blass	Basic Principles of Drug Discovery and Development	Elsevier,	2015 & 1 st Edn
2.	Claudio N. Cavasotto	<i>In Silico</i> Drug Discovery and Design Theory, Methods, Challenges, and Applications	CRC Press.	2016 & 1 st Edn

Course Designer:

Dr. V. Bhuvaneshwari

COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	CREDITS
MBY23P5	PLANT BIOTECHNOLOGY & GENETIC ENGINEERING AND OMICS CONCEPT PRACTICAL	PRACTICAL	-	-	75	4

Preamble

- To develop the knowledge on plant culture techniques
- To understand the process of producing cell suspension cultures and utilize them for producing rare regenerated plants
- To apply the concepts of genetic engineering in plant development
- To understand and apply the omics techniques to explore the genetic design of 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 callus induction and micropropagation using tissue culture techniques.	K6
CLO2	Execute procedures for establishing and maintaining plant cell suspension cultures.	K2
CLO3	Apply cloning methods in gene manipulation experiments.	K3
CLO4	Analyze the role of different vectors in recombinant DNA technology.	K4
CLO5	Integrate omics tools to investigate the genetic framework of organisms.	K5

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
CLO5	S	S	M	M	S

S- Strong; M-Medium

MBY23P5 - PLANT BIOTECHNOLOGY & GENETIC ENGINEERING AND OMICS
CONCEPT PRACTICAL (75 hrs)

PLANT BIOTECHNOLOGY

1. Murashige & Skoog (MS) Media preparation components and techniques
2. Micropropagation with a suitable example
3. Callus induction from plant tissues
4. Embryo culture
5. Anther culture for haploid production
6. Cell suspension culture
7. Protoplast isolation
8. Preparation of artificial seeds-Sodium Alginate
9. Agrobacterium mediated transformation in tobacco

GENETIC ENGINEERING AND OMICS CONCEPT

1. Restriction Enzyme digestion of plasmid DNA and size determination of the fragments.
2. Elution of DNA and Cloning in vector system
3. Transformation and screening of putative colonies
4. Reverse transcriptase PCR to study gene expression
5. RFLP marker analysis to study the variation
6. Isolation and Separation of protein SDS PAGE
7. Western blotting to analyze the protein expression
8. Next generation sequencing (Demo)

TEXTBOOKS

S.No	Authors	Title of the book	Publishers	Year & Edn
1	Nagar Santosh, Adhav Madhavi	Practical Biotechnology and Plant Tissue Culture	S Chand & Company	2010
2	Green, M. R., & Sambrook, J.	Molecular cloning: A laboratory manual.	Cold Spring Harbor, NY, USA	2012
3	Simpson R	Proteins and proteomics: A laboratory manual.	Cold Spring Harbor Laboratory Press.	2002

REFERENCE BOOKS

S.No.	Authors	Title of the Book	Publishers	Year & Edn
1.	C. C. Giri, Archana Giri, I.K	Plant Biotechnology: Practical Manual	International Publishers	2007
2.	Carson, S., Miller, H., Srougi, M., and Witherow, S.	Molecular Biology techniques – A classroom laboratory manual	Academic Press, USA	2019 & 4 th Edn
3	Satish Kumar Sinha	Plant Tissue Culture: Theory and Practice	Oxford Book Company	2012

Course Designer:

Dr. R. Nirmal Kumar

COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	CREDITS
MBY23P6	BIOPROCESS TECHNOLOGY AND MARINE BIOTECHNOLOGY PRACTICAL	PRACTICAL	-	-	75	4

Preamble

- To impart knowledge on Bioreactors to mass multiply microorganisms at industrial scale.
- To enlighten on downstream processing to convert them as value added products.
- To develop practical skills in the isolation, identification, and cultivation of marine microorganisms, including algae
- To obtain overall holistic knowledge and applications of Bioprocess and marine technology

Course Learning Outcomes

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

CLO Number	CLO Statement	Knowledge Level
CLO1	Select and prepare suitable culture media for microbial cultivation.	K2
CLO2	Assess classical and modern techniques for enzyme production.	K3
CLO3	Execute downstream processing to purify and convert biological products.	K4
CLO4	Demonstrate isolation, identification, and culturing of marine microorganisms.	K5
CLO5	Evaluate process design and scalability for industrial-scale bioproduct generation.	K6

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
CLO5	M	S	S	S	S

S- Strong; M-Medium;

MBY23P6 - BIOPROCESS TECHNOLOGY AND MARINE BIOTECHNOLOGY
PRACTICAL (75 hrs)

BIOPROCESS TECHNOLOGY

Upstream processing

1. Extraction of extracellular enzyme (Protease) from bacteria
2. Optimization of culture condition for growth and enzyme production (Media, pH and Temperature and Incubation time)
3. Production and estimation of organic acid –lactic acid by Sauerkraut preparation
4. Wine Production and estimation of alcohol

Downstream processing

5. Protein purification- 1. Ammonium sulfate 2. Dialysis 3. Column chromatography
6. Immobilization of Enzyme – Gel entrapment
7. Operation of Fermenter (Demonstration)
8. Production of Mushroom by solid substrate fermentation (Demonstration).

MARINE BIOTECHNOLOGY

9. Collection of samples from marine sources
10. Isolation and identification of marine microorganism
11. Production of antibiotics from marine microbes
12. Media preparation for microalgae
13. Culturing of microalgae and microscopic analysis
14. Marine beach monitoring and clean up

TEXTBOOKS

S.No	Authors	Title of the book	Publishers	Year & Edn
1	S.Kulandaivel&S.Ja narthanan	Practical Manual on Fermentation Technology	Kindle Edn I K International Publishing House	2012
2	Alicia L, Ragout De Spencer, John F.T. Spencer	Environmental Microbiology: Methods and Protocols	John M. Walker, John F. T. Spencer, Alicia L. Ragout de Spencer	2023

REFERENCE BOOKS

S.No	Authors	Title of the book	Publishers	Year & Edn
1	Chellapandi P	Laboratory Manual in Industrial Biotechnology	Pointer publishers	2007
2	Baunthiyal M, Ravi I and Saxena. J	Comprehensive Laboratory Manual of Life Sciences.	Scientific Publishers.	2019
3	Robert A. Andersen	Algal Culturing Techniques	Academic Press	2005

Course Designer:

