S.S. JAIN SUBODH P.G. COLLEGE

(Autonomous)

(Affiliated to University of Rajasthan)

Department of Biotechnology

Syllabus
For

Curriculum Framework
M.Sc. Biotechnology
Based on National Education Policy- 2020
CBCS Based

About the Department:

The Department of Biotechnology was established with the vision to accomplish new epitome in the domain of biotechnology education and research, shaping life sciences into a premier precision tool for the future and develop technologies that seek solutions to real life. Recently the department has received fund under DBT STAR Scheme for the establishment of state of art research centre. The primary responsibility of the department is to set high teaching and research standards using modern tools and technology that encourage the students to pursue new scientific knowledge and career opportunities in Biotechnology. Apart from the academic curricula the students are assigned research institute visits, excursions, and Industrial visits and special in-plant training, genetic engineering and immunological work in industries. The students are encouraged for research through the projects, dissertations and summer trainings.

Curriculum Framework based on National Education Policy-2020

NEP-2020 has conceptualized the idea to develop well rounded competent individuals for making the nation a self-reliant and global leader. In the same spirit, we at Department of Biotechnology have developed a curriculum framework to encompass the goals of NEP 2020. To this end, we have incorporated choice of subject/disciplines of study, creating academic pathways having constructive combinations of disciplines for study with multiple entry and exit points as well as focus on experiential learning for students by introducing multidisciplinary and skill enhancement courses and actual Hand's on training in the recent and trending aspects of Biotechnology.

M.Sc. Biotechnology

Biotechnology finds application in a variety of fields such as Animal and Plant Biotechnology, Bioinformatics, Food and dairy, Marine Biotechnology, Growth of Vaccines,

Medicines, Nanotechnology, forensic Science, Agriculture, Pollution Control, Energy Production and Conservation, Healing of Prolonged Disease and Ecological Conservation, and in development of GM food, vaccines, medicine, insecticides, fertilizers and quality of seeds. M.Sc. Biotechnology course is designed in a way that it provides adequate knowledge of Biotechnology and related subjects such as Marine Biotechnology, Immunology, Genetic Engineering, Bioinformatics, Cell biology, Molecular Biology, Microbiology, Biochemistry, Food Technology, Molecular Biotechnology, etc.

Contents:

1. Eligibility:

A candidate who has passed the B.Sc. examination from any recognized university with Zoology Chemistry, Botany and B.Sc. Biotech, BSc. Microbiology, B.Sc. Biochemistry with minimum 55% aggregate marks or CGPA of 3.5 in the UGC Seven Point scale (45% or CGPA 2.5 in the UGC Seven Point Scale for SC/ST/Non-creamy layer OBC) shell be eligible to apply for the M.Sc. program in Biotechnology. Choice based Credit System and Grade System as per Ord. 199F.The admission will be on merit basis.

2. Scheme of Examination:

- Each theory EoSE shall carry 70 marks. The EoSE will be of 3 hours duration. Part "A" of theory paper shall contain 10 short Answer Questions out of which only seven have to be attempted of 14 marks based on knowledge, understanding and applications of the topics/texts covered in the syllabus. Each question will carry two marks for correct answer.
- Part "B" of paper will be consisting of Four questions with internal choice (except in cases where a different scheme is specifically specified in the syllabus) of 14 mark each. The limit of answer will be five pages.
- Each Laboratory EoSE will be of four/six hour durations and involve laboratory experiments/exercises, and viva-voce examination with weightage in ratio of 60:40.

3. **Course Structure:** The details of the courses with title assigned are as given below. Duration: 4 Semesters (2 Years)

Semester I	**Name of Paper and Elective Group A (Choose Any one from a group of 3 papers)**	**Course**	**Credits**	**Total Credits**
Paper I	Cell Biology	DSC-1	4	24
Paper II	Genetics	DSC-2	4	
Paper III	Microbiology	DSC-3	4	
Paper IV	Elective	DSE-4	4	
PR-I	*Based on Theory Papers (1 ,2 & 3)*	*DSCP-1*	*6*	
PR-II	*Based on Theory Elective Papers*	*DSEP-2*	*2*	
Semester II	**Name of Paper Elective Group B (Choose Any one from a group of 3 papers)**	**Course**	**Credits**	**Total Credits**
Paper I	Molecular Biology	DSC-1	4	24
Paper II	Enzymology	DSC-2	4	
Paper III	Immunology	DSC-3	4	
Paper IV	Elective	DSE-4	4	
PR-I	*Based on Theory Papers (1 ,2 & 3)*	*DSCP-1*	*6*	
PR-II	*Based on Theory Elective Papers*	*DSEP-2*	*2*	
Semester III	**Name of Paper and Elective Group C (Choose Any one from a group of 3 papers)**	**Course**	**Credits**	**Total Credits**
Paper I	Genetic Engineering & System Biology	DSC-1	4	24
Paper II	Animal Biotechnology	DSC-2	4	
Paper III	Seminar, Scientific writing & PowerPoint Presentation	DSC-3	4	
Paper IV	Elective	DSE-4	4	
PR-I	*Based on Theory Papers (1 ,2 & 3)*	*DSCP-1*	*6*	
PR-II	*Based on Theory Elective Papers*	*DSEP-2*	2	
Semester IV	**Name of Paper and** Elective Group D (Choose Any one from a group of 3 papers)	**Course**	**Credits**	**Total Credits**
Paper I	Plant Biotechnology	DSC-1	4	28
Paper II	IPR and Bioethics	DSC-2	4	
Paper III	Applied Environmental Biotechnology	DSC-3	6	
Paper IV	Elective or MOOCS/Swayam/Coursera chosen by students	DSE-4	4	
		or DSE-4	4	
PR-I	*Based on Theory Papers (1 ,2 & 3)*	*DSCP-1*	*6*	
PR-II	*Based on Theory Elective Papers & Dissertation and Industrial training*	*DSEP-2*	6	
Total credit				100

