M. Tech. Biotechnology – 2021 Batch onwards

Program Educational Objectives (PEOs)

PEO-1: To impart basic and advance knowledge in the emerging areas biotechnologies
PEO-2: To inculcate the laboratory skills to cater the needs of industries and high end research
PEO-3: To inculcate team work with ethics to solve problems using multidisciplinary approaches

M.Tech. Biotechnology Course Curriculum

FIRST SEMESTER

Sr.No.	Code	Subject	L-T-P	Credits
1	13M11BT111	Advances in Molecular Cell Biology	3-0-0	3
2	13M17BT171	Advances in Molecular Cell Biology Lab	0-0-2	1
3	18M11BT113	Research Methodology and Ethics	3-0-0	3
4	18M11BT114	Patenting in Biotechnology	3-0-0	3
5	13M11BT112	Advanced Bioinformatics	3-0-0	3
6	13M17BT172	Advanced Bioinformatics Lab	0-0-2	1
7	13M11BT114	High Throughput Technologies	3-0-0	3
8	Elective	DE-1	3-0-0	3
9	Elective	DE-II	3-0-0	3
		Total	**25**	**23**

SECOND SEMESTER

Sr.No.	Code	Subject	L-T-P	Credits
1	14M11BT211	Industrial Biotechnology	3-0-0	3
2	14M17BT271	Industrial Biotechnology Lab	0-0-2	1
3	14M11BT212	Immunotechnology	3-0-0	3
4	14M17BT272	Immunotechnology Lab	0-0-2	1
5	14M11BT214	Bioenterpreunership Management	2-0-0	2
6	14M11BT213	Functional Genomics	3-0-0	3
7	14M17BT273	Functional Genomics Lab	0-0-2	1
8	14M11BT215	Metabolic Engineering	3-0-0	3
9	Elective	DE-III	3-0-0	3
10	Elective	DE-1V	3-0-0	3
		Total	**26**	**23**

THIRD SEMESTER

Sr.No.	Code	Subject	L-T-P	Credits
1.		Seminar	0-0-4	2
4.		Project- Thesis Part I		12
		Total	**04**	**14**

FOURTH SEMESTER

Sr. No.	Code	Subject	L-T-P	Credits
1.		Seminar	0-0-4	2
3.		Project- Thesis Part II		14
		Total	**04**	**16**

Total Credit Hours: 76

Approved in Academic Council Meeting held on 28 July, 2021

M. Tech. Biotechnology Electives courses

ODD SEMESTER			
	Course Code	Credits	Elective Courses
1	20M1WBT131	03	Food Processing & Engineering
2	20M1WBT132	03	Plant Tissue Culture Technologies
3	18M1WBT134	03	Microbial Ecology
4	20M1WBT134	03	Advances in Gene manipulations
5	20M1WBT133	03	Vaccine Production
6	18M1WBT133	03	Advances in Computational System Biology

EVEN SEMESTER			
	Course Code	Credits	Elective Courses
1	20M1WBT232	03	Industrial Enzyme Technology
2	20M1WBT231	03	QC Analysis and Management
3	20M1WBT234	03	Clinical Diagnostics
4	11IIWBT433	03	Plant Biotechnology
5	11BIWBT840	03	Nano Biotechnology

Advances in Molecular Cell Biology

COURSE CODE

COURSE CREDITS: 3

CORE

L-T-P: 3-0-0

Pre-requisite: Molecular Biology, Biochemistry

Course Objectives

1. This is an advance course with objective expose students to the advanced topics of Molecular Cell Biology

Course Outcomes

Sr. No.	Course outcomes	Level Attainment
CO I	Students will acquire knowledge about the Topological properties of DNA and importance of topoisomarases for cell survival	Familiarity
CO II	Students will have understanding about the unique aspect of ekaryotic replication and DNA damage, repair and recombination	Familiarity
CO III	Students will acquire advance knowledge Eukaryotic RNA and Protein synthesis	Assessment
CO IV	Students will acquire advance knowledge on gene regulation and regulation of cell cycle and cell communication	Usage
CO V	Students will be able to comprehend the recent development in the area of genome editing tools and their application	Usage

Topic Covered

S. No.	Contents	Lecture required.
1	Concept: Closed circular DNA, Negative and Positive supercoiling, Linking Number twist writhe. Topoisomerases and their mode of action, Antibiotics based on topoisomerases	4
2	Unique aspects of eukaryotic replication, fidelity of replication, DNA damage, repair mechanisms, homologous and site-specific recombination,	5
3	Eukaryotic RNA polymerases, RNA synthesis and RNA processing in eukaryotes, RNA editing, splicing, and polyadenylation	4
4	Aminoacylation of tRNA, tRNA-identity, aminoacyl tRNA synthetase, and translational proof-reading, translational inhibitors, Post- translational modification of proteins.	4
5	Inducible, Repressible Positive and Negative Control of Gene Expression, Lac operon mutants, Tryptophan Repression and Attenuation, Repression of Lambda Lytic Pathway Genes, Translational Control of Gene Expression, Post-Translational gene regulation, Major gene regulation mechanisms in eukaryotes with examples	10
6	Cell Cycle Checkpoints, **cyclins and cyclin-dependent kinases (CDKs),** Regulation of Cell Cycle Apoptosis, pathways, Regulation and role in cancer	5
7	General principles of cell communication cell surface receptor, signaling through G-protein coupled receptors, signal transduction pathways, second messengers, regulation of signalling pathways, interaction of cancer cells with normal cells	6
8	Genome editing, Zinc finger nuclease, ALLEN, CRISPR/Cas, CRISPER/Cas vectors and their delivery, Advancement in genome editing tools, Application of	4

	genome editing	
	Total Contact Hours	42

TEXT BOOKS

1. Molecular Cell Biology by Lodish
2. Molecular Biology, PS Verma VK Agarwal
3. Principles of genetics / D. Peter Snustad, Michael J. Simmons Snustad, D. Peter

REFERENCE BOOKS

1. **Research and Review Articles:**
2. Lewin's GENES IX, X XII

Evaluation Scheme:

Assessment	Max. marks	Duration	Course Covered
T1 Test	15	1 hr.	Syllabus covered upto T-1
T2 Test	25	1.5 hrs.	Syllabus covered upto T-2
End Term Test	35	2 hrs.	Entire Syllabus
Teacher Assessment	25	Entire Sem	Based on Assignments, quizzes etc.

Advances in Molecular Cell Biology lab

COURSE CODE

COURSE CREDITS: 2

CORE/ELECTIVE: CORE

L-T-P: 0-0-2

Pre-requisite: Molecular Biology, Biochemistry

Course objectives:

1. The course is intended to provide hand on experiments on Molecular biology techniques. Students will able to carry out both basic bioinformatics work and genomics work.
2. The course will explore that how different advance molecular biology techniques unravel the understanding of diseases at genetic level

Course Outcomes:

Sr. No.	Course outcomes	Level Attainment
CO I	Students will have a thorough understanding of gDNA extraction from microbial cells, plant and animals cells	Familiarity
CO II	Students will have will have hand on learning on how to perform agarose gel electrophoresis and Polymerase Chain Reaction to amplify gene candidate genes	Assessment
CO III	Students will learn restriction sites present in the in the DNA sequence and how to perform restriction digestion using *E. coli* plasmid DNA	Usage

Experiments covered:

Index

S.NO.	TITLE
1	General laboratory practices and Calculations of morality and normality of the solutions
2	Introduction to general Instrumentations for lab. Practices; pH meter, centrifuge, spectrophotometer etc.
3	Isolation of genomic DNA from microbial cells, plant and animals cells,
4	To perform agarose gel electrophoresis, Polymerase Chain Reaction to amplify gene candidate genes,
5	Isolation of RNA, synthesize cDNA from total RNA preparation using reverse transcriptase and oligodT primer,
6	Expression analysis using RT PCR,
7	To perform restriction digestion using *E. coli* plasmid DNA.

Reference books

1. Methods in Molecular Biology. Starkey, Michael P. Elaswarapu, Ramnath. Genomics Protocols. 2000. Vol. 175. Humana Press
2. Sambrook, J., Fritsch, E. F., Manitiatis, T., Molecular Cloning: A Laboratory Manual, New York: Cold Spring Laboratory Press, 1998, 25—27.
3. Current Protocols in Molecular Biology. Frederick M. Ausubel. John Wiley & Sons Inc. 1988

Laboratory Manuals

Evaluation Scheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Lab Assessment	60 Marks
	Total	100 marks

Research Methodology and Ethics

COURSE CODE

COURSE CREDITS: 3

CORE/ELECTIVE: CORE

L-T-P: 3-0-0

Pre-requisite: B. Tech completed

Course Objectives

1. The objective of the course is to make the student aware of research, planning design and appropriate methodology for research.
2. To learn statistical treatment, analysis of data, interpretation of results and grant writing.

Course Outcomes

Sr. No.	Course outcomes	Level Attainment
CO I	Able to understand and apply various research approaches, techniques and strategies in life science research	Familiarity
CO II	Develop understanding of research ethics and research misconduct	Familiarity
CO III	Develop necessary critical thinking skills in order to do data analysis and interpretation in relation to the research process	Assessment
CO IV	Understand the importance scientific communication and develop technical writing skills	Assessment
CO V	Able to identify, formulate, plan and prepare research based project proposals	Usage
CO VI	Develop understanding of statistical validation of hypothesis and basic principles of experimental designs	Usage

Topic Covered

Unit no.	Contents	Lecture required
1	Introdcution, the social foundation of science, values in science, Responsible conduct of scientist, meaning of research, Types of research, Research Methods versus, Methodology, Criteria of good research, problems encountered by researches in India	3
2	Research Ethics for scientist and Research Misconduct: Fabricating Data, Collaboration in research authorship, resource sharing and mentoring , Conflicts of interest and scientific objectivity, Collaboration between academia and private industry, The use of animals in research. The scientist and society.	7
3	Research methodology: Research Problem, selection technique involved in defining research problem, , Literature search and personal reference databases, strategies, Planning and analysis of basic medical research, epidemiology: scientific communication Sampling and Sampling Methods, Data classification and presentation	14
4	Authorship, Successful lecturing, Grant Writing, Research and development of projects in biotechnology, bioethics, Peer Review	6
5	Testing of Hypothesis: Statistical hypothesis, critical region, level of significance,	6

	power of test, degree of freedom, steps in testing a hypothesis, Applications of z and t tests for testing hypothesis	
6	Principles of Experimental designs Basic definitions; Experiment, treatment, replication, Experimental material, Experimental units, Fisher's principles of experimental design	6
	Total	42

TEXT BOOKS

1. Research Methodology: Methods and Techniques. CR Kothari, New Age International Publishers
2. Biostatistics A foundation in the Health Sciences: Wayne W Daniel
3. Fundamental of Mathematical Statistics: SC Gupta VK Kapoor
4. Research this is it! Guide to quantitative and qualitative research Ben Baarda, Routledge

Evaluation Scheme:

Assessment	Max. marks	Duration	Course Covered
T1 Test	15	1 hr.	Syllabus covered upto T-1
T2 Test	25	1.5 hrs.	Syllabus covered upto T-2
End Term Test	35	2 hrs.	Entire Syllabus
Teacher Assessment	25	Entire Sem	Based on Assignments, quizzes etc.