Dr. G. Anbarasi

Dr. P. Suganya

COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	CREDITS
MBY23S1	RESEARCH METHODOLOGY	THEORY	45	-	-	3

Preamble

- To Gain the skill in selecting appropriate research project, design of experiments, methods, and techniques that align with the research objectives.
- To understand the concepts in Bioethics
- To examine the biosafety and risk assessment of products derived from recombinant DNA research
- To distinguish National and International biosafety regulations.
- To justify the concept of research ethics and responsible conduct in research

Course Learning Outcomes

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

CLO Number	CLO Statement	Knowledge Level
CLO1	Summarize the components of a research review, report and manuscript	K5
CLO2	Understand the Concepts in Bioethics	K3
CLO3	Examine the biosafety and risk assessment of products derived from recombinant DNA research	K4
CLO4	Distinguish National and International biosafety regulations.	K2
CLO5	Justify the concept of research ethics.	K6

Mapping with Programme Learning Outcomes

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	S	S	S	S	S
CLO2	S	S	S	S	M
CLO3	S	S	S	S	S
CLO4	S	S	M	S	M
CLO5	S	S	M	S	S

M-Medium S- Strong

MBY23S1 - RESEARCH METHODOLOGY (45 hrs)

Unit I Introduction to Research

(9 hrs)

Definition, Basic and Applied research, Interdisciplinary research. Literature Review – Research reading, Discriminative reading, consulting source material, Reference cards. Primary and Secondary literature. Literature citation, Components of a research report, Use of tables and figures, Preparation of photographs and microphotographs, Formatting and requirements for manuscript preparation, Biological abstract, Review, Monographs, Peer reviewed journals, Plagiarism software, e-resources, Digital library, Electronic research tools, Bibliography software. Internet - Worldwide Web - Search Engines - their functions. Boolean searching - File formats.

Unit II Bioethics

(9 hrs)

Introduction, ethical conflicts in biological sciences - interference with nature. Bioethics in health care - patient confidentiality, informed consent, euthanasia, artificial reproductive technologies, prenatal diagnosis, genetic screening, gene therapy, transplantation. Bioethics in research – cloning and stem cell research, Human and animal experimentation, animal rights/welfare, Agricultural biotechnology - Genetically engineered food, environmental risk, labeling and public opinion. Sharing benefits and protecting future generations - Protection of environment and biodiversity – biopiracy

Unit III Biosafety

(9 hrs)

Biosafety and Biosecurity - introduction; historical background; primary containment for biohazards, GRAS organisms, Definition of GMOs & LMOs, principles of safety assessment of transgenic plants – sequential steps in risk assessment. Environmental risk assessment and food and feed safety assessment, risk assessment of transgenic crops Vs cisgenic plants or products derived from RNAi, genome editing tools.

Unit IV National & International biosafety regulations

(9 hrs)

International regulations – Cartagena protocol, OECD consensus documents and Codex Alimentarius, Indian regulations – EPA act and rules, guidance documents, regulatory framework – RCGM, GEAC, IBSC and other regulatory bodies; Draft bill of Biotechnology Regulatory authority of India – containments – Biosafety levels and category of rDNA experiments; field trials –biosafety research trials – standard operating procedures - guidelines of state governments; GM labeling – Food Safety and Standards Authority of India (FSSAI).

Unit V Research Ethics and Responsible Conduct in Research

(9 hrs)

Brief history and analytical basis of research ethics, responsible conduct in research (Honesty in Science: Integrity, Authorship, Conflicts of Interest, Privacy and Confidentiality, Informed Consent, Risk/Benefit Assessment), The legal regulation of research ethics in India (From UGC, MHRD and other governing agencies), Regulatory requirements relevant to international research.

TEXT BOOKS

S.No	Authors	Title of the Book	Publishers	Year & Edn
1.	Campbell, A.V.	Bioethics -The basics.	Routledge	2018
2.	John W. Creswell, J. David Creswell	Research Design: Qualitative, Quantitative, and Mixed Methods Approaches	SAGE Publications,	2018 & 5 th Edn

REFERENCE BOOKS

S.No	Authors	Title of the Book	Publishers	Year & Edn
1.	Sibi, G.	Intellectual property rights, Bioethics, Biosafety and Entrepreneurship in Biotechnology.	Wiley India Pvt Ltd	2021
2.	Uzochukwu S.	Biosafety and Bioethics in Biotechnology.	Taylor and Francis Ltd, UK	2022
3.	Gurumani, N.	Research Methodology: for Biological Science	MJP Publishers, India	2019

Course Designer:

Dr. V. Bhuvaneshwari

Module No.	Topic	CLO level	No. of periods	Content delivery method	Student engagement	Learning methods
Unit I Introduction to Research						
1	Definition, Basic and Applied research.	CLO2 CLO4	1	Lecture – Chalk and Talk	Word cloud	Participatory Learning
2	Interdisciplinary research. Literature Review – Research reading	CLO2 CLO4	1	Video	Presentation	Problem-based Learning
3	Discriminative reading, consulting source material, Reference cards.	CLO2 CLO4	1	Chalk and talk/ Picture	Diagrams, Sketch board	Participatory Learning
4	Primary and Secondary literature. Literature citation,	CLO2 CLO4	1	Research article discussion	Presentation	Problem-based Learning
5	Components of a research report, Use of tables and figures, Preparation of photographs and microphotographs	CLO2 CLO4	1	PPT	Diagrams	Experiential Learning
6	Formatting and requirements for manuscript preparation, Biological abstract, Review, Monographs, Peer reviewed journals, Plagiarism software, e-resources,	CLO2 CLO4	1	Lecture – Chalk and Talk	Presentation	Problem-based Learning
7	Digital library, Electronic research tools, Bibliography software.	CLO2 CLO4	1	Picture	Sketchboard	Participatory Learning
8	Internet - Worldwide Web - Search Engines - their functions.	CLO2 CLO4	1	PPT	Quesdiscussion , Pro-con grid	Problem-based Learning
9	Boolean searching - File formats.	CLO2 CLO	1	Video / Observati on	Group discussion	Experiential Learning
Unit II Bioethics						