Semester –I

S.No	Paper code	Course Title	Course Category	Credit	Contact hours per week		EoSE Duration (Hrs)	
					L	P	Theory	PR
1.	MSBT101	Cell Biology	CCC	4	4	0	3	0
2.	MSBT102	Genetics	CCC	4	4	0	3	0
3.	MSBT103	Microbiology	CCC	4	4	0	3	0
4.	MSBT101A	Theory Elective -1	ECC	4	4	0	3	0
5.	MSBT104B	Theory Elective -2	ECC	4	4	0	3	0
6.	MSBT104C	Theory Elective -3	ECC	4	4	0	3	0
7.	MSBT151	General Practical lab based on Paper I, II & III	CCC	6	0	6	0	6
8.	MSBT152A	Elective Practical Lab 1	ECC	2	0	4	0	4
9.	MSBT152B	Elective Practical Lab 2	ECC	2	0	4	0	4
10.	MSBT152C	Elective Practical Lab 3	ECC	2	0	4	0	4

Semester –II

S.No	Paper code	Course Title	Course Category	Credit	Contact hours per week		EoSE Duration (Hrs)	
					L	P	Theory	PR
1.	MSBT201	Molecular Biology	CCC	4	4	0	3	0
2.	MSBT202	Enzymology	CCC	4	4	0	3	0
3.	MSBT203	Immunology	CCC	4	4	0	3	0
4.	MSBT201A	Theory Elective -1	ECC	4	4	0	3	0
5.	MSBT204B	Theory Elective -2	ECC	4	4	0	3	0
6.	MSBT204C	Theory Elective -3	ECC	4	4	0	3	0
7.	MSBT251	General Practical lab based on Paper I, II &III	CCC	6	0	6	0	6
8.	MSBT252A	Elective Practical Lab 1	ECC	2	0	4	0	4
9.	MSBT252B	Elective Practical Lab 2	ECC	2	0	4	0	4
10.	MSBT252C	Elective Practical Lab 3	ECC	2	0	4	0	4

Semester-III

S.No	Paper code	Course Title	Course Category	Credit	Contact hours per week		EoSE Duration (Hrs)	
					L	P	Theory	PR
1.	MSBT301	Genetic Engineering & System Biology	CCC	4	4	0	3	0
2.	MSBT302	Animal Biotechnology	CCC	4	4	0	3	0
3.	MSBT303	Seminar, Scientific writing & PowerPoint Presentation	CCC	4	4	0	3	0
4.	MSBT301A	Theory Elective -1	ECC	4	4	0	3	0
5.	MSBT304B	Theory Elective -2	ECC	4	4	0	3	0
6.	MSBT304C	Theory Elective -3	ECC	4	4	0	3	0
7.	MSBT351	General Practical lab based on Paper I, II &III	CCC	6	0	6	0	6
8.	MSBT352A	Elective Practical Lab 1	ECC	2	0	4	0	4
9.	MSBT352B	Elective Practical Lab 2	ECC	2	0	4	0	4
10.	MSBT352C	Elective Practical Lab 3	ECC	2	0	4	0	4

Semester-IV

S.No	Paper code	Course Title	Course Category	Credit	Contact hours per week		EoSE Duration (Hrs)	
					L	P	Theory	PR
1.	MSBT401	Plant Biotechnology	CCC	4	4	0	3	0
2.	MSBT402	IPR and Bioethics	CCC	4	4	0	3	0
3.	MSBT403	Applied Environmental Biotechnology	CCC	4	4	0	3	0
4.	MSBT401A	Theory Elective -1	ECC	4	4	0	3	0
5.	MSBT404B	Theory Elective -2	ECC	4	4	0	3	0
6.	MSBT404C	Theory Elective -3	ECC	4	4	0	3	0
7.	MSBT451	General Practical lab based on Paper I and II	CCC	6	0	6	0	6
8.	MSBT452A	Elective Practical Lab 1 & Dissertation	ECC	2+4	0	4	0	4
9.	MSBT452B	Elective Practical Lab 2& Dissertation	ECC	2+4	0	4	0	4
10.	MSBT452C	Elective Practical Lab 3& Dissertation	ECC	2+4	0	4	0	4

Note:- Elective core courses lab can be opted only if the respective Elective has been opted by the students. ECC Lab Examination will be based on ECC lab work of above papers wherever available.

Credits offered for 2-year PG Degree (General):

SEM I	SEM 2	SEM 3	SEM 4	
24	24	24	28	Total Credits: 100

*Project work/Dissertation is considered as a special course involving application of knowledge in solving / analyzing /exploring a real-life situation / difficult problem. A Project/Dissertation work would be of 4 credits. A Project/Dissertation (10 weeks) is mandatory for all the students of Sem IV with lab 2.