Patenting in Biotechnology

COURSE CODE

COURSE CREDITS: 3

CORE/ELECTIVE: CORE

L-T-P: 3-0-0

Pre-requisite: Biotechnology

Course Objectives

1. To provide an insight and understanding about different aspects of protection of inventions and research developments
2. Learn about procedures for filling and registration of patent and other Intellectual Property Rights.
3. Learn about prerequisites for patenting in Biotechnology.

Course Outcomes

Sr. No.	Course outcomes	Level Attainment
CO I	To enable students with basic concepts and knowledge of intellectual property rights.	Awareness
CO II	Able to learn about procedures of patenting in biotechnology and other biological arenas.	Assessment and technical skills
CO III	Able to understand about the mechanisms of different IP protections, registrations and applications	Technical
CO IV	To be capable of tackling all issues related to IP, Bioethics and Biosafety wrt. Biotechnology	Assessment
CO V	Able to learn the strategies for effective IP management and value addition in biotechnological aspects	Analytical skills
CO VI	To understand the procedures for developing safe biotechnological products for the benefit generation and for mass utilization by	Usage

Topic Covered

S. No.	Contents	Teaching required
1	**Introduction**: Introduction of Intellectual properties and rights conferred . Integration of Intellectual Property, Bioethics and Biosafety for biological and applied sciences in research and academia.	4
2	**Types of IP tools**: Different types of IPR(Patents, copyrights and related rights, Trademark, Tradesecret, Integrated circuit layout, Geographical indications, Traditional knowledge, Industrial designs and PBR) Rationale of different IPR ,their mechanism of protection and provisions in Law	6
3	**Patent** :Drafting Patent Application and Documentations Procedure of filling and its types Revocation of Patent, Litigation and Infringement	6
4	**International Agreements** and Treaties: International IP treaties (Madrid Agreement, Trademark law treaty, Patent Law treaty etc.) WIPO, EPC, WTO, and TRIPS. International agreements relevant to	8

	biotechnology-associated IP	
5	**Assignment and Licensing**: Types of licensing models and modes to carry out, Assignments and its benefits	6
6	**IP Management:** Strategies for IP Management and commercialization. Intellectual Property in Biotechnology and Bioentreprenuership Commercialization of biotechnology and bioinformatics Patents	4
7	**Biosafety and Bioethics for Biotechnology patents** :Basic guidelines and principles. Biosafety levels and Bioethics tools. Case studies with latest concerns. Litigation and law enforcement for generation of safe biotechnological products.	8
	Total Number of Lectures	**42**

Suggested Text Book(s):

1. Intellectual Property Rights & Copyright By Bouchoux.
2. IPR, Biosafety and Bioethics Book by Deepa Goel and Shomini Parashar

Suggested Reference Book(s):

1. Intellectual Property Rights, the WTO and Developing Countries: The TRIPS ...Book by Carlos María Correa
2. Bioethics and Biosafety by M K Sateesh.

Evaluation Scheme:

Assessment	Max. marks	Duration	Course Covered
T1 Test	15	1 hr.	Syllabus covered upto T-1
T2 Test	25	1.5 hrs.	Syllabus covered upto T-2
End Term Test	35	2 hrs.	Entire Syllabus
Teacher Assessment	25	Entire Sem	Based on Assignments, quizzes etc.

Advanced Bioinformatics

COURSE CODE

COURSE CREDITS: 3

CORE/ELECTIVE: CORE

L-T-P: 3-0-0

Pre-requisite: Molecular Biology, Introduction to Bioinformatics

Course Objectives

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

Course Outcomes

Sr. No.	Course outcomes	Level Attainment
CO I	Able to apply bioinformatics to modern day biology with special focus on next generation sequencing	Familiarity
CO II	Able to perform computational analysis of metagenomics	Familiarity
CO III	Able to perform computational analysis of RNA-seq	Assessment
CO IV	Able to understand and perform Chip-seq analysis	Assessment
CO V	To develop a strong foundation variant analysis	Usage
CO VI	Able to understand the contemporary research in biology through NGS techniques	Usage

Topics Covered

S. No.	**Contents**	Lecture required.
1	Bioinformatics and its applications in translational medicine (p4 medicine, Homology modelling, drug design etc)	1
2	Metagenomics and its computational analysis, alpha and beta diversity	4
3	Next generation sequencing (NGS), its applications and its computational analysis, Galaxy package	4
4	R language for bioinformatics	10
5	Relational databases: Design and implementation of relational databases and software programs, ER diagrams	6
6	Gene expression databases and gene expression analysis (microarrays, RNA-seq)	5
7	Chip-Seq and Variant analysis, BAM/SAM file, VCF file	5
8	Protein structure, function and stability prediction, sequence and domain analyses	2
9	Research seminars on contemporary bioinformatics (related to metagenomics, transcriptomics etc.)	5
		42

TEXT BOOKS

1. Biological Sequence analysis by R Durbin, Sean Eddy et al.
2. Metagenomics: perspectives, methods and applications by Muniyandi Nagarajan

3. Microarray Gene Expression Data Analysis: A Beginner's Guide by Helen Causton

Evaluation Scheme:

Assessment	Max. marks	Duration	Course Covered
T1 Test	15	1 hr.	Syllabus covered upto T-1
T2 Test	25	1.5 hrs.	Syllabus covered upto T-2
End Term Test	35	2 hrs.	Entire Syllabus
Teacher Assessment	25	Entire Sem	Based on Assignments, quizzes etc.

Advanced Bioinformatics Lab

COURSE CODE

COURSE CREDITS: 3

CORE/ELECTIVE: CORE

L-T-P: 3-0-0

Pre-requisite: Bioinformatics

Objective

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

Course Outcome

Sr. No.	Course outcomes	Level Attainment
CO I	**A**dvanced searches in NCBI and Expasy resources	Familiarity
CO II	Sequence analysis including alignments and phylogenetic analysis	Assessment
CO III	Mapping of metabolic enzymes and various proteins to KEGG and GO	Usage

Topics Covered (List of Experiments):

Index

S. No.	Title
1	Hands-on on Linux OS, Use of basic commands and shell
2	MOTHUR, QIIME packages for metagenomics
3	GEO, RNA-seq Atlas databases
4	R language-variable and workspace, vectors, matrices and arrays
5	R language- Lists and data frames
6	R language- Strings and factors, Flow control and Loops
7	Use of BWA, Bowtie, TopHat, MapSplice
8	DESeq, edgeR packages in R
9	RNA-seq analysis on sample dataset
10	Phylogenetic analysis methods and tree viewers: Phylip and Archaeopteryx
11	Genome browsers- ZENBU, UCSC
12	Galaxy Package
13	Homology modeling in MODELLER, Docking in PatchDock
14	Chip-seq analysis on sample dataset
	Capstone project based on any NGS technique covered in the semester

TEXT BOOKS

1. Microarray Gene Expression Data Analysis: A Beginner's Guide by Helen Causton
2. Metagenomics: perspectives, methods and applications by Muniyandi Nagarajan

Evaluation Scheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Lab Assessment	60 Marks
	Total	100 marks

High Throughput Technologies

COURSE CODE 13M11BT114

COURSE CREDITS: 3

CORE/ELECTIVE: CORE

L-T-P: 3-0-0

Pre-requisite: Molecular Biology, Biochemistry

Course Objectives

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

2. The course will explore that how technological innovations fostered by the prokaryotic and eukaryotic genome Projects, will lead to significant advances in our understanding of diseases/ biological processes that have a genetic basis and, more importantly, how health care will be delivered from this point forward

Course Outcomes

Sr. No.	Course outcomes	Level Attainment
CO I	Students will have a thorough understanding of various genomic technologies such as whole genome mapping & sequencing, genome annotation, global gene cloning and gene expression technologies, proteomics.	Familiarity
CO II	The students will know the vast amount of genome information in publically available databases and how to access and best utilize for practical purposes	Familiarity
CO III	Able to analyze the gene expression data sets to derive the biologically meaning information	Uses

Topic Covered

S. No.	Topics Covered	Teaching required
1	Experimental evidence & History of Genetic material Biological relevance of the primary and secondary database	3
2	Genome and Genome organization of model organisms Sanger sequencing (Introduction and history) High throughput sequencing 1.Pyrosequencing, 2. Solid phase sequencing 3. Sequencing by Ligation Sequence alignment & mapping to the reference genome	8
3	Genome annotation. Gene predictions with transcripts analysis (Alternate splicing) 2. Transcriptome. DNA microarray. Types of array. 3. Oligobased Array and cDNA-based Array. 4. Characteristics of Microarray	8
4	Fluorescent labeling of cDNA. 2. Hybridization. Normalization of Data, Output. Data analysis and data 3.Presentation of gene expression high-through put data (Heat-map, K-mean) 4. Application of microarray (gene expression, Single nucleotide	8

	polymorphisms. Serial Analysis of gene expression.	
5	Proteome. 2-D gel electrophoresis. 2. Protein sequence analysis by mass spectroscopy. MALDI 3. Predicting structure and function.	7
6	Protein expression (functional assay). Characteristics and properties of protein array 2. High through put screening of functional properties such as 1. Protein-protein interaction 2. Protein-substrate interaction 3. Protein-ligand interaction	6
7	Application of protein detection as Biomarker, Structure and ligand based approaches to screen lead molecules.	2
	No. of lectures	42

TEXT BOOKS& REFERENCE RESEARCH ARTICLES

1. Discovering Genomics, proteomics & bioinformatics. Second edition by A Malcolm Campbell, Davidson College; Laurie J. Heyer Davidson College ; With Foreword by Francis S. Collins
2. Molecular Biology of the Gene (1987) Watson J. D., Hopking N., Robast J. and Steiz, J.
3. BIOINFORMATICS: A Practical Guide to the Analysis of Genes and Proteins (Third edition) Andreas D. Baxevanis & B. F. Francis Ouellette
4. Ronaghi M. Pyrosequencing sheds light on DNA sequencing. Genome Res. 2001. Jan;11(1):3-11. Review. PubMed PMID: 11156611.
5. Kim JB, Porreca GJ, Song L, Greenway SC, Gorham JM, Church GM, Seidman CE,Seidman JG. Polony multiplex analysis of gene expression (PMAGE) in mouse hypertrophic cardiomyopathy. Science. 2007 Jun 8;316(5830):1481-4. PubMed PMID:
    a. 17556586
6. MacBeath G, Schreiber SL. Printing proteins as microarrays for high-throughput function determination. Science. 2000 Sep 8;289(5485):1760-3. PubMed PMID: 10976071
7. Shankar J, Wu TD, Clemons KV, Monteiro JP, Mirels LF, et al. (2011) Influence of 17b-Estradiol on Gene Expression of Paracoccidioides during Mycelia-to-Yeast Transition. PLoS ONE 6(12): e28402. doi:10.1371/journal.pone.0028402

Evaluation Scheme:

Assessment	Max. marks	Duration	Course Covered
T1 Test	15	1 hr.	Syllabus covered upto T-1
T2 Test	25	1.5 hrs.	Syllabus covered upto T-2
End Term Test	35	2 hrs.	Entire Syllabus
Teacher Assessment	25	Entire Sem	Based on Assignments, quizzes etc.