10	Introduction, ethical conflicts in biological sciences – interference with nature.	CLO2 CLO4	1	Lecture – Chalk and Talk	Diagrams, Sketch board	Participatory Learning
11	Bioethics in health care - patient confidentiality.	CLO2 CLO4	1	Chalk and talk/ Picture	Debate, Quescussion, Pro-con grid	Problem-based Learning
12	informed consent, euthanasia, artificial reproductive technologies, prenatal diagnosis, genetic screening, gene therapy, transplantation.	CLO2 CLO4	1	Chalk and talk/ Picture	Debate, Quescussion, Pro-con grid	Problem-based Learning
13	Bioethics in research – cloning and stem cell research	CLO2 CLO5	1	Video	Debate	Participatory Learning
14	Human and animal experimentation	CLO3 CLO4	1	Picture	Quescussion Pro-con grid	Problem-based Learning
15	, animal rights/welfare, Agricultural biotechnology	CLO2 CLO	1	Video	Quiz	Participatory Learning
16	Genetically engineered food, environmental risk, labeling and public opinion.	CLO2 CLO4	1	Lecture – Chalk and Talk	Think Write and Share	Participatory Learning
17	Sharing benefits and protecting future generations	CLO2 CLO5	1	Video / Observation	Group discussion	Experiential Learning
18	Protection of environment and biodiversity – biopiracy	CLO2 CLO5	1	PPT	Diagrams, Sketchboard	Participatory Learning
Unit III Biosafety						
19	Biosafety and Biosecurity – introduction, historical background	CLO2 CLO4	1	Chalk and talk/ Picture	Debate, Quescussion, Pro-con grid	Problem-based Learning
20	containment for biohazards, GRAS organisms	CLO2 CLO4	1	Lecture PPT	Peer teaching	Participatory Learning
21	Definition of GMOs & LMOs, principles of safety assessment of transgenic plants – sequential steps in risk assessment	CLO2 CLO5	1	PPT	Diagrams	Experiential Learning

22	Environmental risk assessment	CLO3 CLO4	1	PPT	Review collection, Case study	Problem-based Learning
23	food and feed safety assessment	CLO2 CLO4	1	Displays	Gallery walk, Post it parade	Experiential Learning
24	transgenic crops Vs cisgenic plants	CLO2 CLO3	1	Research article reading	Case thinking	Problem-based Learning
25	Risk assessment of transgenic and cisgenic crops	CLO2 CLO5	1	Lecture – Chalk and Talk	Poster	Experiential Learning
26	Risk assessment of products derived from RNAi	CLO3 CLO4	1	Seminar / PPT	Flipped classroom	Participatory Learning
27	Genome editing tools	CLO3 CLO5	1	Research article reading	Case thinking	Problem-based Learning
Unit IV National & International biosafety regulations						
28	Cartagena protocol, OECD consensus documents	CLO2 CLO4	1	Lecture – Chalk and Talk	Presentation	Problem-based Learning
29	Codex Alimentarius	CLO2 CLO4	1	Lecture – Chalk and Talk	Flipped classroom, Poster	Experiential Learning
30	Indian regulations – EPA act and rules, guidance documents	CLO2 CLO5	1	Video / Observation	Group discussion	Experiential Learning
31	regulatory framework – RCGM, GEAC, IBSC and other regulatory bodies	CLO3 CLO4	1	PPT	Review collection, Case study	Problem-based Learning
32	Draft bill of Biotechnology Regulatory authority of India	CLO2 CLO4	1	Lecture PPT	Student seminar	Participatory Learning
33	Containments and biosafety levels	CLO3 CLO5	1	Lecture – Chalk and Talk	Poster	Experiential Learning
34	Biosafety levels and category of rDNA experiments	CLO3 CLO5	1	Video	Quescussion	Participatory Learning
35	field trials –biosafety research trials – standard operating procedures - guidelines of state governments	CLO3 CLO5	1	PPT	Debate	Participatory Learning

36	GM labeling – Food Safety and Standards Authority of India (FSSAI)	CLO2 CLO4	1	Video / Observation	Group discussion	Experiential Learning
Unit V Research Ethics and Responsible Conduct in Research						
37	Brief history and analytical basis of research ethics,	CLO3 CLO5	1	Video	Quescussion , Pro-con grid	Problem-based Learning
38	responsible conduct in research	CLO2 CLO4	1	Picture	Diagrams	Experiential Learning
39	Honesty in Science: Integrity, Authorship	CLO2 CLO5	1	Displays	Gallery walk, Post it parade	Experiential Learning
40	Conflicts of Interest, Privacy and Confidentiality, Informed Consent,	CLO3 CLO4	1	PPT	Review collection, Case study	Problem-based Learning
41	Risk/Benefit Assessment),	CLO3 CLO4	1	Lecture/ Virtual lab	Poster	Experiential Learning
42	The legal regulation of research ethics in India	CLO3 CLO5	1	Video	Presentation	Problem-based Learning
43	From UGC, MHRD	CLO3 CLO5	1	Video	Quescussion , Pro-con grid	Problem-based Learning
44	Other governing agencies	CLO3 CLO5	1	Research article reading	Case thinking	Problem-based Learning
45	Regulatory requirements relevant to international research	CLO4	1	Lecture, Chalk and talk	Think, write and share	Participatory learning

Name of the course	MBY23S1- Research Methodology
Name of the Faculty	Dr. Sarah Jaison
Participatory Learning	30 %
Experiential Learning	30 %
Problem-based Learning	40 %



MASTER OF SCIENCE IN BIOTECHNOLOGY
CHOICE BASED CREDIT SYSTEM (CBCS) &
LEARNING OUTCOME- BASED CURRICULUM FRAMEWORK (LOCF)
SCHEME & SYLLABUS OF EXAMINATION
2024-2026 BATCH
SEMESTER IV

Semester	Course Code	Title of the Course	Course Type	Instruction hours/week	Contact hours	Tutorial hours	Duration of Examination	Examination Marks			Credits
								CA	ESE	TOTAL	
IV	MBY2415	Bioentrepreneurship and IPR	CC	3	43	2	3	25	75	100	3
	MBY2416	Forensic Biotechnology	CC	3	43	2	3	25	75	100	3
	MBY24PROJ	Project and Viva Voce	DSE	24	360	-	-	25	75	100	6
	MBY22AC1/ MBY22AC2	Stem Cell Technology/ Microbial & Clinical Genomics	ACC	SS	-	3	25	75	100	5*	
I-IV	Grand total									2650+ 100*	90+5*

CC-Core Courses CA – Continuous Assessment ESE - End Semester Examination, *ACC-Additional Credit course

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: $2 \times 3 = 6$

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

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

Total = 45 Marks

End Semester Examination – Question Paper Pattern and Distribution of Marks

ESE Question Paper Pattern for Core and Allied Course: $5 \times 15 = 75$ Marks

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

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

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

Total = 75 marks

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.