*The Medium of Instruction and Examination Shall Be English Only

Theory Elective Courses: -

Elective Course Code	Specialization	Paper Title	Prerequisite	Semester in which course will be available
MSBT104A	GEN	Analytical techniques		Sem I
MSBT104B	GEN	Protein Engineering		Sem I
MSBT104C	GEN	Proteomics and Genomics		Sem I
MSBT204A	GEN	Virology		Sem II
MSBT204B	GEN	Communication Skill		Sem II
MSBT204C	IB	Food and Dairy Technology		Sem II
MSBT304A	GEN	Bioinformatics & Biostatistics		Sem III
MSBT304B	EB	Stem Cell Biology		Sem III
MSBT304C	GEN	Vaccine Production		Sem III
MSBT404A	GEN	Bio-processing and Engineering		Sem IV
MSBT404B	IB	Plant Metabolic Engineering		Sem IV
MSBT404C	IB	Scientific Research Writing		Sem IV

4. Programme specific outcomes, Programme and course outcome of M.Sc biotechnology

After completion of M.Sc. in Biotechnology the student will be able to

POS1: Develop a foundational understanding of basic biological principles, genetics, microbiology, biochemistry, molecular biology, and cell biology, as they relate to biotechnology.

POS 2: Acquire practical laboratory skills in techniques commonly used in biotechnological research and applications, including DNA isolation and manipulation, protein purification, cell culture, and microbial techniques.

POS 3: Gain proficiency in applying biotechnological tools and methodologies to solve problems in various fields such as agriculture, medicine, pharmaceuticals, environmental science, and industrial biotechnology.

PSO4: Develop the ability to critically analyze scientific literature, experimental data, and biological systems to solve complex problems and make informed decisions in biotechnological research and industry.

PSO5: Understand the principles of bioinformatics and utilize bioinformatics tools and databases to analyze biological data, predict protein structures, annotate genomes, and conduct sequence analysis..

PSO6: Appreciate the ethical, legal, and societal implications of biotechnological advancements and adhere to ethical standards and regulatory guidelines in research and applications.

PSO7: Demonstrate effective communication skills through written reports, oral presentations, and scientific discourse, to convey ideas, research findings, and conclusions to diverse audiences.

PSO8: Work effectively as part of interdisciplinary teams, collaborate with peers, mentors, and professionals from diverse backgrounds, and contribute positively to group projects and research endeavors.

PSO9: Develop a lifelong learning mindset, stay updated with advancements in biotechnology, engage in professional development activities, and pursue further education or careers in academia, industry, healthcare, or entrepreneurship.

PSO10: Students will be able to develop aptitude for formulating research problem and experimental planning, data collection and statistical planning.

Programme Outcome

PO 1: Cognitive Knowledge: To provide education that leads to comprehensive understanding of the principles and practices of biotechnology.

PO 2: Information and Computer Literacy: To educate and make them up to date with the current scientific literature, computer programs and web information.

PO 3: Experimental Skills: To provide broad based training in technical skills in methods Of biotechnology.

PO 4: Critical Thinking: To empower students with the ability to think and solve problems in the field of biotechnology.

PO 5: Scientific Communication: To ensure students are able to effectively communicate

with biotech and other interdisciplinary professionals.

PO 6: Professional Attitude: To produce responsible biotechnologists that can work within the interdisciplinary framework of biotechnology and related fields

Couse Outcome

CO1: To provide a comprehensive understanding of the key concepts and principles Of biotechnology, including molecular biology, genetics, biochemistry, and cell biology.
Research Skills:

CO2:To develop advanced research skills necessary for designing and conducting experiments in biotechnology, including proficiency in modern laboratory techniques and data analysis.

CO3:To foster innovation and problem-solving skills by applying biotechnological methods to address complex biological, medical, environmental, and industrial problems.

CO4:To ensure technical proficiency in the use of biotechnological tools and technologies, such as genetic engineering, bioinformatics, and bioprocessing.
Interdisciplinary Approach:

CO5:To promote an interdisciplinary approach, integrating knowledge from different scientific fields to develop new biotechnological applications.
Ethics and Professionalism:

CO6: To instill a deep understanding of ethical issues, regulatory frameworks, and professional standards in biotechnology research and practice.
Communication Skills:

CO7:To enhance communication skills, enabling students to effectively present their research findings and collaborate with peers, professionals, and the public.

CO8:To prepare students for careers in the biotechnology industry by providing knowledge of industry practices, trends, and innovations.
Critical Thinking and Analysis:
CO9:To develop critical thinking and analytical skills necessary for evaluating scientific literature, designing experiments, and interpreting results.
Lifelong Learning:
CO10:To encourage a commitment to lifelong learning and continuous professional development in the rapidly evolving field of biotechnology.
Global Perspective:

CO11:To provide a global perspective on biotechnological issues, preparing students to work in international and multicultural environments.
Application of Knowledge:

To apply theoretical knowledge to real-world scenarios through practical training, internships, and collaborative projects with industry partners.

By achieving these objectives, graduates of the MSc Biotechnology program will be well-equipped to contribute to advancements in biotechnology and related fields, whether in academia, industry, or regulatory sectors.