Industrial Biotechnology

COURSE CODE

COURSE CREDITS: 3

CORE/ELECTIVE: CORE

L-T-P: 3-0-0

Pre-requisite: B. Tech Biotechnology

Course Objectives

1. The course emphasizes mainly on the biotechnological applications in different industries along with the fundamentals of Industrial Biotechnology. As a part of the course curricula, discussion about the recent advances in fermentation technology, immobilization have been included in the course content.
2. Introduction of biotechnological applications in different industries
3. Fundamentals of biocatalysts/ Microbes improvement through immobilization, Directed evolution and systems biology approach

Course Outcomes

Sr. No.	Course outcomes	Level Attainment
CO I	Fundamentals, History and Scope of Industrial Biotechnology	Familiarity
CO II	Fermentation technologies, Industrial enzymes production and Downstream Processing	Familiarity
CO III	Role of IB in different industries	Assessment
CO IV	Enhancement of biocatalysts/microbes through immobilization, Directed Evolution and systems biology approaches	Assessment
CO V	Environmental, Economic and Societal issues of Industrial Biotechnology	Usage

Topic Covered

S. No.	Topics Covered	Teaching required
1	Introduction to Industrial Biotechnology: History of Industrial Biotechnology in allied areas; Scope of Industrial Biotechnology	4
2	Fermentation Technology; Industrial Production of Enzymes; Downstream processing in Industrial Biotechnology	12
3	Industrial Biotechnology in Chemical, Pharmaceutical, Food, Feed, Biofuel, Pulp & Paper and allied sectors	12
4	Directed evolution of Industrial Biocatalysts, Applied Biocatalysis; NanoBiotechnology; Industrial systems biology	10
5	Environmental, Economic and Societal issues of Industrial Biotechnology	4
	No. of lectures	42

TEXT BOOKS

1. Industrial Biotechnology: Sustainable Growth and Economic Success by Soetaert and Erick J. Vandamme

2. Fermentation and Biochemical Engineering Hand Book by HC Vogel
3. Industrial Biotechnology by J. Thompson
4. Industrial Biotechnology by AS Maturiya
5. Industrial Biotechnology by IS Thakur

REFERENCE BOOKS

1. Review articles from Science Direct, Springer, Wiley and PubMed Publishers

Evaluation Scheme:

Assessment	Max. marks	Duration	Course Covered
T1 Test	15	1 hr.	Syllabus covered upto T-1
T2 Test	25	1.5 hrs.	Syllabus covered upto T-2
End Term Test	35	2 hrs.	Entire Syllabus
Teacher Assessment	25	Entire Sem	Based on Assignments, quizzes etc.

Industrial Biotechnology Lab

COURSE CODE

COURSE CREDITS: 2

CORE/ELECTIVE: CORE

L-T-P: 0-0-2

Pre-requisite: Hands on experience in Microbiology, Biochemistry and Basic instrumentation experiments

Course objectives

1. To provide exposure to the students with hands on experience on various practices in Industrial Biotechnology Sector.
2. Implementation of theoretical knowledge of Industrial Biotechnology for production of different Industrial products / commodities.

Course Outcome

Sr. No.	Course outcomes	Level Attainment
CO I	Hand on experience in submerged and solid state fermentations for product of Industrial enzymes	Familiarity
CO II	Able to devise the downstream processing, characterization and kinetics of Industrial enzymes	Assessment
CO III	Industrial applications in enzymes	Usage

Topics Covered (List of Experiments):

Index

S. No.	Title
1	Production of α- Amylase through submerged fermentation
2	Assay and Protein estimation of α- Amylase
3	Partial purification of α- Amylase through Ammonium sulphate precipitation
4	Partial purification of α- Amylase through Acetone precipitation
5	Kinetic constants determination of α- Amylase
6	Characterization of partially purified α- Amylase towards the effect of Temperature and pH
7	Immobilization of α- Amylase in calcium alginate beads
8	Characterization of immobilized α- Amylase and comparative study with soluble enzyme
9	Production of lignocellulolytic enzymes through solid state fermentation
10	Assay and Protein estimation of lignocellulolytic enzymes
11	Characterization and kinetic constant determinations of lignocellulolytic enzymes
12	Hydrolysis of starch through immobilized α- Amylase
13	Enzymatic delignification of lignocellulosic substrate
14	Pectinase mediated fruit juice clarification

TEXT BOOKS

1. **Laboratory Manual in Industrial Biotechnology by P. Chellapandi**
2. Introduction to Biotechnology Lab Manual by Fletcher et al.

Evaluation Scheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks

3	Lab Assessment	60 Marks
	Total	100 marks

Immunotechnology

COURSE CODE

COURSE CREDITS: 3

CORE/ELECTIVE: CORE

L-T-P: 3-0-0

Pre-requisites: Fundamentals of Biology and preliminary Immunology

Course Objectives:

1. The objective of the course is to develop a sound knowledge of immunological principles and be able to understand different technology driven immunological applications in disease and health.

Course Outcomes:

Sr. No.	Course outcomes	Level Attainment
CO I	Use correct scientific terminologies to describe & explain fundamental concepts in immunology	Familiarity
CO II	Able to interpret and apply knowledge in context of immunology based techniques in health and disease	Assesment
CO III	Students with plans to carry out higher studies should be able to relate and apply immunological principles in their research while students inclined towards industrial career should be able to envision themselves as a part of the R &D sector in the area of immunology	Usage

. **Topics Covered:**

S.N.	Content	Lecture required
1	**Immunoglobins and antigens**: Immunoglobins: structure and function, immunoglobin classes	3
2	**Antigens:** Immunogenicity, antigenicity, epitopes, haptens, mitogens; Antigen Recognition by immune system: recognition of antigens by T and B Cells: Antigen processing and presentation, MHCs, role of MHC molecules in antigen presentation and co stimulatory signals.	5
3	**Production, Detection, measurement and characterization of antibodies and their use as research and diagnostic tools:** Production of antibodies: monoclonal and polyclonal antibodies, Anti-immunoglobulin antibodies; Monoclonal Antibody – Concept, Hybridoma technology, Strategy and protocol for production, examples. Monoclonal Antibody Types - murine, chimeric, humanized, human – limitations, applications. Cancer Immunotherapy.	10
4	**Antigen-Antibody Interactions and Techniques :** Introduction, Lattice Theory, Precipitin Curve, specific and cross reactivity, Microscopy and Imaging-Immunohistochemistry, Immunoprecipitation and co-immunoprecipitation, Immunoblotting Simple Immunodiffusion (Radial Immunodiffusion – Qualitative, Quantitative); Double Diffusion (Mechanism of Reaction of Identity, Partial – Identity, and Non-Identity); Immunoelectrophoresis; Agglutination – Antibody titer, Prozone Phenomenon, Direct and Indirect Agglutination, Hemagglutination, ABO Blood typing, Agglutination Inhibition; Immunofluorescence, Radioimmunossay; ELISA – Theory, Designing an ELISA method, Types – Direct, Indirect, Sandwich, Competitive, Dot ELISA	12
5	**Characterization and analysis of cellular and soluble immune components:**	7

	Isolation and enrichment of specific immune cells, ELISPOT, Flow-cytometer and FACS for quantitative/qualitative analysis and sorting of different immune cell subsets, Cell functional assays- lymphoproliferation, Cell cytotoxicity, mixed lymphocyte reaction, apoptosis.	
6	**Vaccination strategies:** Active immunization: Sub unit vaccines; Recombinant DNA and protein based vaccines, Peptide vaccines, conjugate vaccines; Passive Immunization: Antibody, Cell based vaccines , high throughput identification of pathogen specific potential antigens for vaccine development, Immunoinformatics and vaccine design.	5
	No of lectures	42

Reference Books:

1. Kenneth Murphy (Charles A Janeway, Paul Travers, Mark Walport) 8th Edition: **Immunobiology**
2. Abbas AK, Lichtman AH and Pillai S **(2001) Cellular and Molecular Immunology**; Elsevier, USA, 7th Ed.
3. Kindt, T.J., Goldsby, R.A. and Osborne, B.A. (2007). **Kuby Immunology** W.H. Freeman and Co., New York, 7th Ed.
4. Roit, I. (2012). **Essential Immunology**. Blackwell Scientific Publications, Oxford, 12th Ed.
5. Primrose SB, Twyman RM and Old RW (2002) **Principle of gene manipulation**. Wiley-Blackwell, UK, 6th Ed.

Evaluation Scheme:

Assessment	Max. marks	Duration	Course Covered
T1 Test	15	1 hr.	Syllabus covered upto T-1
T2 Test	25	1.5 hrs.	Syllabus covered upto T-2
End Term Test	35	2 hrs.	Entire Syllabus
Teacher Assessment	25	Entire Sem	Based on Assignments, quizzes etc.

Immunotechnology Lab

COURSE CODE

COURSE CREDITS: 2

CORE/ELECTIVE: CORE

L-T-P: 0-0-2

Prerequisites: Fundamental Immunology

Course objectives:

1. To demonstrate application of basic immunological concepts and mechanisms
2. Enable students to translate the theoretical foundation in immunology into practical understanding.

Course Outcomes:

Sr. No.	Course outcomes	Level Attainment
CO I	Able to describe practical aspects of immunological principles through hands-on experimentation	Familiarity
CO II	Able to correlate application of basic immunology in industries like Engineering of antibodies, vaccine formulations and other immune-Intervention immune strategies, diagnostics, quality control/assurance and R & D in research settings	Assessment & Usage

Experiments covered:

Index

Sr. No.	Name of Experiment
1	To quantify the amount of precipitation by Quantitative precipitation assay.
2	To quantify the concentration of unknown antigen by radial Immunodiffusion (RID)
3	To determine the identity of antigen by double Immunodiffusion (DID)
4	To quantify the concentration of unknown antigen by rocket Immunoelectrophoresis
5	To perform hemagglutination assay for ABO blood group typing and determination of Rh factor
6	To perform Latex Agglutination and Latex Agglutination Inhibition
7	To determine the concentration of antigen by Sandwich ELISA method.
8	To determine the presence of antigen by Dot ELISA method.
9	To learn mice handling and dissection.

Reference book

- Kindt, T.J., Goldsby, R.A. and Osborne, B.A. (2007). Kuby Immunology W.H. Freeman and Co., New York, 7th Ed.
- Roit, I. (2012). Essential Immunology. Blackwell Scientific Publications, Oxford, 12th Ed.
- Kit and Lab Manuals

Evaluation Scheme:

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Lab Assessment	60 Marks
	Total	100 marks

Bioentrepreneurship and Management

COURSE CODE

COURSE CREDITS: 3

CORE/ELECTIVE: CORE

L-T-P: 3-0-0

Pre-requisite: B. Tech

Course Objectives

1. The objective of the course is to provide an insight to the students on different aspects of entrepreneurship in different streams of Biotechnology and related ones, so that their technological expertise would be utilize to generate new business avenues.