Internal component for ALC-25 marks

CA -10 marks

Model exam -15 marks

Total -25 marks**Model/End Semester for PG - 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**Internal Evaluation of Project**

Review I: Selection of the field of study, Topic & Literature College - 5 Marks

Review II: Research Design & Data Collection - 10 Marks

Review III: Analysis & Conclusion Preparation of rough draft - 10 Marks

Total - 25 Marks**End Semester Examination of Project**

Evaluation of the project - 25 Marks

Viva Voce & Report - 50 Marks

Total - 75 Marks

COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	CREDITS
MBY2415	BIOENTREPRENEURSHIP AND IPR	THEORY	43	2	-	3

Preamble

- To interpret the basics of entrepreneurship and recognize the challenges in product development in life sciences. To analyze the business feasibility and marketing tactics. This course will scrutinize basic financial and accounting requirements for a thriving business and to appraise the importance of regulatory affairs and IP in a business.

Prerequisite

Basics of biotechnology, life sciences, and general business concepts

Course Learning Outcomes

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

CLO Number	CLO Statement	Knowledge Level
CLO1	Interpret the basics of entrepreneurship in biotech sector.	K2
CLO2	Recognize the challenges in product development in life sciences.	K3
CLO3	Analyze the business feasibility and Marketing tactics	K4
CLO4	Scrutinize basic financial and accounting requirements for a thriving business	K5
CLO5	Appraise the importance of regulatory affairs and IP in a business	K6

Mapping with Programme Learning Outcomes

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	S	M	S	S	S
CLO2	S	S	S	S	S
CLO3	S	S	S	S	M
CLO4	S	M	S	S	S
CLO5	S	M	S	S	S

S- Strong; M-Medium;

BIOENTREPRENEURSHIP AND IPR - MBY2415- 43 HRS

Unit I Foundation to Bio entrepreneurship

(9 Hrs)

Introduction to bio entrepreneurship – Scope in Bio-entrepreneurship, Importance of entrepreneurship, Opportunities in bio-entrepreneurship, Sectors in biotech industry, types of entrepreneurship, Stages in entrepreneurial process, Entrepreneurship development programs of public and private agencies (MSME, DBT, BIRAC, Make In India), Types of bio-industries, Types of business organizations (LLP, Pvt Ltd, OPC, group of companies, Joint venture etc.), steps involved in their registration, Building biotech business : Challenges in Indian context, operational biotech parks in India, Accelerators, Incubators, Indian Company act for Biobusiness-schemes and subsidies.

Unit II Product Development and Management cycle

(9 Hrs)

Product Development Cycle: New product development necessity and planning, aligning product goals with business strategy. Product Development Stages - Concept generation and evaluation, development, testing, Identifying, and selecting market opportunities and product launch plan. Production consumption cycle. Product Management cycle: Leveraging technology to drive new product development, Encouraging entrepreneurial approaches for innovation, Success factors and reasons for failure. Key elements of successful products (market fit, differentiation, timing). Common failure causes (poor market research, weak execution). Ensuring continuous improvement and adaptability. Understanding flow and value addition from production to consumption.

Unit III Business strategy and Marketing

(9 Hrs)

Stakeholders in Business; Vision, Mission and Purpose; Business Definition, Objectives and Goals; Business plan preparation: business feasibility analysis by SWOT, Market assessment, Marketing models, prediction of market changes, branding, Sales pitching: elevated pitch, customer pitch, channel partner pitch etc., Case studies on marketing strategies, types of sales negotiation, Principles of sales management, developing distribution channels – franchising policies, promotion, advertising, branding and market linkages.

Unit IV Finance and Accounting

(8 Hrs)

Sources of financial assistance – making a business proposal, approaching loan from bank and other financial institutions, budget planning and cash flow management, Introduction to Micro and macro- economics, basics in accounting practices - balance sheet, P&L account, double entry book keeping, and estimation of income, expenditure, and Income tax. Asset valuation and Annual report analysis.

Unit V Regulatory affairs and IPR

(8 Hrs)

Understanding of regulatory compliances and procedures (CDSCO, NBA, GCP, GLA, GMP, FDA, NCAP, FSSAI). Concept of property, Intellectual Property (IP) and Intellectual Property Rights (IPR), Importance of IP, Types of IP, Advantages of IP protection, Role of IP in business.

Reference Links

S.No.	Topics	Links
Unit 1-Foundation to Bio-entrepreneurship		
1.	Stages in entrepreneurial process	https://youtu.be/KlVdZCIpYis?si=4mm7vw83ILMJVrfy
2.	Types of bio-industries	https://youtu.be/mJqm7Saof0?si=n0-WEvYsR6-RXh-Y
3.	Types of business Organizations	https://youtu.be/UGSlED1Jx1Y?si=ZfdqCLZtFctzxI3Q
Unit II- Product Development and Management cycle		
4.	Identifying and selecting market opportunities and product launch plan	https://youtu.be/V5kGgU7bVuU?si=2O9fWE5iO9KT114m
5.	Common failure causes (poor market research, weak execution)	https://youtu.be/jpOKAoJOxbg?si=R5WnPmYW6ccMAArf
6.	Understanding flow and value addition from production to consumption.	https://youtu.be/yAoErpsZRfs?si=DPCdpQ84uqjP4qFR
Unit III-Business strategy and Marketing		
7.	Marketing models, prediction of market changes	https://youtu.be/xA27x7GRMZQ?si=CYxxHeEot-uzAuA8
8.	Case studies on marketing strategies, types of sales Negotiation	https://ojs.unm.ac.id/administrare/article/view/45101
Unit IV-Finance and Accounting		
9.	Budget planning and cash flow management	https://doi.org/10.4337/9781803922652.00013
10.	Asset valuation and Annual report analysis	https://doi.org/10.54691/bcpbm.v24i.1531
Unit V-Regulatory affairs and IPR		
11.	Types of IP	https://doi.org/10.18231/j.ijpca.2023.028
12.	Advantages of IP Protection	https://doi.org/10.18231/j.ijpca.2023.028
13.	Role of IP in business.	https://youtu.be/87BkLriNTF4?si=IyVuBhYArPUY74Ij

Text Book

S.No.	Authors	Title of the Book	Publishers	Year and Edition
1.	Shimasaki C.D.	Biotechnology Entrepreneurship: Starting, Managing, and Leading Biotech Companies.	Elsevier, Netherlands.	2014 1 st Edn.
2.	Jordan J.F.	Innovation, Commercialization and Start-Ups in Life Sciences.	CRC Press, UK	2014 1 st Edn.
3.	Adams D. J. & Sparrow J. C.	Enterprise for Life Scientists: Developing Innovation and Entrepreneurship in the Biosciences.	Scion Publishing Ltd.	2008 1 st Edn.
4.	Thiel P & Masters B	Zero to One: Notes on Start Ups.	Random House, UK	2014 1 st Edn.