S.S. Jain Subodh PG College (Autonomous), Jaipur

DEPARTMENT OF BIOTECHNOLOGY

Model Paper

M. Sc. Biotechnology (Semester - ….), Practical -I …...
External Practical Examination - ……..

Paper Name -

Batch -

Time Duration - 5 Hours | Max. Marks -90

Date -

Q.1 Major Exercise - 20 Marks

Q.2 Major Exercise - 20 Marks

Q.3 Minor Exercise - 15 Marks

Q.3 Spotting (i) to (iv) 3x5 =15 Marks

(i) (ii)

(iii) (iv) (v)

Q.4 Viva-Voce - 10 Marks

Q.5 Practical Record - 10 Marks

Internal Examiner **External Examiner**

S.S. Jain Subodh PG College (Autonomous), Jaipur

DEPARTMENT OF BIOTECHNOLOGY

Model Paper

M. Sc. Biotechnology (Semester - ….), Practical - I…..
Internal Practical Examination - ……..

Paper Name -

Batch -

Time Duration – 1and half hour | Max. Marks - 60

Date -

Attempt all Questions.

Q.1 20 Marks

Q.2 20 Marks

Q.3 20 Marks

Internal Examiner

Core Paper -I Cell Biology

Duration: 4 hrs. Per week

1 credit -25 Marks
4 credit- 100 Marks
External: 70 Marks
Internal: 30 Marks

Note: There will be two parts in end semester theory paper.
Part A of the paper shall contain 7 short answer questions of 14 marks. Each questionwill carry one mark for correct answer.
Part B of the paper will consist of four questions, one question from each unit with internal choice. Each question will carry 14 marks.

Learning Objective: The objectives of this course are to sensitize the students to the fact that as we go down the scale of magnitude from cells to organelles to molecules, the understanding of various biological processes.

Unit-I: Cells and evolution
The molecules of life: DNA, RNA, ATP, proteins, water, phospholipids with emphasis on why each was chosen as the building block. Discovery of cell structure and function through experimental studies. Common experimental organisms and role of each to understand the functioning of a cell; Viruses to understand molecular cell biology; bacteria to understand fundamental functions of cell, yeast for cell cycle study. Introduction to prokaryotic verses eukaryotic cell organization and the evolution of cells, including the origin of eukaryotes, the endosymbiotic theory, and the RNA world hypothesis

Unit-II: The cell boundary
Overview of membrane structure: Membrane lipids, membrane proteins and glycocalyx; Physical and chemical parameters that affect membrane fluidity; Membrane rafts; Lipid movement – ABC proteins; Gated and non-gated channels; Uniporters, Symporters and antiporters; Role of cytoskeleton in maintaining membrane integrity. Role of membrane in energy generation: Role of membrane in electron transport chain; Bacteriorhodopsin; ATP generation; the structure of F0-F1 complex, its assembly, movement of ATP synthase and production of ATP.

Unit-III: Regulatory molecules of the cell Introduction to signal transduction.
How signal reaches from extracellular to intracellular response. The role of signaling molecules, receptors, G-protein coupled Receptors-Structure and mechanism; secondary messengers- amplifiers, GTP-binding protein-ON/OFF switch. Tyrosine kinases- role in cell division,. JAK/STAT pathway. Ras/MAP kinase and PI3K/AKT pathway. Role of signaling in cell growth, proliferation, and cancer.

Unit-IV: From Cells to multicellular organisms (Germ cells and fertilization); Cellular Mechanisms of development; Morphogenetic movements and the shaping of the body plan; Differentiated cells and the maintenance of tissues; Cell diversification in the early embryo; Cell memory, cell determination and concept of positional values; Developmental control genes and the rules of cell behavior (*C. elegans*); Genesis of the body plan and homeotic selector genes and the patterning of body parts in Drosophila. Apoptosis and programmed cell death in development.

Suggested Readings
Various articles from journals Suggested Books as references:

1. Plopper, G., Ivankovic, D.B. Principles of Cell Biology. 3rd Edition, Jones & Bartlett (2021).

2. Karp, G. Cell and Molecular Biology: Concepts and Experiments. 9th Edition, Wiley (2021).Molecular cell Biology:(2016)Lodish, Berk, Kaiser, Krieger et al. 8th ed, WH
Freeman,
3. Lodish, H., Berk, A., Kaiser, C., Krieger, M. et al. Molecular Cell Biology. 9th Edition, W.H. Freeman (2021).The Cell: Bruce Alberts, Alexander Johnson, Julian Lewis (2015), Garland Science
4. Alberts, B. et al. Molecular Biology of the Cell. 7th Edition, Garland Science (2022).World of the Cell(2019) (9ed): Jeff Hardin and Gregory Paul Bertini.
5. Cooper, G.M. & Hausman, R. The Cell: A Molecular Approach. 8th Edition, Oxford University Press (2019).
6. Bertoni, G.P. World of the Cell. 9th Edition, Pearson (2019).
7. New Addition: Alberts, B. et al. Essential Cell Biology. 6th Edition, Garland Science (2022).

Core Paper –II (Genetics)

Duration: 4 hrs. Per week

1 credit -25 Marks
4 credit- 100 Marks
External: 70 Marks
Internal: 30 Marks

Note: **There will be two parts in end semester theory paper.**
Part A of the paper shall contain 7 short answer questions of 14 marks. Each question will carry one mark for correct answer.
Part B of the paper will consist of four questions, one question from each unit with internal choice. Each question will carry 14 marks.

Learning Objective The objectives of this course are to learn the students about Organization and measure of genetic variation and the understanding history of Classical and Modern Genetics.

Unit-I: Population and evolution genetics Sources responsible for changes in gene frequencies –Mutation, selection, migration and isolation; random genetic drift; insights into human migration, natural selection and evolution. Population substructure: Hierarchical population, Isolate breaking, Inbreeding, Assortative mating, concept of heritability, artificial selection and realized heritability.