Course Outcomes

Sr. No.	Course outcomes	Level Attainment
CO I	Able to understand the nature and functions of the bio-based industries	Familiarity
CO II	Able to explore different biotech business models and to acquire the fundamentals of biotech business management	Familiarity
CO III	Able to understand the fundamentals of business setup including organizational structure, market strategy, financial planning etc.	Assessment
CO IV	To understand the requirements of a biotech business plan in particular from the perspective of prospective funders	Usage
CO V	Able to launch a new business with a holistic understanding of the firm functions and their role and have presentation skills to market a new venture	Usage

Topic Covered

S. No.	Topics Covered	Teaching required
1	Importance of entrepreneurship and its essential features, Entrepreneurs: Types, characteristics, qualities and skills, and their functions, Entrepreneurial Attributes and Characteristics, Factors affecting entrepreneurship in action	3
2	**Introduction to bioentrepreneurship**: Biotechnology in a global scale; Scope in bioentrepreneurship; Types of bio-industries: Biopharma, Bioagri, Bioservices & Bioindustrial; Opportunities: Entreprenuership development programs of public and private agencies (MSME, DBT, BIRAC, Startup & Make in India); Patent landscape, IP protection & commercialization strategies.	5
3	**Business plan and its preparation:** Definition, its importance, its various components, writing of a business plan**. Business feasibility:** Business idea generation and feasibility analysis by SWOT, socio-economic costs benefit analysis. **Market validation:** Opportunity recognition as entrepreuner, marketability analysis, identifies key information such as market size and opportunities (are there other uses/markets besides what the researcher has identified?; trends in the industry, presence of competitors),	4

4	**Financing options:** Funds/support from Government agencies like MSME/banks and private agencies like venture capitalists:/angel investors for bioentrepreneurship; Business plan proposal for "virtual startup company"; statutory and legal requirements for starting a company/venture; **Basics in accounting practices:** Concepts of balance sheet, profit and loss statement, double entry, bookkeeping; collaborations & partnerships; information technology for business administration and expansion.	3
5	**Creating the Organization:** Development of organizational vision and mission and its culture issues Organization design, Statutory and legal requirements for starting a venture **Launching the venture:** Establishing the organizational goals and strategies, marketing functions, designing the venture's information systems, financial and accounting systems	3
6	Assessment of market demand for potential product(s) of interest; Market conditions, segments; Identifying needs of customers including gaps in the market, packaging the product; Market linkages, branding issues; Developing distribution channels; Pricing/Policies/Competition; Promotion/Advertising. Managing growth and downturns, Succession or contingency planning, Founder's dilemma	4
7	Knowledge Centre and R&D Knowledge centres e.g., in universities, innovation centres, research institutions (public & private) and business incubators; R&D for technology development and upgradation; assessment of technology development; managing technology transfer; industry visits to successful bio-enterprises, regulations for transfer of foreign technologies; quality control; technology transfer agencies; Understanding of regulatory compliances and procedures (CDSCO, NBA, GLP, GCP, GMP)	6
	No. of Lectures	42

Case Studies

1. Prepare a proposal for funding from any one of the Government funding agency.

2. Students should be made to start a 'mock company' based on their ideas, systematically following all the procedures. The market analysis developed by them will be used to choose the product or service. The students need to defend their idea of making a product or service through mock company.

TEXT BOOKS

1. Entrepreneurship and small firms. D. Deakins, M. Freel. The McGrawHill Education, 5th Edition.
2. Enterprise for life scientists: Developing innovation and entrepreneurship in the biosciences. Adams, D. J., & Sparrow, J. C. (2008). Bloxham: Scion
3. Biotechnology entrepreneurship: Starting, managing, and leading biotech companies. Shimasaki, C. D. (2014). Amsterdam: Elsevier. Academic Press is an imprint of Elsevier.. Innovation, Commercialization, and Start-Ups in Life Sciences. Jordan, J. F. (2014). London: CRC Press.

REFERENCE BOOKS

1. The Dynamics of Entrepreneurial Development and Management. Desai, V. (2009). New Delhi: Himalaya Pub. House.
2. Business modeling for life science and biotech companies: Creating value and competitive advantage with the milestone bridge. Onetti, A., & Zucchella, A. (n.d.). Routledge. Entrepreneurship, R. D. Hisrich, M. P. Peters. The McGrawHill Education, 5th Edition
3. Entrepreneurship: New Venture Creation, D. H. Holt. Prentice-Hall India (2004).

Evaluation Scheme:

Assessment	Max. marks	Duration	Course Covered
T1 Test	15	1 hr.	Syllabus covered upto T-1

T2 Test	25	1.5 hrs.	Syllabus covered upto T-2
End Term Test	35	2 hrs.	Entire Syllabus
Teacher Assessment	25	Entire Sem	Based on Assignments, quizzes etc.

Functional Genomics

COURSE CODE

COURSE CREDITS: 3

CORE/ELECTIVE: CORE

L-T-P: 3-0-0

Pre-requisite: Molecular Biology, Biochemistry

Course Objectives

1. The course will explore that how technological innovations fostered by the prokaryotic and eukaryotic genome Projects, will lead to significant advances in our understanding of diseases/ biological processes that have a genetic basis and, more importantly, how health care will be delivered from this point forward

Course Outcomes

Sr. No.	Course outcomes	Level Attainment
CO I	Students will have understanding on the application genomic technologies such as whole genome mapping & sequencing, gene expression technologies, comparative genomics, introduction to pharmacogenomics,.	Familiarity
CO II	The students will learn the approach to decipher the insight into the functional aspects of the organism/ normal or disease condition.	Familiarity
CO III	Able to apply the knowledge of function genomics in public health	Assessment & usage

Topic Covered

S. No.	Contents	Teaching required.
1	Introduction Genes and Genomes, Genome Organization, Exon-Introns, Alternate splicing, Model Genomes	3
2	Application of next generation sequencing Next generation sequencing; Reverse termination sequencing, Single cell RNA sequencing or digital RNA sequencing and Applications	8
3	Comparative genomics Genome Annotation i.e. Mining Genomic Sequence Data, gene prediction methods, Metagenomics, evolutionary relationship,	8
4	Approaches to functional genomics Serial Analysis of Gene Eexpression-SAGE, DNA- Microarray, cDNA-PCR, etc.	8
5	SNP	7

	SNP Technologies: Platforms & Analysis Haplotyping: Concepts and Applications and relevance in cancer Biology	
6	Gene regulation Gene Function Technologies (Gene Targeting, Gene Silencing (RNAi))	4
7	Biomarkers Pharmacogenomics: Concepts and Applications in Healthcare Role of genotype in drug metabolism Identification & Utilisation of cancer bio-marker	4
	Total Number of Lectures	**42**

REFERENCE RESEARCH ARTICLES & TEXT BOOKS

1. Discovering Genomics, proteomics & bioinformatics. Second edition by A Malcolm Campbell, Davidson College; Laurie J. Heyer Davidson College ; With Foreword by Francis S. Collins Molecular Biology of the Gene (1987) Watson J. D., Hopking N., Robast J. and Steiz, J.
2. BIOINFORMATICS: A Practical Guide to the Analysis of Genes and Proteins (Third edition) Andreas D. Baxevanis & B. F. Francis Ouellette
3. Ronaghi M. Pyrosequencing sheds light on DNA sequencing. Genome Res. 2001Jan;11(1):3-11. Review. PubMed PMID: 11156611.
4. Schulze A, Downward J. Navigating gene expression using microarrays—a technology review. Nat Cell Biol. 2001 Aug;3(8):E190-5. Review. PubMed PMID:
5. 11483980.
6. Kim JB, Porreca GJ, Song L, Greenway SC, Gorham JM, Church GM, Seidman CE, Seidman JG. Polony multiplex analysis of gene expression (PMAGE) in mouse hypertrophic cardiomyopathy. Science. 2007 Jun 8;316(5830):1481-4. PubMed PMID: 17556586
7. MacBeath G, Schreiber SL. Printing proteins as microarrays for high-throughput function determination. Science. 2000 Sep 8;289(5485):1760-3. PubMed PMID: 10976071. \
8. Shankar J, Wu TD, Clemons KV, Monteiro JP, Mirels LF, et al. (2011) Influence of 17b-Estradiol on Gene Expression of Paracoccidioides during Mycelia-to-Yeast Transition. PLoS ONE 6(12): e28402. doi:10.1371/journal.pone.0028402
9. Mary V. Relling, William E. Evans Nature. Author manuscript; available in PMC 2016 Jan 13.
10. Published in final edited form as: Nature. 2015 Oct 15; 526(7573): 343–350. doi: 10.1038/nature15817

Evaluation Scheme:

Assessment	Max. marks	Duration	Course Covered
T1 Test	15	1 hr.	Syllabus covered upto T-1
T2 Test	25	1.5 hrs.	Syllabus covered upto T-2
End Term Test	35	2 hrs.	Entire Syllabus
Teacher Assessment	25	Entire Sem	Based on Assignments, quizzes etc.

Approved in Academic Council Meeting held on 28 July, 2021

Functional Genomic Lab

COURSE CODE

COURSE CREDITS: 2

CORE/ELECTIVE: CORE

L-T-P: 0-0-2

Pre-requisite: Molecular Biology

Pre-requisites: Molecular Biology, Biochemistry

Course Objectives

1. The course is intended to provide hand on experiments on comparative and functional genomics. Students will able to carry out both basic bioinformatics work and function genomics work.
2. The course will explore that how different advance molecular biology techniques unravel the understanding of diseases at genetic level

Course Outcomes:

Sr. No.	Course outcomes	Level Attainment
CO I	Students will have a thorough understanding of various functional genomic technologies SNP, SSR, SCAR, cDNA-AFLP, etc	Familiarity
CO II	The students will know the vast amount of genome information in publically available databases and how to access and best utilize for practical purposes e.g., NCBI. DDBJ, EMBL.	Familiarity
CO III	Able to analyze the gene expression experimental data sets to derive biologically meaning information	Assessment & usage

Experiments covered:

Index

S.NO.	TITLE
1	Isolation of Genomic DNA from different organisms (lower eukaryotes and higher eukaryotes).
2	Detection of SNP through RFLP (Restriction Fragment Length Polymorphism).
3	Detection of repeats in higher eukaryotes through SSR (Simple Sequence Repeats) markers.
4	Detection of polymorphism through SCAR (Sequence Characterized Amplified Region).
5	Extraction of Total RNA from eukaryotic species.
6	Preparation of cDNA template from isolated RNA. First stand synthesis Second strand synthesis
7	cDNA-AFLP (Amplified Fragment Length Polymorphism) of *Picrorhiza kurroa* strains for polymorphism analysis.
8	Pulsed Field Gel Electrophoresis
9	In silico identification of gene of interest from genomic DNA region. Mapping of candidate gene (Associated with disease) from genomic data by using Mapviewer.
10	Physical restriction mapping of gene of interest (In-silico).
11	Designing of Primers from a given gene of interest using online tools.
12	Demonstration of Real-Time PCR to quantify expression of gene.