Books for Reference

S.No.	Authors	Title of the Book	Publishers	Year and Edition
1.	Poornima M & Charanthmath	Entrepreneurship Development – Small business enterprises.	Pearson Education. India.	2018 3 rd Edn
2.	Desai V	Dynamics of Entrepreneurial Development and Management.	Himalaya Publishing House, India.	2011 6 th Edn
3.	Pisano G.P.	Science Business The Promise, the Reality, and the Future of Biotech	Harvard Business School Press, USA	2013 1 st Edn.

Course Designers

1. Dr. Sarah Jaison

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 Methods	Learning Methods
UNIT I - Foundation to Bio Entrepreneurship (9 Hours)					
1.	Introduction to bio entrepreneurship - Scope in Bio-entrepreneurship, Importance of entrepreneurship, Opportunities in bio-entrepreneurship, Sectors in biotech industry, types of entrepreneurship, Stages in entrepreneurial process	CLO1	2	Lecture /Chalk and Talk / Group reading/Videos	Participatory Learning
2.	Entrepreneurship development programs of public and private agencies (MSME, DBT, BIRAC, Make in India)	CLO1	2	PPT	Participatory Learning
3.	Types of bio-industries, Types of business organizations (LLP, Pvt Ltd, OPC, group of companies, Joint venture etc.), steps involved in their registration	CLO1, CLO2	2	OER	Experiential learning
4.	Building biotech business: Challenges in Indian context, operational biotech parks in India, Accelerators, Incubators	CLO1	2	Lecture /Chalk and Talk / Group reading	Problem based Learning
5.	Indian company act for bio- business schemes and subsidies	CLO1, CLO2	1	Displays/Videos	Experiential learning
Unit II - Product Development and Management Cycle (9 Hours)					
6.	Product Development Cycle: New product development necessity and planning, aligning product goals with business strategy	CLO2	1	PPT	Problem based Learning
7.	Product Development Stages - Concept generation and evaluation, development, testing, Identifying, and selecting market opportunities and product launch plan	CLO2	2	Lecture / Seminar/OER	Problem based Learning
8.	Production-consumption cycle	CLO2	2	PPT	Participatory Learning
9.	Product Management cycle: Leveraging technology to drive new product development, Encouraging entrepreneurial approaches for innovation	CLO2	2	Lecture / Group reading	Experiential learning
10.	Success factors and reasons for failure. Key elements of successful products	CLO2	1	PPT/Discussion	Problem based Learning

	(market fit, differentiation, timing). Common failure causes (poor market research, weak execution). Ensuring continuous improvement and adaptability				
11.	Understanding flow and value addition from production to consumption.	CLO2	1	Lecture / Seminar	Participatory Learning
Unit III - Business Strategy and Marketing (9 Hours)					
12.	Stakeholders in Business; Vision, Mission and Purpose	CLO3	1	OER / PPT	Problem based learning
13.	Business Definition, Objectives, and Goals	CLO3	1	Lecture PPT	Experiential Learning
14.	Business plan preparation: business feasibility analysis by SWOT, Market assessment, Marketing models, prediction of market changes, branding	CLO3	3	Video / Observation	Problem based Learning
15.	Sales pitching: elevated pitch, customer pitch, channel partner pitch	CLO3	2	Video / Observation	Problem based learning
16.	Case studies on marketing strategies, types of sales negotiation	CLO3	1	Lecture PPT, Group reading	Problem based learning
17.	Principles of sales management, developing distribution channels - franchising policies, promotion, advertising, branding and market linkage	CLO3	1	Lecture PPT/Video	Experiential Learning
Unit IV-Finance and Accounting (8 Hours)					
18.	Sources of financial assistance - making a business proposal, approaching loan from bank and other financial institutions	CLO4	1	Chalk talk/PPT	Participatory learning
19.	Budget planning, cash flow management	CLO4	1	Video/OER	Experiential learning
20.	Micro and macroeconomics	CLO4	1	OER	Experiential learning
21.	Basics in accounting practices - balance sheet, P&L account, double entry book keeping	CLO4	2	Chalk talk/PPT	Problem based learning
22.	Estimation of income, expenditure, and Income tax	CLO4	2	Group reading/PPT	Problem-based Learning
23.	Asset valuation and Annual report analysis	CLO4	1	PPT/Video	Problem-based Learning
Unit V - Regulatory Affairs and IPR (8 Hours)					
24.	Understanding of regulatory compliances and procedures (CDSCO, NBA, GCP, GLA, GMP, FDA, NCAP, FSSAI)	CLO5	2	Talk/PPT/ Video	Experiential Learning
25.	Concept of property, Intellectual	CLO5	2	Video /Talk/PPT	Experiential

	Property (IP) and Intellectual Property Rights (IPR), Importance of IP				Learning
26.	Types of IP	CLO5	2	Talk/PPT	Participatory Learning
27.	Advantages of IP protection	CLO5	1	Video / Observation/PPT	Problem based Learning
28.	Role of IP in business	CLO5	1	Video / Observation/PPT	Participatory 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	CREDITS
MBY2416	FORENSIC BIOTECHNOLOGY	THEORY	43	2	-	3

Preamble

- To Introduce students, the basic concepts and theories of criminology and to train them in examining the crime scene management processes. It will further help students to introduce to handle forensic evidences and apply the concepts of molecular biology in analyzing the samples.