Unit-II: Organization and measure of genetic variation: Random mating population, Hardy-Weinberg principle, special cases of random mating– multiple alleles different frequencies between sexes (autosomal and X-linked). Molecular Evolution: Evolution of origin of species and theories of evolution; The basic force of evolution – Mutation, recombination and gene flow; Variation and divergence of populations; Molecular evolution of genes and proteins; Evolution of genomes; Phylogeny and systematics; Molecular clock.

Unit III: Quantitative and ethical Genetics: Johannsen pure line theory, multiple factor hypothesis, types of quantitative traits, components of phenotypic variation and genetic models for quantitative traits, Methods to study human gene diversity- Biochemical and molecular marker, VNTR, STR, microsatellite, SNP and their detection techniques RFLP, genotyping, RAPD, AFLP etc. Ethical, legal and social issues in Human genetics.

Unit IV: History of Classical and Modern Genetics: Concept and organization of Genetic material in Bacteria, Plant and Animal (*E.coli, Arabidopsis thaliana, Coenorhabditis elegans*). **Concept of gene**: Allele, multiple alleles, pseudo alleles and complement test.
Cytogenetics: Human karyotype, Banding techniques, Human genetic diseases. Pedigree analysis.

Suggested Readings:

1. Alberts. (2002). Molecular Biology of the Cell –. Garland publication, Fourth Edition.
2. Principles Of Genetics 7Th Asia Edition **(2019)** by SNUSTAD DP, pub: JOHN WILEY
3. GardenerE.J,.SimmonsM.J and Snustad, D.P. (2005).Principles of Genetics – John Wiley & SonsPublications.
4. Principles of Genetics.**(2015)** by Purohit SS and Purohit S, First edition, Publisher Agrobios (India).
5. Principles of Genetics 8Ed **(2015)** by Gardner E.J., publisher: Wiley India

6. Paul A. (2011). Text Book of Genetics- from Genes to Genomes- Books and Allied (P) Ltd, Kolkata.Third Edition.
7. Genetics, (2015)3Rd Edition by Strickberger, Pub:Pearson India

Core Paper-III (Microbiology)

Duration: 4 hrs. per week

1 credit -25 Marks
4 credit- 100 Marks
External: 70 Marks
Internal: 30 Marks

Note: There will be two parts in end semester theory paper.

Part A of the paper shall contain 7 short answer questions of 14 marks. Each question will carry one mark for correct answer.

Part B of the paper will consist of four questions, one question from each unit with internal choice. Each question will carry 14 marks.

Learning Objective: The overarching goals for the laboratory portion of this course are to teach microbiological techniques and to show students the impact of microbes on our daily lives and their central roles in nature

Unit I: Basic Microbiology

Introduction to Microbiology. General characteristics of Microbes. Understanding the structure (Cell wall composition), and classification of Microbial cell (Bacteria), Archaea cell and Viruses. Classification of microbes (Bacteria) based on their optimum growth conditions (Nutrition).

Unit II: Cultivation of Metabolic Distinct Microbes:

Cultivation and Control of Microbes Cultivation of metabolic distinct microbes, Microbial Control (Physical and chemical methods) and Chemotherapeutics (Antibiotics and sulpha drugs); Microbial Growth and its kinetics; Understanding basics of Metagenomics for non-cultivable microbes.

Unit III: Bacterial genetic system: Recombination - transformation, conjugation, transduction; Bacterial genetic map with reference to *E. coli*. Genetic system of Yeast and Neurospora. Bacteriophage: Virulent Phages (T4), Temperate Phages (Lambda). Transposable Phages (Mu) and their genetic organization. Yeast Genetics: isolation and characterization of auxotrophic and temperature sensitive mutant.

Unit IV: Microbial Metabolism: Bacterial Photosynthesis: Types of Photosynthetic bacteria, Photopigments, Carbon and electron Pathways in bacterial photosynthesis. Metabolism of energy Reserve Compounds: Polyglycans, Poly and Beta – hydroxybutyrate. Metabolic energetics: differences in anaerobic and respiratory energy metabolism, Energy conservation in Chemolithotropic Bacteria: Nitrobacter, Nitrosomonas, Methanogens

References:

1. Brock · Biology of Microorganisms, Global Edition, 26 March (2018)by Michael Madigan, Kelly Bender, Daniel Buckley.
2. Jay JM, Loessner MJ and Golden DA. (2005). Modern Food Microbiology. 7thedition, CBS Publishers and Distributors, Delhi, India.
3. Microbiology Fundamentals: (2012) A Clinical Approach by Marjorie Kelly Cowan Pub: mac graw hill india
4. Madigan MT, Martinko JM and Parker J. (2009). Brock Biology of Microorganisms. 12th edition. Pearson/Benjamin Cummings.
5. PelczarMJ, Chan ECS and Krieg NR. (2001). Microbiology. 5th edition. McGraw Hill Book Company.
6. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. (2005). General Microbiology. 5th edition. McMillan.

Elective Paper- 1of Group A (Analytical Technique)

Duration: 4 hrs. per week

1 credit -25 Marks
4 credit- 100 Marks
External: 70 Marks
Internal: 30 Marks

Note: There will be two parts in end semester theory paper.
Part A of the paper shall contain 7 short answer questions of 14marks. Each questionwill carry one mark for correct answer.
Part B of the paper will consist of four questions, one question from each unit with internal choice. Each question will carry 14 marks.
Learning Objective: To provide students with the theory and practical experience of variousBiotechniques and instruments used in the Biotechnology.