Reference books

1. Methods in Molecular Biology. Starkey, Michael P. Elaswarapu, Ramnath. Genomics Protocols. 2000. Vol. 175. Humana Press
2. Sambrook, J., Fritsch, E. F., Manitiatis, T., Molecular Cloning: A Laboratory Manual, New York: Cold Spring Laboratory Press, 1998, 25—27.
3. Current Protocols in Molecular Biology. Frederick M. Ausubel. John Wiley & Sons Inc. 1988

Laboratory Manuals

1	Mid Sem. Evaluation	20 Marks
2	End Sem. Evaluation	20 Marks
3	Lab Assessment	60 Marks
	Total	100 marks

Metabolic Engineering

COURSE CODE

COURSE CREDITS: 3

CORE/ELECTIVE: CORE

L-T-P: 3-0-0

Pre-requisite: Biochemistry, Molecular biology

Course Objectives:

1. To impart understanding of designing metabolic pathways to increase the formation of desired metabolites and decrease formation of unwanted metabolites in bioprocesses.

Course outcomes

Sr. No.	Course outcomes	Level Attainment
CO I	At the end of the course students will have a fundamental understanding of the interplay between different intracellular reactions.	Familiarity
CO II	Student will able to understand the control of a metabolic process utilizing the enzymatic regulation and thermodynamic principles.	Familiarity
CO III	Student will able to understand the regulation and maintenance of fluxes of different pathways of a biological cell for production of different metabolites.	Assessment
CO IV	Students will be able to understand the molecular details of pathways leading to industrially relevant products like primary metabolites, secondary metabolites, antibiotics, industrial enzymes and pharmaceutical proteins.	Usage

Course Outline

Sr. No	**Contents**	**Teaching required**
1	Introduction to metabolic engineering	**2**
2	Overview of biochemical pathways. Biosynthetic pathways of polyketides, phenylpropanoids, terpenoids, steroids, alkaloids, peptide antibiotics. Importance of secondary metabolites in medicine and agriculture	**10**
3	Enzyme Kinetics and Rate Laws, Energetics, Regulation of pathways	**4**
4	Identification of gross measurement errors. Metabolic flux analysis: Theory and applications. Application of ^{13}C-isotopes for quantification of metabolic fluxes	**6**
5	Metabolic control analysis: Theory and Application. Application of metabolic control analysis on complex reaction network.	**4**
6	Thermodynamic analysis of biochemical reactions	**5**
7	Genomics and proteomics, Introduction of directed genetic modifications, Recombination, Regulatory genes	**4**

8	Molecular biological tools in metabolic engineering. Whole genome transcription analysis using DNA arrays, Implications of modifying a pathway	**4**
9	Bioinformatics. Cluster analysis for evaluation of DNA array data.	**3**
	Total lectures	**42**

Books and References

1. Metabolic Engineering: Principles and Methodologies' by Gregory N. Stephanopoulos, Aristos A. Aristidou, Jens Nielsen, Academic Press, 1998.
2. Microbial Metabolic Engineering, Methods and Protocols Series: Methods in Molecular Biology, Vol. 834, Cheng, Qiong (Ed.) Humana Press, 2012.
3. Research articles related to Metabolic Engineering.

Evaluation Scheme:

Assessment	Max. marks	Duration	Course Covered
T1 Test	15	1 hr.	Syllabus covered upto T-1
T2 Test	25	1.5 hrs.	Syllabus covered upto T-2
End Term Test	35	2 hrs.	Entire Syllabus
Teacher Assessment	25	Entire Sem	Based on Assignments, quizzes etc.

Industrial Enzyme Technology

COURSE CODE

COURSE CREDITS: 3

CORE/ELECTIVE:

L-T-P: 3-0-0

Pre-requisite: Enzyme screening production purification and applications

Course Objectives

1. The objective of the course is to develop an understanding of important aspects of production and purification of industrially important enzyme and their application in industry.

Course Outcomes

Sr. No.	Course outcomes	Level Attainment
CO I	To develop an understanding of basic concepts of enzymes.	Familiarity
CO II	To understand the basic mechanism of action and working behaviour of enzymes	Familiarity
CO III	To familiarize the students with various applications of enzymes in laboratory as well as Industrial scale.	Assessment
CO IV	To conceptualize about immobilized enzyme technology, and other specific enzymes and their applications.	Assessment
CO V	To familiarize the students with present potential of enzyme in industrial application and improved activity of the enzyme using various molecular biology techniques.	Usage
COVI	To understand the principle and function of enzyme in various adverse conditions like high temperature and pH(s).	Usage

Topic Covered

S. No.	Contents	Contact Hrs.
1	**Enzymes: Basic concepts** **Introduction** and classification of enzymes, free energy and enzymes, the formation of the transition state, catalytic strategies. **Properties of enzymes**: Enzyme specificity, stability and structure, Factors affecting enzyme activity; effect of pH and Temperature, Substrate and Enzyme concentration.	5
2	**Kinetics of enzymes** **Enzyme kinetics**: Michaelis-Menten kinetics, evaluation of parameters in the Michaelis-Menten equation, 3-D structure of active site, Kinetics of single and bi-substrate enzyme catalysed reactions, Inhibition & its kinetics.	5
3	**Production and purification techniques** **Enzyme preparation techniques**: Sources of enzymes, production, Recovery and purification of intracellular products: cell disruption, chromatographic techniques. Analytical assays of purity level of enzymes.	5

4	**Preparation, Quantification and Industrial applications** **Application of enzymes**: In leather, glucose syrup production, starch and sugar industry, Dairy and food industry, Beverage industry, Textile industry. Industrial enzymes: Cellulase, lipase, esterase laccase amylase, glucose isomerase, protease, xylanase, invertase, peroxidises. Other applications of enzymes in solution: medical applications of enzymes, non-hydrolytic enzymes in current and developing industrial technology.	8
5	**Enzymes: molecular engineering** **Enzyme engineering:** Mechanisms and manifestations of protein denaturation. Strategies for enzyme stabilization: Physical and chemical modifications, Selection, directed evolution and Rational design. Design and construction of mutant enzymes, Enzyme in organic solvents.	5
6	**Immobilization of enzymes using various techniques** **Immobilized-enzyme technology:** Introduction, enzyme immobilization method: Entrapment, carrier-binding and cross-linking method. Medical and analytical applications of immobilized enzymes.	8
7	**Specified Enzymes and applications** Thermozymes, Cold adapted enzymes, Ribozymes, Hybrid enzymes, Diagnostic enzymes, Therapeutic enzymes: Characteristics, principles and applications.	6
	Total Number of Lectures	**42**

REFERENCE & TEXT BOOKS

1. Industrial Biotechnology: Sustainable Growth and Economic Success by Soetaert and Erick J. Vandamme
2. Fermentation and Biochemical Engineering Hand Book by HC Vogel
3. Industrial Biotechnology by J. Thompson
4. Industrial Biotechnology by AS Maturiya
5. Industrial Biotechnology by IS Thakur
6. Review articles from Science Direct, Springer, Wiley and PubMed Publishers

Evaluation Scheme:

Assessment	Max. marks	Duration	Course Covered
T1 Test	15	1 hr.	Syllabus covered upto T-1
T2 Test	25	1.5 hrs.	Syllabus covered upto T-2
End Term Test	35	2 hrs.	Entire Syllabus
Teacher Assessment	25	Entire Sem	Based on Assignments, quizzes etc.

Approved in Academic Council Meeting held on 28 July, 2021

Food Processing and Engineering

COURSE CODE

COURSE CREDITS: 3

CORE/ELECTIVE: CORE

L-T-P: 3-0-0

Pre-requisite: Biology

Course Objectives

1. This course is designed to make the students familiar with the processes employed in the manufacture of food products and Engineering aspects of food processes at commercial scale.
2. Students specializing in food engineering learn to apply engineering principles and concepts to handling, storing, processing, packaging, and distributing food and related products.

Course Outcomes

Sr. No.	Course outcomes	Level Attainment
CO I	Students become aware of Concept of Food Processing and Engineering.	Familiarity
CO II	Students will acquire knowledge about processing techniques of different food commodities.	Familiarity
CO III	Will develop understanding the basic principles and equipments used in food Processing.	Assessment
CO IV	Students will learn engineering aspects and equipments used of common unit operations of food processing.	Usage
CO V	Will develop understanding of food packaging methods and trends in this area	Usage

Topic Covered

S. No.	Contents	Contact Hrs.
	Module I Food Processing	
1	Food Processing and Engineering Concept, Scope, Importance and Subject matter	1
2	Food Fermentation Benefits of fermentation - nutritive value of fermented food, Microorganisms in fermented foods: Case studies of manufacturing of some non alcoholic Fermented Foods: Sauerkraut, Soy based fermented products, dairy products	4
3	Fruit Processing Techniques Apple Processing, Anola Processing, Grapes processing, Banana Processing, Citrus Processing, Guava Processing, Mango Processing, Pineapple Processing	5
4	Vegetable Processing Techniques Tomato Processing Cabbage Processing, Carrot Processing, Cauliflower Processing, Garlic Processing, Onion Processing, Ginger Processing, Potato Processing	5
	Module II Food Process Engineering	
5	Basic Principles and Equipments used in Food Processing Steam generation and utilization, Refrigeration, Heat exchange and heat exchange Equipments	8
6	Principles and Equipments involved unit operations of food processing Size reduction and separation, Evaporation and evaporation equipments,	13

	Dehydration and Drying equipments, Material handling and transportation	
7	Food Packaging Thermal and Non-thermal processing for packaging, packaging material, Advanced and innovative packaging technologies	3
8	Plant Design, Location and Equipment Layout**:** General Principles, Design and Functionality of Building, Design and Fabrication of Equipments, Plant Location, Role of Food Engineers'	3
	Total Number of Lectures	42

Methodology

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

REFERENCE & TEXT BOOKS

1. Guide to Post Harvest Uni Operations – NK Dhamsaniya, Kalyani
2. Food Microbiology: Fundamentals and frontiers - M.P. Doyle, L.R. Beuchat and Thomas J. Montville, (2001), ASM press, USA
3. Post Harvest Management and Processing of Fruit and Vegetable – NS Tathore GK Mathur and SS Chasta
4. Fundamental Of Food Engineering - DG Rao PHI Learning Pvt Ltd

Evaluation Scheme:

Assessment	Max. marks	Duration	Course Covered
T1 Test	15	1 hr.	Syllabus covered upto T-1
T2 Test	25	1.5 hrs.	Syllabus covered upto T-2
End Term Test	35	2 hrs.	Entire Syllabus
Teacher Assessment	25	Entire Sem	Based on Assignments, quizzes etc.