Prerequisite

Basic Knowledge in molecular techniques

Course Learning Outcomes

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

CLO Number	CLO Statement	Knowledge Level
CLO1	Define the basic concepts of forensic science.	K2
CLO2	Develop molecular techniques to investigate and analyze Crime scenes	K3
CLO3	Execute handling and analysis of different physical evidences at crime scene	K4
CLO4	Analyze the concepts of Biotechnology in crime scene Investigation	K5
CLO5	Apply and optimize protocols to analyze samples precisely	K6

Mapping with Programme Learning Outcomes

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5
CLO1	S	M	S	S	S
CLO2	S	S	S	S	S
CLO3	S	S	S	S	M
CLO4	S	M	S	S	S
CLO5	S	M	S	S	S

S- Strong; M-Medium;

FORENSIC BIOTECHNOLOGY - MBY2416- 43 hrs

Unit I: Introduction to Forensic Science

(9 Hrs)

Introduction, history, and development of Forensic Science, basic principles and significance, organizational structure of Forensic Science laboratories, utilization of Forensic Science at the crime scene and in the court, role, qualities and importance of an investigating officer and a forensic scientist at the scene of crime.

Unit II: Crime and Crime Scene Investigation

(9 Hrs)

Definition and scope of crime and criminology, types of crime, elements and cause of crime, correlates and theories of crime. Punishment: definition, types, controversy regarding death penalty. Crime scene-experts team composition, first responding officer, physical evidences. Collection, preservation, packaging, transporting and forwarding. Techniques used for handling, physical and trace evidences, crime scene tool kits and equipment's. Ethics in crime scene investigation.

Unit III: Crime Scene Evidences

(9 Hrs)

Forensic samples: Biological evidence -Body Fluids like Blood, semen, saliva, urine, and vaginal secretions. Skin tissues, hair and DNA. Trace evidence: Natural and synthetic fibers. Soil and Vegetation- Dirt, plants, seed materials and other organic matter. Glass Fragments, Impression evidence- Fingerprints and shoe prints, footprints and tire track. Pattern evidence- Toolmarks and handwriting. Firearms evidence- Bullets and shell casings. Digital evidence - computers and phones

Unit IV: Sample collection and Preservation

(8 Hrs)

Evidence collection: Blood & Other Body Fluids- Cuttings, Wet Absorption, Scraping method, Lifting with tape. Hair & Fiber Collection-Tape lifting and Vacuuming method. Flinders Technology Associates (FTA) Cards, Whatman FTA Blood Collection Kit, Buccal Cell Collection. Steps to prevent contamination, packaging and storage of samples.

Unit V: Molecular Techniques for investigation

(8 Hrs)

DNA fingerprinting, DNA variations and polymorphism. DNA typing system- RFLP analysis, PCR amplifications, sequence of polymorphism, Analysis of SNP, Y-STR, Mitochondrial DNA analysis, Y chromosome analysis. DNA chip technology- Microarrays Cell- free DNA, Touch DNA, Low Copy Number DNA (LCN DNA).

Reference Links

S.No.	Topics	Links
Unit I		
1.	Stages in entrepreneurial process	https://youtu.be/KIVdZCipYis?si=4mm7vw83ILMJVrfy
2.	Types of bio-industries	https://youtu.be/mJqm7Saoft0?si=n0-WEvYsR6-RXh-Y
3.	Types of business organizations	https://youtu.be/UGSIED1Jx1Y?si=ZfdqCLZtFctzxI3Q
Unit II		
4.	Identifying and selecting market opportunities and product launch plan	https://youtu.be/V5kGgU7bVuU?si=2O9fWE5iO9KT11
5.	Common failure causes (poor market research, weak execution).	https://youtu.be/jpOKAoJOxbg?si=R5WnPmYW6ccMAArf
6.	Understanding flow and value addition from production to consumption.	https://youtu.be/yAoErpsZRfs?si=DPCdpQ84uqjP4qFR
Unit III		
7.	Marketing models, prediction of market changes	https://youtu.be/xA27x7GRMZQ?si=CYxxHeEot-uzAuA8
8.	Case studies on marketing strategies, types of sales negotiation	https://ojs.unm.ac.id/administrare/article/view/45101
Unit IV		
9.	Budget planning and cash flow management	https://doi.org/10.4337/9781803922652.00013
10.	Asset valuation and Annual report analysis	https://doi.org/10.54691/bcpbm.v24i.1531
Unit V		
11.	Types of IP	https://doi.org/10.18231/j.ijpca.2023.028
12.	Advantages of IP protection	https://doi.org/10.18231/j.ijpca.2023.028
13.	Role of IP in business.	https://youtu.be/87BkLriNTF4?si=IyVuBhYArPUY74Ij

Text Book

S.No.	Authors	Title of the Book	Publishers	Year and Edition
1	Amadeo Pesce	Forensic Biotechnology	CRC Press	2022 1 st Edn
2	Richard Saferstein	Forensic Science: From the Crime Scene to the Crime Lab	Pearson	2015 8 th Edn
3	Richard Li	Forensic Biology	CRC Press	2015 2 nd Edn

Books for Reference

S.No.	Authors	Title of the Book	Publishers	Year and Edition
1	Deepak Rawtani & Chaudhery Mustansar Hussain	Modern Forensic Tools and Devices: Trends in Criminal Investigation	Wiley-Scrivener	2023 1 st Edn
2	Hirak Ranjan Dash., Kelly M., Elkins & Noora Rashid Al-Snan	Advances in Forensic Biology and Genetics	Springer Singapore	2025 1 st Edn

Course Designers

Dr. R. Nirmal Kumar

Dr. G. Shalini

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 Methods	Learning Methods
Unit I (9 Hours)					
1	Introduction	CLO1	1	Lecture – Chalk and Talk	Participatory Learning
2	History and Development of Forensic Science	CLO1	1	Video	Problem- based Learning
3	Basic Principles and significance	CLO1	2	Chalk and talk/ Picture	Participatory Learning
4	Organizational Structure of Forensic Science Laboratories	CLO1	1	PPT	Experiential Learning
5	utilization of Forensic Science at the crime scene and in the court, role,	CLO1	2	Lecture – Chalk and Talk	Problem- based Learning
6	qualities & Importance of an Investigating Officer	CLO1	1	PPT	Problem- based Learning
7	a forensic scientist at the scene of crime.	CLO1	1	Video / Observation	Experiential Learning
Unit II (9 Hours)					
8	Definition and Scope of Crime and Criminology	CLO2	1	Lecture – Chalk and Talk	Participatory Learning
9	Types of Crime, Elements and Causes of Crime	CLO2	1	Chalk and talk/ Picture	Problem-based Learning
10	Correlates and Theories of Crime	CLO2	1	Video	Participatory Learning
11	Punishment: Definition and Types	CLO2	1	Picture	Problem- based Learning
12	Controversy regarding death penalty	CLO2	1	Video	Participatory Learning
13	Crime Scene-expert Team Composition, First Responding Officer	CLO2	1	Lecture – Chalk and Talk	Participatory Learning
14	Physical Evidence. Collection, Preservation, Packaging, Transporting, and Forwarding	CLO2	1	Video / Observation	Experiential Learning
15	Techniques used for handling, physical and trace evidences	CLO2	1	PPT	Participatory Learning
16	crime scene tool kits and equipment's. Ethics in crime scene investigation.	CLO2	1	Chalk and talk/ Picture	Problem-based Learning
Unit III (9 Hours)					
17	Forensic samples: Biological Evidence: Blood, Semen, Saliva, Urine, and Vaginal Secretions	CLO3	1	Lecture PPT	Participatory Learning