Unit –I: Microscopy-
Principles Applications of Bright field and Dark-field Microscopy and fluorescent Microscopy, Phase contrast Microscopy, Confocal Microscopy. Electron Microscope-Principles and Applications of Transmission Electron Microscope (TEM), Scanning Electron Microscope (SEM), Sample preparation for Electron Microscopy.

Unit- II: Centrifugation:
Basic principles of sedimentation and centrifugation, Type of centrifuge rotors. Types of centrifuges: (high speed, low speed, ultracentrifuge, and density gradient). **Chromatography:** General principle of chromatographic separation. Principle, instrumentation and applications of Partition Chromatography, Adsorption Chromatography, HPTLC, Ion Exchange Chromatography, Gel permeation Chromatography, Affinity Chromatography, GC, GLC and HPLC,

Unit- III: Electrophoresis
Basic principle and types of electrophoresis. Electrophoretic mobility. Factors affecting electrophoretic migration, Technique and uses of Agarose gel electrophoresis, PAGE, SDS-PAGE, Two-dimensional electrophoresis and Isoelectric focusing.

Unit –IV Spectroscopy-
Beer-Lambert law and its limitations. Light absorption and transmission. Basic design of photoelectric colorimeter and spectrophotometer. Applications of UV-visible spectroscopic techniques. Flame Photometry. Principle and application of NMR.
Crystallography-Principle, instrumentation and applications of X-Ray Crystallography

Suggested Readings:

1. Boyer, R.F. (2000). Modern Experimental Biochemistry, 3rd Edition, PrenticeEdition Wiley-Inter science, USA.
2. Biotechniques (Theory & Practice). (2018) by Prof. S.V.S. Rana (Author),Rastogi Publications

3. Hammes, G. G. (2007). Physical Chemistry for the Biological Sciences, 1stTechniques. 4th Edition, MKU, Madurai.
4. Introduction to Biotechnology (2014). 3 Edition by Thieman and William, Pub: Pearson India.
5. P.Palanivelu and M.Salihu. (2009). Analytical Biochemistry and Separation and Molecular Biology. 2nd Revised edition. W. H. Freeman, USA.

Elective 2 of Group A (Protein Engineering)

Duration: 4 hrs. per week

1 credit -25 Marks
4 credit- 100 Marks
External: 70 Marks
Internal: 30 Marks

Note: There will be two parts in end semester theory paper.
Part A of the paper shall contain 7 short answer questions of 14 marks. Each question will carry one mark for correct answer.
Part B of the paper will consist of four questions, one question from each unit with internal choice. Each question will carry 14 marks.

Learning Objective: Protein engineering purposes, especially in enzymes, is enlarging the active position, changes activity (change specific activity, change the characteristics of the substrate), sustainability (change thermal stability, protease stability and oxidation stability) and resistance to surfactants and detergents

Unit –I: Structure of protein and predictions overview of protein
Structure of protein and predictions overview of protein structure based classification database visualisation tools structure alignment domain architecture database protein legend interaction primary structure and its determination secondary structure prediction and determination of motives profile pattern fingerprints super secondary structure protein protein folding pathway.

Unit -II: Structure and modification of proteins
Tertiary structure quarterly structure method to determine tertiary and quarterly structure post translation modification introduction to protein engineering definition basic principle features and characteristics of proteins that can be engineering affinity and specificity spectroscopic property stability to change in parameters as a pH temperature and amino acid sequence aggregation methods for the protein engineering rational design.

Unit –III: Mutagenesis
Directed mutagenesis random mutagenesis DNA shuffling evolutionary methods oblique directed evolution and modelling Dino more enzyme engineering strategies and case study additional of sulphide bonds T4 lysozyme, human pancreatic ribonucleus changing aspresent to other amino acids reducing the number of free sulphur hydral residence increasing enzyme activities modifying metal.

Unit IV: Food and Dairy Industry
Food and dairy industry applications environmental challenges and protein engineering theraptic proteins production antibody modeling biopolymer production applications in Nano biotechnology.

Suggested Readings:

1. Edited by T E Creighton, Protein structure: A practical approach, 2nd Edition, Oxford university press, 1997.
2. Edited by T E Creighton, Protein function. A practical approach, 2nd Edition, Oxford university press, 1997.
3. Edited by T E Creighton, Protein function. A practical approach.Oxford university press. 2004.
4. Cleland and Craik, Protein Engineering, Principles and Practice, Vol 7, Springer Netherlands 1998.
5. Mueller and Arndt., Protein engineering protocols, 1st Edition, Humana Press, 2006.
6. Ed. Robertson DE, Noel JP, Protein Engineering Methods in Enzymology, 388, Elsevier Academic Press, 2004.
7. J Kyte, Structure in protein chemistry, 2nd Edition, Garland publishers, 2006.

Elective 3 of Group A (Proteomics and Genomics)

Duration 4 hrs. Per week

1 credit -25 Marks
4 credit- 100 Marks
External: 70 Marks
Internal: 30 Marks

Note: There will be two parts in end semester theory paper.
Part A of the paper shall contain 7 short answer questions of 14 marks. Each question will carry one mark for correct answer.
Part B of the paper will consist of four questions, one question from each unit with internal choice. Each question will carry 14 marks.