Plant Tissue Culture Technology

COURSE CODE

COURSE CREDITS: 3

CORE/ELECTIVE: CORE

L-T-P: 3-0-0

Pre-requisite: Biology

Course objective:

1. To provide an insight to the students on different aspects of Plant tissue culture technologies their Course Outcomes:

Sr. No.	Course outcomes	Level Attainment
CO I	To enable students for applying the knowledge about basic techniques of plant tissue culture technologies	Familiarity
CO II	To apply the learnt techniques for solving constraints linked with production of phytochemicals through cell and tissue culture technologies	Familiarity
CO III	. They will learn the strategies for analyzing, upscaling and commercialization of plant based products.	Assessment
CO IV	To enable students for exploring their avenues for entrepreneurship and social welfare	Usage
CO V	To apply To be able for developing skills for benefit generation and utilization of plant tissue culture technologies. knowledge of plant biotechnology for effective planning and strategizing of projects	

.

Course content

Sr. No	**Contents**	**Lecture hrs.**
1	Introduction of plant tissue culture and different commercial units associated	2
2	Different techniques like organ culture, somatic embryos, haploids , callus and suspension cultures	8
3	Commercially important products generated through plant cell and tissue cultures	3
4	Development of Transgenics crops (corn ,maize ,poatao, soyabean etc and concerns	4
5	Secondary metabolites, classifications and utilization for masses	5
6	Plant stem cells , their maintenance and products	4
7	Hydrophonics and Aquaphonics along with their industrial applications	2
8	Upscaling and Quantification of plant products (Phytochemicals, volatile oils and flovorants) in different bioreactor setups	3
9	Automation and robotics ,Extra terrestrial plants	3
10	Production of flavanoids and phenols through cell culture	3
11	Production of terpenoids ,alkaloids and their pathways	3
12	Role of metabolic engineering and high throughput techniques for the advancements and plant products production	3
	No of Lectures	42

Reading and reference books:

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

2. Plant cell and tissue culture for the production of food ingredients By Tong-Jen Fu, Gurmeet Singh, Wayne R. Curtis, American Chemical Society
3. Tissue Culture for Plant Propagators by R.A. de Fossard
4. Application of Plant Cell and Tissue Culture to Agriculture and Industry by D.T. Tomes, B.E. Ellis, P.M. Harney, K.J. Kasha and R.L. Peterson
5. Plant Culture Media, Volume 1,Formulations and Uses
6. by E.F. George, D.J.M. Puttock and H.J.George
7. Plant Culture Media, Volume 2,Commentary and Analysis
8. by E.F. George, D.J.M. Puttock and H.J.George
9. Micropropagation: Technology and Application by P.C. Debergh and R.H. Zimmerman Kluwer Academic Publishers

Evaluation Scheme:

Assessment	Max. marks	Duration	Course Covered
T1 Test	15	1 hr.	Syllabus covered upto T-1
T2 Test	25	1.5 hrs.	Syllabus covered upto T-2
End Term Test	35	2 hrs.	Entire Syllabus
Teacher Assessment	25	Entire Sem	Based on Assignments, quizzes etc.

Advances in Computational System Biology

COURSE CODE

COURSE CREDITS: 3

CORE/ELECTIVE: CORE

L-T-P: 3-0-0

Pre-requisite: Molecular Biology

Objective:

1. To enable students to predict and ultimately control functionalities of complex biological systems

Sr. No.	Course outcomes	Level Attainment
CO I	Students will acquire knowledge on system biology	Familiarity
CO II	Students will have understanding about gene regulatory network	Familiarity
CO III	Students will acquire advance knowledge about metabolic networking	Assessment
CO IV	Understanding on Signal transduction	Usage
CO V	Students will be able to comprehend system biology	Usage

Course Outline

Sr. No.	**Contents**	**Hours Allotted**
1	Introduction to Systems biology and associated entities. System and its properties. Types of biological networks and their characteristics. Comparison of bioinformatics, and other similar streams with systems biology and its progression towards synthetic biology.	5
2	Gene regulatory networks, Genetic Network Analysis and System Discovery. Modeling Complex Biological Systems , Approaches to *Numerical* Simulation of Regulatory Pathways.	5
3	Metabolic Networks and pathways, Mass/Flux Balance Analysis. Characteristics and applications of metabolic pathways. Partial differential equations for the same. Recent research based developments in metabolic networks.	6
4	XML for Bioinformatics and systems biology, includes BioXML, SBML, CellML and their practical applications towards modelling and simulations of biological systems	6
5	Signal Transduction Networks and Pathways, their characteristics and applications. Recent research based developments in TRNs.	6
6	Systems Approach to Metabolic Networks and Protien-Protein Interaction Networks, Online tools and databases for SYSTEMS BIOLOGY- STRING, BIND, MINT, IPATH, GeneGo, Gypasi, MetaCYC	6
7	Biocircuits: Blocks and Designing; Various case studies along with their applications. Petri Nets and modeling. E-Cell and other bio-electronic Projects	4
8	Research based methods for solving biological network problems for all kind of	4

	biological networks.	
	Total	**42**

Text and Reference Books:

1. **Systems Modeling in Cellular Biology.** by Zoltan Szallasi, Joerg Stelling, Vipul Periwal, MIT Press,
2. **Systems Biology : Properties of Reconstructed Networks.** by Bernard Palsson, Cambridge Univ. Press
3. **Advances in Systems Biology (Advances in Experimental Medicine and Biology).** Opresko, L., Gephart, J., and Mann, M. (eds.), Plenum US, 2005
4. **Artificial Intelligence Methods and Tools For Systems Biology.** Dubitzky, W. and Azuaje, F. (eds.), Kluwer Academic Publisher
4. **Metabolome Analyses: Strategies for Systems Biology.** Vaidyanathan, S. et al (eds.), Springer-Verlag
5. **Systems Biology in Practice: Concepts, Implementation And Application.** Klipp, E et al., John Wiley & Sons Inc.
6. **Foundations of Systems Biology.** Kitano, H.(ed.); The MIT Press
7. **Systems Biology.** Alberghina L. & Westerhoff, H.V., eds.; Springer Verlag

Evaluation Scheme:

Assessment	Max. marks	Duration	Course Covered
T1 Test	15	1 hr.	Syllabus covered upto T-1
T2 Test	25	1.5 hrs.	Syllabus covered upto T-2
End Term Test	35	2 hrs.	Entire Syllabus
Teacher Assessment	25	Entire Sem	Based on Assignments, quizzes etc.

Advances in Gene Manipulation

COURSE CODE

COURSE CREDITS: 3

CORE/ELECTIVE: CORE

L-T-P: 3-0-0

Pre-requisite: Molecular Biology

Course Objectives

1. This is an advance course with objective expose students to the advanced topics of Genetic Engineering

Course Outcomes

Sr. No.	Course outcomes	Level Attainment
CO I	Students will acquire knowledge about the gene cloning and express tools developed for bacterial host other than *E.coli*	Familiarity
CO II	Students will have understanding about gene cloning and expression fungal hosts	Familiarity
CO III	Students will acquire advance knowledge about genetic engineering of animals and plants	Assessment
CO IV	Understanding of other gene manipulation methods such as site direc mutations, use of molecular markers, gene knock down knock in etc	Assessment
CO V	Students will be able to comprehend the recent development in the a of genome editing tools and their application	Usage

Topic Covered

S. No.	Contents	Contact Hrs.
1	Cloning in bacteria other than *Escherichia coli* *Cloning Vectors* and Cloning in Gram-negative bacteria other than E. coli, *Cloning Vectors and* Cloning in Gram-positive bacteria	7
2	Cloning in *Saccharomyces cerevisiae* and other fungi Importance, Yeast and fungi transformation, Different kinds vectors of *S. Cerevisiae*, *Cloning and manipulating large fragments of DNA* Yeast promoters, Hetrologus protein expression in yeast and Phichia,	7
3	Gene transfer to animal cells Chemical transfection techniques for animal cells, Physical transfection techniques, selectable marker for animal cells, Plasmid, Viral vectors for the transfection of animal cells	8
4	Genetic manipulation of animals Development of transgenic mice, Applications of genetically modified mice, Nuclear transfer technology to clone animals, Gene transfer to Xenopus oocytes or germline, Gene transfer to fish and drosophila,	6
5	Gene manipulation by Site-directed mutagenesis Introduction, Methods of introduces changes in target genes. (Primers extension and PCR as method for site-directed mutation), *Protein engineering;* Methods for amino acid substitutions at a selected site	4
6	Genomic approaches of gene manipulation Molecular markers, Marker assisted selection, Gene expression studies	4
7	Gene and Genome manipulation by silencing recombination and editing RNAi mechanism and delivery and applications, Recombinase based gene knock out and gene knock in, Gene editing tools and their delivery, Advancement in	6

	genome editing tool, Application of genome editing	
	Total Contact Hours	42

TEXT BOOKS

1. Principles of Gene Manipulation and Genomics SEVENTH EDITION S.B. Primrose and R.M. Twyman Genetic Engineering; Samita Rastogi and Neelam Pathak
2. Recombinant DNA: A Short Course by JD Watson, J. Tooze and DT Kurtz.
3. Research and Review Articles:

Evaluation Scheme:

Assessment	Max. marks	Duration	Course Covered
T1 Test	15	1 hr.	Syllabus covered upto T-1
T2 Test	25	1.5 hrs.	Syllabus covered upto T-2
End Term Test	35	2 hrs.	Entire Syllabus
Teacher Assessment	25	Entire Sem	Based on Assignments, quizzes etc.

Vaccine Production

COURSE CODE

COURSE CREDITS: 3

CORE/ELECTIVE: CORE

L-T-P: 3-0-0

Pre-requisite: Immunology

Course Objectives

1. The objective of the course is to give a thorough knowledge on the human vaccines and to provide substantial information on various aspects of vaccine production right from their development to delivery.