18	Skin, Tissue, Hair, and DNA	CLO3	1	PPT	Experiential Learning
19	Trace Evidence: Natural and Synthetic Fibers	CLO3	1	PPT	Problem-based Learning
20	Soil and Vegetation Evidence: Dirt, Plants, Seeds, and Organic Matter	CLO3	1	Displays	Experiential Learning
21	Glass Fragments	CLO3	1	Research article reading	Problem-based Learning
22	Impression Evidence: Fingerprints, Shoe Prints, Footprints, and Tire Tracks	CLO3	1	Lecture – Chalk and Talk	Experiential Learning
23	Pattern Evidence: Toolmarks and Handwriting	CLO3	1	Seminar / PPT	Participatory Learning
24	Firearms Evidence: Bullets and Shell Casings	CLO3	1	Research article reading	Problem-based Learning
25	Digital Evidence: Computers and Phones	CLO3	1	Lecture – Chalk and Talk	Problem-based Learning
Unit IV (8 Hours)					
26	Evidence collection: Blood & Other Body Fluids-	CLO4	1	Flipped classroom, Poster	Experiential Learning
27	Cuttings, Wet Absorption, Scraping method	CLO4	1	Group discussion	Experiential Learning
28	Lifting with tape.	CLO4	1	Review collection, Case study	Problem-based Learning
29	Hair and Fiber Collection: Tape Lifting and Vacuuming Method	CLO4	1	Student seminar	Participatory Learning
30	Flinders Technology Associates (FTA) Cards	CLO4	1	Poster	Experiential Learning
31	Whatman FTA Blood Collection Kit	CLO4	1	Quescussion	Participatory Learning
32	Buccal Cell Collection and Steps to Prevent Contamination	CLO4	1	Debate	Participatory Learning
33	Packaging and Storage of Samples	CLO4	1	Video / Observation	Experiential Learning
Unit V (8 Hours)					
34	DNA Fingerprinting:	CLO4	1	Video	Problem-based Learning
35	DNA Variations and Polymorphism	CLO4	1	Picture	Experiential Learning

36	DNA Typing Systems: RFLP Analysis	CLO4	1	Displays	Experiential Learning
37	PCR Amplification Sequence Polymorphism	CLO4	1	PPT	Problem-based Learning
38	Analysis of SNP, Y-STR, and Mitochondrial DNA analysis	CLO4	1	Lecture/ Virtual lab	Experiential Learning
39	Y chromosome analysis	CLO4	1	Video	Problem- based Learning
40	DNA Chip Technology - Microarrays	CLO4	1	Video	Problem- based Learning
41	Touch DNA, Low Copy Number (LCN) DNA	CLO4	1	Research article reading	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	CREDITS
MBY24PROJ	PROJECT AND VIVA VOCE	PROJECT	-	-	-	6

Preamble

- To make the students understand the importance of experimental analysis, scientific approach in solving problems related to the environment and society and to educate and train the students to write scientific papers. To develop critical thinking through the tackling of an independent research project.

Execution procedure for the allotment of students for the project

- Project students are assigned through the system. Staff members are allotted to choose the project students by lot system. Projects were all based on the student's interest.

Execution of research

- The research work can be carried out in the department or any other organization approved by the research project supervisor and the Head of the Department.
- Three review meetings will be conducted in between to monitor the progress of the research.
- Viva voce examination will be conducted by an external examiner and the research project supervisor guiding the project.

Area of work

- Genetic Engineering, Biotechnology, Microbiology, Enzyme technology, Bioremediation, Solid waste management, Genomics, Cloning, Transcriptomics, Synthetic Biology, Molecular Biology, Bioinformatics, Artificial Intelligence and areas relevant to Biotechnology.

Methodology

Each project should contain the following details

- Brief introduction to the topic
- Review of literature
- Materials and Methods
- Experimental Results and Discussion- evidence in the form of Figures, tables, graphs and photographs can be enclosed.
- Summary and References

COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	CREDITS
MBY22AC1	STEM CELL TECHNOLOGY	THEORY	-	-	-	5

Preamble

- To explain basic concepts of cell culture types, aseptic techniques, risk assessment and safety issues, cell culture methods. To evaluate the impact of cell transformation, establishment, cryopreservation of cell line, cell banks, and transportation of cells. To summarize recent advances in cell line research, principles of tissue engineering & applications.

Prerequisite

- Basic Knowledge in aseptic techniques and tissue engineering.

STEM CELL TECHNOLOGY- MBY22AC1

Unit I Stem cells and Types

Introduction to stemcells: Definition, properties, proliferation, culture of stem cells. Classification, Sources and Properties –Types of stem cells: methods of isolation, study of stem cells and their viability IPSC, embryonic stem cells, cancer stem cells. – Preservations of Stem cell. Embryonic stem cell: Isolation, Culturing, Differentiation, Properties – Adult stem cell: Isolation, Culturing, Differentiation, Trans-differentiation, Plasticity, and Properties.

Unit II Preparation and Cell Culture Maintenance

Media: Physicochemical Properties, Balanced Salt Solutions, Complete Media, Serum, Disadvantages of Serum supplemented media, Serum-Free Media, Advantages of Serum-Free media. Types of cell culture: anchorage dependent and suspension cultures; Steps involved in Primary cell culture: Isolation of Tissue, Subculture, Propagation and maintenance. Contamination: Sources, Type of microbial contamination, Monitoring, Eradication of Contamination, Cross-Contamination. Cryopreservation: Need of Cryopreservation, Preservation, Cell banks, Transporting Cells.