Learning Objective: The ultimate goal of proteomics is to identify or compare the proteins expressed from a given genome under specific conditions, study the interactions between the proteins, and use the information to predict cell behavior or develop drug targets

Unit-I: Structural organization of genome
Structural organization of genome in Prokaryotes and Eukaryotes; Organelle DNA-mitochondrial, chloroplast; DNA sequencing- principles and translation to large scale projects; Recognition of coding and non-coding sequences and gene annotation; Tools for genome analysis-RFLP, DNA fingerprinting, RAPD.

Unit –II: Genome sequencing projects
Microbes, plants and animals; Accessing and retrieving genome project information from web; Comparative genomics, Identification and classification using molecular markers-16S rRNA typing/sequencing, EST's and SNP's.

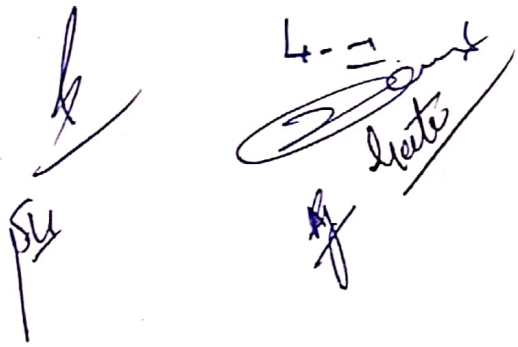
Unit- III: Proteomics
Protein analysis (includes measurement of concentration, amino- acid composition, N-terminal sequencing); 2-D electrophoresis of proteins; Microscale solution isoelectricfocusing; Peptide fingerprinting; LC/MS-MS for identification of proteins and modified proteins; Yeast two hybrid system.

Unit –IV: Pharmacogenetics
Introduction to Pharmacogenetics/Pharmacogenomics: The study of how genetic variations affect drug responses. Genetic Basis:Understanding fundamental genetics and molecular biology concepts relevant to drug response. Pharmacokinetics (PK) and Pharmacodynamics (PD):How genetic variations affect drug absorption, distribution, metabolism, excretion (ADME), and drug targets. Polymorphisms:The study of genetic variations in genes encoding drug-metabolizing enzymes, drug transporters, and drug targets.

Suggesting Reading:

1. Voet D, Voet JG & Pratt CW, Fundamentals of Biochemistry, 2nd Edition. Wiley 2006
2. Brown TA, Genomes, 3rd Edition. Garland Science 2006.
3. Campbell AM & Heyer LJ, Discovering Genomics, Proteomics and Bioinformatics, 2nd Edition. Benjamin Cummings 2007

4. Primrose S &Twyman R, Principles of Gene Manipulation and Genomics, 7thEdition, Blackwell, 2006.
5. Glick BR & Pasternak JJ, Molecular Biotechnology, 3rd Edition, ASM Press,1998.



Lab 1 (Practicals based on Paper I, II& II): 6 Credits

Duration: 8hrs. Per week

1 credit -25 Marks
Total 6 credit- 150 Marks
External: 90 Marks
Internal: 60 Marks

Learning Objective: Course objectives for practical Microbiology, Cell Biology, and Genetics focus on developing hands-on skills and conceptual understanding through laboratory techniques like microscopy and microbial cultivation, genetic analysis, and cellular observation, ultimately enabling students to apply these principles to real-world problems in health, industry, and the environment. Specific objectives include isolating and identifying microorganisms, studying cellular structures and processes (like cell division), performing genetic experiments with mutants, and applying these combined skills to solve practical challenges.

1. Study of stages of cell division Mitosis (onion roots) and meiosis (Flower bud)
2. Identification of Barr body from salivary DNA.
3. Study of Polytene chromosomes in salivary glands of Chironomus larva
4. Cell counting by Heamocytometer.
5. Demonstration of RFLP.
6. Study of Various developmental stages of chick embryo.
7. Karyotype analysis, banding pattern by G-banding method
8. Demonstration of pedigree analysis.
9. Preparation of Nutrient agar and broth media &sterilization methods,
10. Preparation and Isolation of pure culture from different sources (Air, water and soil).
11. Isolation of Plasmid from bacterial cell
12. Demonstration of Bacterial growth curve.
13. Demonstration of TDP.
14. Demonstration of TDP
15. Demonstration of staining methods: Gram staining, spore staining, negative staining, acid fast staining.

Lab 2 (Practicals based on Elective Paper- 1 of Group A Analytical Technique): 2 Credits

Duration: 4 hrs. per week

1 credit -25 Marks
2 credit- 50 Marks
External: 30 Marks
Internal t: 20 Marks

Learning Objective: Instrumentation practicals focus on providing hands-on experience with measuring instruments, developing skills in selecting and using appropriate sensors and transducers for different physical quantities, and understanding how to interpret and analyze measurement data to ensure accurate and reliable system performance.