Sr. No.	Course outcomes	Level Attainment
CO I	To understand the concepts and immunological basis of vaccines and vaccination.	Familiarity
CO II	To identify various vaccine targets and understand various expression systems for vaccine production.	Familiarity
CO III	To understand vaccine production process of common viral and bacterial vaccines.	Assessment
CO IV	To understand various vaccine delivery systems and their relative utility.	Usage

Topic Covered

S. No.	Contents	Contact Hrs.
1	**History and introduction to vaccines** Historical perspectives of vaccines, Edward Jenner's Role in the Introduction of Smallpox Vaccine, Pasteur and the Birth of Vaccines Made in the Laboratory, Overview how the vaccine enters market.	3
2	**Vaccine immunology/basics** Immune response to vaccines, stimulating immune response for an effective vaccine (immunomodulation), types of vaccines, active and passive immunization, role of adjuvants in vaccines, primary and secondary immune response, immunological memory.	6
3	**Evaluation of vaccine efficiency** Vaccines target identification, Methods for evaluation of clinical immune response to vaccines, vaccine safety.	3
4	**Expression systems for vaccine production** E. Coli, Fungal and novel; **vaccine purification:** viral and protein subunit; **conjugate vaccine production technology; stabilization and formulation of vaccines; lyophilization in vaccine processes.**	6
5	**Viral vaccines and their production** Vaccines for important common viral diseases and their production; MMR Hepatitis viruses (Hepatitis A, Hepatitis B, Hepatitis C Virus: current status), Polio, Japanese encephalitis, HIV (current status), Yellow fever, Influenza, Rabies (biology of these viruses, various approaches to develop vaccines for these, vaccine production and quality control, and their current status).	7
6	**Different bacterial vaccine and their production** DPT group of vaccines, their production quality control and future prospects.	6

	(Diphtheria, Pertussis and Tetanus). BCG vaccine for tuberculosis, production and quality control. New generation tuberculosis vaccine. Vaccines against typhoid, Vaccines against enteric bacterial infection like *Escherichia coli* and *Shigella dysenteriae.*	
7	**New generation technology for vaccine production** Reverse Vaccinology: A Novel Genomic Approach to Antigen Identification, The Serogroup B Meningococcus Vaccine. Pan-Genome Reverse Vaccinology. Applications of Functional Genomics and High-Throughput Sequencing in Vaccine Design. Edible vaccines and their production. DNA vaccines for infectious bacteria and their limitations. Recombinant DNA vaccines. **Challenges to Malaria/ Kalazar vaccine.**	8
8	**Vaccine delivery** Liposomal, virosomes, emulsion, polymeric nanoparticle, micellar and dentrimer delivery systems, immunostimulatory complexes, edible vaccines.	3
	Total Number of Lectures	**42**

REFERENCE BOOKS

1. Wen PE, ELLIS P and PUJAR NS (2015) Vaccine development and manufacturing. John Wiley & Sons, Inc., Hoboken, New Jersey.
2. WHO TRS (World Health Organization: Technical Report Series on Vaccines)
3. Paoletti LC and McInnes PM (1999) Vaccines: From Concept to Clinic: A Guide to the Development and Clinical Testing of Vaccines for Human Use. CRC Press, N.Y.
4. Morrow WJW, Sheikh NA, Schmidt CS, Davies DH (2012) Blackwell Publishing Ltd. Levine MM (2010) New Generation Vaccines, 4th Ed., Informa Healthcare, N.Y.

Evaluation Scheme:

Assessment	Max. marks	Duration	Course Covered
T1 Test	15	1 hr.	Syllabus covered upto T-1
T2 Test	25	1.5 hrs.	Syllabus covered upto T-2
End Term Test	35	2 hrs.	Entire Syllabus
Teacher Assessment	25	Entire Sem	Based on Assignments, quizzes etc.

QC Analysis and Management

COURSE CODE

COURSE CREDITS: 3

CORE/ELECTIVE: CORE

L-T-P: 3-0-0

Pre-requisite: B Tech

Course Objectives

1. The Objective of the course is to make the student aware of quality control techniques and process for routine analysis of various biotech and pharmaceutical products. They will learn design of QC laboratory for chemical, instrumental and microbiological analysis.

Course Outcomes

Sr. No.	Course outcomes	Level Attainment
CO I	To understand concept of quality control & importance of quality control of various biotechnological products	Familiarity
CO II	Able to design and prepare quality sheets for various process	Familiarity
CO III	Able to learn quality control guidelines for maintaining various equipment and process used in biotech industry	Assessment
CO IV	To understand various validation process involved in R& D industry	Usage
CO V	To be able to use quality tools to prepare process control chart	Usage

Topic Covered

Unit no.	Contents	Contact Hrs.
1	Evaluation of quality control, Quality Control & Quality Assurance, Using Quality Assurance for the Best Results; The Role of Inspection in Quality Control, Collecting Your Quality Data; Quality Models in business, Six Sigma Concept, Six Sigma tools, Continuous improvements and its applications, Lean concept for Process Improvements Ten Steps for Incorporating Quality into a New Product and/or Process; Quality Management: Practices, Tools, and Standards	4
2	Statistics Process control: control chart for variable and attributes, P charts C charts, Chebychew's in equations and normal distribution curve, Sampling plan and characteristics of OC curves,	3
3	Quality Control techniques for routine analysis with HPLC: Quality control aspects of Pharmaceuticals and Food products, Quality control aspects of Bioactive natural products, QC Monoclonal antibody products QC rDNA products ,	20
4	Quality control laboratory: Design of QC laboratory for chemical, instrumental and microbiological analysis. Good Practices in QC laboratory, Schedule L1, standardization of reagents, labeling of reagents, control, samples, controls on animal house, data generation and storage, QC documentation, LIMS Environmental monitoring, setting of limits and its evaluation. Control of	10

	contamination and cross contamination. Stability Studies, ICH Guidelines, WHO Guidelines Waste disposal, disposal procedures and records, current regulations for waste disposal Contract manufacturing and analysis	
5	QA Lot release, non-conforming material review, failure reviewQC Lot release testing –chemical assays & bioassays QC Raw material testing, in-process testing, validation support QA Audit procedures and vendor certification Handling out-of-specification results	5
	Total	42

TEXT BOOKS

1. Fundamentals of Quality control and improvement by Ämitav Mitra A John Wiley & Sons, Inc., Publication
2. Good Manufacturing Practices for Pharmaceuticals by Sidney H Willig, Marcel and Dekker
3. Quality Assurance in Environmental Monitoring by
   P. Quevauviller, Wiley VCH

Bioactive Natural Products: Quality Control & Standardization by V.K.Gupta, s.c. Taneja and B.D. Gupta, Studium Press LLC, U.S.A.

Evaluation Scheme:

Assessment	Max. marks	Duration	Course Covered
T1 Test	15	1 hr.	Syllabus covered upto T-1
T2 Test	25	1.5 hrs.	Syllabus covered upto T-2
End Term Test	35	2 hrs.	Entire Syllabus
Teacher Assessment	25	Entire Sem	Based on Assignments, quizzes etc.

CLINICAL DIAGNOSTICS

COURSE CODE

COURSE CREDITS: 3

CORE/ELECTIVE: CORE

L-T-P: 3-0-0

Pre-requisite: Microbiology, Immunology

Course Objectives

1. The objective of the course is to develop an understanding of important concepts, technologies and methods used in diagnostics in clinical settings

Course Outcomes

Sr. No.	Course outcomes	Level Attainment
CO I	Able to use correct biological terms to describe & analyze problems in diagnostics	Familiarity
CO II	A thorough knowledge of techniques and high throughput technologies used for diagnostics	Familiarity
CO III	Able to understand, analyze and compare protein based diagnostic procedures	Assessment
CO IV	Able to understand, analyze and compare DNA based diagnostic procedures	Usage
CO V	To develop a strong foundation and thorough understanding of important diseases and diagnostic procedures used along with new terminologies used in the domain	Usage

Topic Covered

S. No.	Conents	Contact Hrs.
1	**Introduction to Clinical Diagnostics** Philosophy and general approach to clinical specimens, Sample collection (Blood, urine, spinal fluid, synovial fluid, amniotic fluid) - method of collection, preservation, transport and processing of samples. Diagnosis – disease altered state, prognosis, direct and indirect, Principles of validation of diagnostic assays for infectious diseases Validation and quality control of polymerase chain reaction methods used for the diagnosis of infectious diseases	6
2	**High-throughput Technologies and Pathological Diagnostic** Histopathology, Immuno-histochemistry and Haematology techniques Microbiological Diagnosis and Reporter assays, Hormone based diagnostic techniques Biosensors – types, applications, examples (glucose etc), telemedicine Fluorescence based techniques (FISH analysis, Flow cytometry, Fluorescent Microscopy)	10

3	**Protein based Clinical Diagnostics** Concept of antigen and antibody. Antigen – Antibody Interaction, Lattice Theory, Precipitin Curve, Simple Immunodiffusion (Radial Immunodiffusion – Qualitative, Quantitative); Double Diffusion (Mechanism of Reaction of Identity, Partial Identity, and Non-Identity) Rocket Electrophoresis, Immunoelectrophoresis; Western Blot, Immunofluorescence, Radioimmunossay; ELISA – types and assay development Agglutination – Antibody titer, Prozone Phenomenon, Direct and Indirect Agglutination, ABO Blood typing, Agglutination Inhibition; Advantages and limitation with respect to clinical diagnosis and research usage. Microparticle based antigen - Antibody interaction techniques. Monoclonal antibody – production, applications, novel approaches in detection, Humanized monoclonal antibodies.	11
4	**Case Studies I** Diagnosis of Infectious Diseases – some specific examples. Diagnosis of bacterial infection caused by *Coliforms, Salmonella, Shigella, Vibrio, and Mycobacterium tuberculosis.* Diagnosis of fungal infections. Dermetophytoses, Candidiosis and Aspergillosis.	**5**
5	**DNA based Clinical Diagnostics** Nucleic acid extraction from clinical samples, quantization, digestion, hybridization, Amplification by PCR (Inverse PCR, Multiplex PCR, Nested PCR, Alu-PCR, Hot-start, *In situ* PCR, Long-PCR, PCR-ELISA, iPCR, applications and limitations) DNA fingerprinting and polymorphism studies (SNP, RAPD, RFLP, Mutation detection etc). Emphasis on interpretation of results and quality control.	**4**
6	**Case Studies II** Diagnosis of DNA and RNA viruses. Pox viruses, Adenoviruses, Rhabdo Viruses, Hepatitis Viruses and Retroviruses. Diagnosis of Protozoan diseases: Amoebiosis, Malaria, Trypnosomiosis, Leishmaniasis, Filariasis and Schistosomiasis. Medical Genetics: Organization of human genome, Human Genome Project, Identifying human disease genes. Genetic Counseling. Genetic disorders: Sickle cell anaemia, Duchenne muscular Dystrophy, Retinoblastoma, Cystic Fibrosis and Sex –linked inherited disorders. Neonatal and Prenatal disease diagnostics.	**6**
	Total Number of Lectures	**42**

REFERENCE & TEXT BOOKS

1. Burtis, Carl A, Ashwood, Edward R, Bruns, David E., "*Tietz textbook of Clinical Chemistry & Molecular Diagnostics*" USA: Saunders, 2006.
2. World Organization for Animal Health: "*Manual of Diagnostic Tests and Vaccines for Terrestrial Animals"* Volumes I & II, 6th Edition, 2010.
3. Rao, Juluri R, Fleming, Colin C., Moore, John E., "*Molecular Diagnostics: current technology and Applications"*, Horizon Bioscience, U. K., 2006.
4. Mahon, Connie R. ; Lehman, Donald C. ; Manuselis, George "*Textbook of Diagnostic Microbiology*". USA: Saunders, 2007.
5. Goldsby, Richard A., Kuby, Janis, "*Immunology*", New York: WH Freeman and Company, 2003.

Documents from Regulatory Bodies/QC-QA documents.
Review Articles

Evaluation Scheme:

Assessment	Max. marks	Duration	Course Covered
T1 Test	15	1 hr.	Syllabus covered upto T-1
T2 Test	25	1.5 hrs.	Syllabus covered upto T-2
End Term Test	35	2 hrs.	Entire Syllabus
Teacher Assessment	25	Entire Sem	Based on Assignments, quizzes etc.