Unit III Assessment of Cytotoxicity

Cytotoxicity: Aberrant Growth Control, Cell counting, Plating Efficiency, Labeling Index, Generation Time of established cell line. Measurement of Cytotoxicity: Cell viability; Cell Proliferation Assays; Metabolic Cytotoxicity Assays; Microtitration and Clonogenic survival; Drug Interaction; Mutagenesis Assay by Sister Chromatid Exchange; Applications of Cytotoxicity Assays. Apoptosis and its determination; Necrosis; Difference between apoptosis and necrosis.

Unit IV Therapeutic applications of various types of stem cells

Different kinds of stem cells – Adult Stem cells, embryonic stem cells, Embryonic Germ cells, Hematopoietic stem cell, neural stem cells, muscle and cardiac stem cells, Umbilical cord blood stem cells,

cancer stem cells. Therapeutic applications: stem cells and neurodegenerative disorders, stem cells and diabetes, stem cells and cardiac disorders, regeneration of epidermis, Success stories of stem cell therapy. Stem cell banking and ethical approaches on stem cells. **Unit V Principles and Applications of Tissue Engineering**

Principles of Tissue Engineering – History and scope, Basics of Tissue Engineering, Cell-ECM interaction, Wound healing mechanism, Tissue Engineering Bioreactors, Models of Tissue Engineering, and Biomaterials in Tissue Engineering. Bioartificial organs – source of cells, choosing the right scaffold material, mode of transplantation. Commercial products: Bladder reconstruction, Skin equivalents, Liver reconstruction, Bone regeneration through tissue engineering.

Text Book

S.No.	Authors	Title of the Book	Publishers	Year and Edition
1.	Clarke M & Frampton J	Stem Cell Biology and Application.	Taylor and Francis, UK	2020 1 st Edn.
2.	Slack JMW	The Science of Stem Cells.	Wiley-Blackwell, USA	2018 1 st Edn.
3.	Huang N, L'heureux N & Li S	Engineering Stem Cells for Tissue Regeneration.	World Scientific Publishing Co Pvt Ltd, Singapore.	2018 1 st Edn.

Books for Reference

S.No.	Authors	Title of the Book	Publishers	Year and Publication
1.	Lanza R, Langer R, Vacanti J.P & Atala, A	Principles of Tissue Engineering.	Academic Press, USA	2020 5 th Edn
2.	Cooper G, Herrera J, Kirkbride J & Iman Z.	Regenerative Medicine for Spine and Joint Pain.	Springer, USA	2020 1 st Edn

Course Designers

Dr. G. Archana

COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	CREDITS
MBY22AC2	MICROBIAL AND CLINICAL GENOMICS	THEORY	-	-	-	5

Preamble

- To describe the current developments in the diagnosis of infectious diseases. To examine the importance of microbes to produce novel compounds. To compare the different chromosomal disorders. To distinguish the different genetically inherited diseases. To report about uses of biomarkers in cancer research.

MICROBIAL AND CLINICAL GENOMICS - MBY22AC2

Unit I Microbial Genomics

Infectious disorders-Identification of human disease genes. Targets for treatment of viral infection. Current development in diagnosis of tuberculosis, malaria and HIV. DNA based approaches to disease diagnosis, Whole genome sequencing, Detecting RNA signatures of disease. Molecular probes in forensic medicine. Biomarkers of pathogens, Use of nucleic acid probes in tissue typing.

Unit II Microbial Engineering

Microorganisms as factories for the production of novel compounds. Genetic engineering of microbes to improve production of antibiotics, amino acids, lipids, enzymes, steroids and secondary metabolites. Biopolymers and bioplastics.

Unit III Clinical Genomics

Chromosomal disorders - Numerical chromosome abnormalities e.g. Trisomy and Monosomy, Structural chromosomal abnormalities e.g. Deletions, Duplications, Translocations and Inversions. Single gene disorders - Sickle Cell Anemia, Thalassemia and Hemophilia. Polygenic disorders & gene clustering, Alzheimer's disease, Type 1 Diabetes, Mitochondrial disorders: Parkinson's disease.

Unit IV Human Genetic disorders

Symptoms and treatment of the Genetically inherited diseases: Phenylketonuria, Alkaptonuria, Galactosemia, G6P Dehydrogenase deficiency, Von Gierke disease, Lesch-Nyhan syndrome, Gout, Lactose intolerance, Therapy of Genetic Disease; Genetic disorders: Prenatal Diagnostic testing and Counseling.

Unit V Cancer Genomics

Historical perspective on development of cancer genomics. Cancer characterization using sequencing approaches. Advances in sequencing technologies, Discoveries using second generation sequencing technologies. Cancer transcriptome sequencing and analysis. Cancer pharmacogenomics & biomarker discovery and development, Uses of biomarkers in cancer research and cancer care. Detection of miRNA signatures of cancers.

Text Books

S.No.	Authors	Title of the Book	Publishers	Year and Edition
1.	Glick B.R & Patten C.L	Molecular Biotechnology: Principles and Applications of Recombinant DNA	John Wiley and Sons, USA.	2022 6 th Edn.
2.	Jorde L.B, Carey J.C & Bamshad M.J.	Medical Genetics	Elsevier, Netherlands.	2019 6 th Edn.
3.	Harzevili F.D. & Chen H.	Microbial Biotechnology: Progress and Trends.	CRC Press, UK	2017 1 st Edn.
4.	Ramaswamy G & Siddhartha, D.	Cancer Genomics for the Clinician.	Springer Publishing	2019 1 st Edn.
5.	Chaitanya K.V.	Diagnostics and gene therapy for Human genetic disorders.	CRC Press	2022 1 st Edn.

Books for Reference

S.No.	Authors	Title of the Book	Publishers	Year and Edition
1.	Glick BR, Delovitch, TL & Patten CL	Medical Biotechnology	ASM Press, USA.	2014 7 th Edn.
2.	Dellaire G, Berman JN & Arceci	Cancer Genomics: from Bench to Personalized Medicine.	Elsevier Science, UK	2014 1 st Edn.
3.	Palavra F, Reis F & Marado D	Biomarkers of Cardiometabolic Risk, Inflammation and Disease.	Springer, USA.	2015 1 st Edn.
4.	Uppal K	Handbook of FAQ's on Basic Genetics and common Genetic disorders for students.	CBS Publishers and Distributors.	2022 1 st Edn.

Course Designer

Dr. G. Archana