Plant Biotechnology

COURSE CODE

COURSE CREDITS: 3

CORE/ELECTIVE: CORE

L-T-P: 3-0-0

Pre-requisite. Cell Biology,

Course Objectives

1. Advances in plant biotechnology, are redefining agriculture and plant-based industries, besides providing alternatives for mass production as well as for modifying and improving crops and other plants.
2. Plants in near future will be used to synthesize novel substances and products. The objective of the course is to familiarize the students with recent advances made in the area of plant biotechnology.

Course Outcomes

Sr. No.	Course outcomes	Level Attainment
CO I	The students will have knowledge of advance tools and strategies plant genetic engineering	Familiarity
CO II	Understand the role plant genetic engineering in alleviating current and future problem of agriculture	Familiarity
CO III	The students will develop an appreciation of the current scope of plant biotechnology in agriculture and enable their use beyond simple agriculture	Assessment
CO IV	The students will and understanding and importance of chloroplast transformation	Usage
CO V	Students will be able to comprehend the recent applications in area of plant biotechnology	Usage

Topic Covered

S. No.	Contents	Contact Hrs.
1	Vectors For Plant Transformation Agro bacterium based Ti plasmid vectors, New virus base vectors for plant transformation	4
2	Advances in Marker and Promoters Selectable Marker Genes, Non selectable Marker Genes or Reporter Genes, Constitutive and inducible plant specific promoters, Marker-Free Strategies. Theme papers	7
3	Plant Genome Editing Tools and applications: RNAi: Concept, Vectors and application in plant Biotechnology, Zinc fingers Nuaclease, TALLEN and CRISPER/Cas Applications Theme research papers	6
4	Engineering for Stress Tolerance Nature of abiotic stress, gylice betain production, approaches to obtain tolerance to specific water deficit stress, alternative approaches to salt stress, cold stress ,COR regulation, tolerance to heat stress, secondary effect of abiotic stress; ROS, ROS scavenging	6
5	Molecular Farming and Applications: Aims and scope, bottlenecks; production of industrial enzymes, biodegradable	6

	plastics, polyhydroxybutyrate, antibodies, edible vaccines; Theme papers	
6	Metabolic Engineering of plants Concept, Selected case studies, modification of plant oil composition via metabolic engineering—better nutrition and industrial oils, Metabolic engineering of sugars and simple sugar derivatives in plants	6
7	Chloroplast Biotechnology Chloroplast Biology & Genome Structure Chloroplast Genome Evolution & Expression Chloroplast Gene Regulation – External & Nuclear control	4
8	Markers Assisted Plant Breeding Theory and Practice, MAS breeding Schemes, Current Status of MAS and Case studies	3
	Total Number of Lectures	**42**

TEXT & REFERENCE BOOKS

1. Plant Biotechnology- Adrian Slater, Nigel W. Scott and Mark R. Fowler (Text Book)
2. Plant Biotechnology Journal
3. Society for Experimental Biology, Association of Applied Biologists and John Wiley & Sons Ltd
4. Research and Review Articles:

Evaluation Scheme:

Assessment	Max. marks	Duration	Course Covered
T1 Test	15	1 hr.	Syllabus covered upto T-1
T2 Test	25	1.5 hrs.	Syllabus covered upto T-2
End Term Test	35	2 hrs.	Entire Syllabus
Teacher Assessment	25	Entire Sem	Based on Assignments, quizzes etc.

Microbial Ecology

COURSE CODE

COURSE CREDITS: 3

CORE/ELECTIVE: CORE

L-T-P: 3-0-0

Pre-requisite: Microbial populations diverse habitat and application

Course Objectives:

1. The course focus is on the structure and function of microbial communities, and current methods in microbial ecology.
2. The following subjects are studied: function and regulation of microbial productivity and metabolism; the importance of microbial processes for the turnover of nutrients and organic carbon; microbial interactions and co-evolution; molecular methods for species identification and quantification of microorganisms; biogeography, succession, and selection of bacteria.

Course Outcomes

Sr. No.	Course outcomes	Level Attainment
CO I	To understand basic concepts, history and overview of microbial ecology	Familiarity
CO II	To interpret the various ecological and evolutionary principles that impact microbes	Familiarity
CO III	To familiarize with experimental approaches used in the field of microbial ecology.	Assessment
CO IV	To understand basic methods and techniquesused in microbial ecology.	Usage
CO V	To gain knowledge about a specific aspect of the microbial ecology.	Usage
CO VI	To understand the applications of microbes growing in extreme environment for welfare of mankind	

Topic Covered

S. No.	Contents	Hrs
1	**Introduction to microbial ecology** **Introduction:** History, overview, definitions, terminology, concepts and applications	2
2	**Classification of microbial populations** **Physiological diversity of microorganisms**: prokaryotic diversity; eukaryotic microorganism; Microbial taxonomy, Phylogeny of *Archea*; **Extremophils:** commercial uses of extremophils; microbial diversity and its application in modern science	6
3	**Role of microorganism in ecosystem** **Individuals and populations**: productivity, growth, distribution, Ecology of macro- and microorganisms: Microbial functions in ecosystems and global cycles, Communities: colonization, succession, diversity, structure	8

4	**Methods in microbial ecology** **Methods**: Culture-based methods, biomarkers, cell stains, Characterization of microbial communities using PCR, real-time PCR, molecular fingerprints, FISH, sequencing, pyro-sequencing techniques		6
5	**Microbial interactions** **Interactions of microbes with environment**: Microbial guilds and biogeochemical cycles, **Interactions with the biotic environment**: symbiosis, competition, parasitism, predation. **Interactions within microbial communities**: Quorum sensing, syntrophy, antibiotics, Interactions of microorganisms with algae and plants, Interactions of microorganisms with animals and humans		8
6	**Microorganisms in Ecosystems** **Marine ecosystems**: deep-sea, methane seeps, anoxic basins, **Freshwater ecosystems**: lakes, rivers, swamps, bogs ocean surface, tidal flats, estuaries **Terrestrial ecosystems**: rocks and soil, prairie, forest, tundra ,		6
7.	**Applications of microbes in maintaining ecosystem**	**Extreme environments**: Deserts, hot springs, mine drainage, glaciers, deep subsurface, Landfills, **Microbial bioremediation:** wastewater treatment reactors, bioleaching, biodegradation, biomining, **Evolving communities:** evolutionary ecology and community stability	6
		Total Number of Lectures	**42**

REFERENCE & TEXT BOOKS

1. Microbial Diversity, D. Colwd
2. Microbial Ecology : Fundamentals and Applications 4th Edition
3. Microbial Ecology, Atlas and Bartha.
4. Microbial Ecology, J.M.Lynch and N. J. Poole
5. Microbial Ecology in Sustainable Agroecosystems (English, Hardcover, Diana H. Wall, Tanya Cheeke, Coleman David C. Prof.)
6. Human Microbial Ecology; Michael J. Hill (Author), Philip D. Marsh (Author)

Evaluation Scheme:

Assessment	Max. marks	Duration	Course Covered
T1 Test	15	1 hr.	Syllabus covered upto T-1
T2 Test	25	1.5 hrs.	Syllabus covered upto T-2
End Term Test	35	2 hrs.	Entire Syllabus
Teacher Assessment	25	Entire Sem	Based on Assignments, quizzes etc.

Approved in Academic Council Meeting held on 28 July, 2021

NanoBiotechnology

COURSE CODE:

COURSE CREDITS: 3

CORE/ELECTIVE: CORE

L-T-P: 3-0-0

Pre-requisite: Microbiology, Immunology**,** Basics of Physics, Chemistry and Biology

Course Objectives

The objective of this course is to develop an understanding of important concepts of nanoscience & Nanotechnology and application of nanomaterial in biological sciences

Course Outcomes

Sr. No.	Course outcomes	Level Attainment
CO I	Introduction to Nano (Basics to Nanoscience and Nanotechnology)	Familiarity
CO II	Introduction to Nano (Basics to Nanoscience and Nanotechnology)	Familiarity
CO III	Introduction to various technique used for the characterization of nanostructures and nanomaterial.	Assessment
CO IV	Fundamental understanding of nanomaterial/nano-biotechnological application in health and disease.	Usage
CO V	Fundamental understanding of nanomaterial/nano-biotechnological application in Environment and food - detection and mitigation	Usage

Topic Covered

S. No.	Conents	Contact Hrs.
1	**Introduction, History & Applications** Various definitions and Concept of Nano-biotechnology & Historical background. Fundamental sciences and broad areas of Nano-biotechnology. Various applications of Nano-biotechnology, Cell – Nanostructure interactions	6
2	**Synthetic methodologies** Introduction to the two approaches (bottom up and top down) followed for the synthesis of nanomaterials: Mechanical Method, Physical vapour deposition methods, Chemical Synthesis, Chemical vapour deposition, Molecular self-assembly, Laser Induced assembly.	8
3	**Characterization of nanoparticles:** Principles of microscopy-light Microscopy, Electron Microscopy (Transmission electron microscopy and Scanning Electron Microscopy), Confocal Microscopy, different fixation and staining techniques for Electron Microscopy. Principles of spectroscopy-UV-visible, FTIR and fluorescence spectroscopy ,Dynamic light scattering, NMR, and XPS spectroscopy.	10
4	**Nano-Drug Delivery System:** Nanoparticles for drug delivery, concepts, optimization of nanoparticle properties for suitability of administration through various routes of delivery, advantages, strategies for cellular internalization and long circulation, strategies for enhanced permeation thrugh various anatomical	8

	barriers.	
4	**Nanotheranostic System:** Nanoparticles for diagnostics and imaging (theranostics); concepts of smart stimuli responsive nanoparticles, implications in cancer therapy, nanodevices for biosensor development.	**6**
5	**NanoBiocatalyst:** development and characterization of nanobiocatalysts, application of nanoscaffolds in sythesis, applications of nanobiocatalysis in the production of drugs and drug intermediates.	**4**
	Total Number of Lectures	**42**

REFERENCE & TEXT BOOKS

TEXT BOOKS

1. C. A. Mirkin and C. M. Niemeyer. Nanobiotechnology - II more concepts and applications. (2007) - Wiley VCH.

2. P. Boisseau, P. Houdy, M. Lahmani, Nanoscience: Nanobiotechnology and Nanobiology

REFERENCE BOOKS

1. A. Nouailhat, An Introduction to Nanoscience and Nanotechnology, Wiley

2. D.A Phoenix, W. Ahmed, nanobiotechnology, One Central Press Ltd, UK

3. L. Filipponi, D. Sutherland, nanotechnologies: Principles, Applications, Implications and Hands-on Activities.Directorate- European commission

Review Articles

Evaluation Scheme:

Assessment	Max. marks	Duration	Course Covered
T1 Test	15	1 hr.	Syllabus covered upto T-1
T2 Test	25	1.5 hrs.	Syllabus covered upto T-2
End Term Test	35	2 hrs.	Entire Syllabus
Teacher Assessment	25	Entire Sem	Based on Assignments, quizzes etc.