1. Explain the principle and procedure of compound Microscope.
2. Demonstration of fluorescent microscopy.
3. Separation of plasma and serum from blood using centrifugation.
4. Demonstration of gel electrophoresis for DNA.
5. Factors affecting electrophoresis mobility (pore size/ voltage)
6. Separation of serum proteins using SDS-PAGE.
7. Separation of amino acids/ secondary metabolites by thin layer chromatography.
8. Separation of plant pigments by column chromatography
9. Explain the Beer-Lambert law with the help of spectrophotometer.
10. Analysis of caffeine in different beverages using UV –Vis spectrophotometer

Practicals based on Elective 2 of Group A (Protein Engineering) 2 Credits

Duration: 4 hrs. per week

1 credit -25 Marks
2 credit- 50 Marks
External: 30 Marks
Internal: 20 Marks

Learning Objective: To provide practical training in protein analysis, purification, and characterization techniques. The course develops foundational skills in handling proteins, assessing structural and functional properties, and understanding basic tools and approaches used in protein engineering.

1. Estimation of protein concentration by Lowry method
2. Estimation of protein concentration by Bradford method
3. Separation of proteins using SDS-PAGE
4. Native PAGE for protein analysis
5. Precipitation of proteins using ammonium sulfate
6. Preparation of buffers (e.g., Tris, PBS) and measurement of pH
7. Enzymatic hydrolysis of casein by trypsin
8. Heat denaturation of egg albumin
9. Electrophoretic separation of serum proteins (agarose or PAGE)
10. Qualitative detection of proteins using Biuret and Xanthoproteic tests

Practicals based on Elective 3 of Group A (Proteomics and Genomics)

Duration: 4 hrs. per week

1 credit -25 Marks
2 credit- 50 Marks
External: 30 Marks
Internal: 20 Marks

Learning Objective: To introduce students to basic techniques in proteomics and genomics, including protein and DNA/RNA extraction, separation, and analysis. The course provides practical exposure to the foundational methods used in studying gene and protein structure, expression, and variation.

1. Isolation of genomic DNA from plant or animal tissue
2. Estimation of DNA concentration using UV spectrophotometry
3. Agarose gel electrophoresis of DNA
4. Isolation of total RNA from biological samples
5. Qualitative and quantitative analysis of RNA
6. SDS-PAGE for separation of cellular proteins
7. Estimation of protein concentration using Bradford method
8. PCR amplification of a target DNA sequence
9. Restriction digestion of DNA and analysis on agarose gel
10. DNA-protein interaction assay using gel retardation (EMSA) – demonstration or discussion-based if not feasible

Semester II
Core Paper I -Molecular Biology

Duration: 4 hrs. per week

1 credit -25 Marks
4 credit- 100 Marks
External: 70 Marks
Internal: 30 Marks

Note: There will be two parts in end semester theory paper.
Part A of the paper shall contain 7 short answer questions of 7 marks. Each question will carry one mark for correct answer.
Part B of the paper will consist of four questions, one question from each unit with internal choice. Each question will carry 7 marks.
Learning Objective: To provide in-depth understanding of molecular biology processes in prokaryotes and eukaryotes, integrating replication, transcription, translation, gene regulation, repair, and modern molecular techniques.

Unit I: DNA Replication & Repair. DNA replication in prokaryotes (theta and rolling circle models), DNA replication in eukaryotes with origin recognition, licensing and formation of pre-replication complex, regulation of replication and checkpoints, end replication problem and role of telomerase, Comparative study of replication in prokaryotes and eukaryotes, DNA damage, DNA repair mechanisms, recombination mechanisms, site-specific recombination.

Unit II: Transcription & RNA Processing. Transcription in prokaryotes including role of sigma factors and regulation through lac, trp and ara operons, transcription in eukaryotes involving RNA polymerases I, II and III, transcription factors, enhancers and silencers, role of mediator complex, chromatin remodeling and nucleosome modifications, RNA processing: 5' capping, polyadenylation and splicing pathways, alternative splicing, RNA editing mechanisms, regulation through small RNAs including siRNA and miRNA pathways.

Unit III: Translation & Regulation of Gene Expression

Translation in prokaryotes and eukaryotes, role of tRNA, ribosomes and initiation, elongation and termination factors, wobble hypothesis and codon usage bias, regulation of translation initiation, co- and post-translational modifications of proteins, role of molecular chaperones in protein folding, Protein targeting and trafficking to ER, Golgi apparatus, lysosomes, mitochondria and nucleus, Regulation of gene expression in eukaryotes: DNA methylation and histone modifications, enhancer-promoter interactions and insulator elements, chromatin states and their regulation

Unit IV: Molecular Biology Techniques
Blotting techniques (Southern, Northern and Western blotting, Reverse North blotting; Southwestern blotting), protein–DNA interaction assays: electrophoretic mobility shift assay and DNase I footprinting, chromatin immunoprecipitation assays for mapping protein–DNA interactions, mutagenesis methods, genome editing: CRISPR/Cas systems, RNA interference, ribosome profiling, promoter bashing.

Suggested Books as references
1. Molecular Cell Biology. Lodish*et al.*(2003).5th Edition. W.H. Freeman and Company

2. Molecular Cloning – (2001). A laboratory manual.Sambrook – Russel, Vol 1, 2, 3.Third edition. CSHL Press
3. Molecular Biology of the Gene.(2003) Watson *et al.* 7th Edition.CSHL Press, Pearson and Cummings.
4. Molecular Biology of the Cell The problems Book (2015) (6ed): John Wilson and Tim Hunt
5. The Cell: Bruce Alberts 6. The Cell: A molecular approach (7ed) Geoffrey Cooper and Robert Hausman
7. World of the Cell (2013.) (8ed): Jeff Hardin and Gregory Paul Bertini.
8. Cell and Molecular Biology (2014). Concepts and Experiments (7ed): Gerald Karp
12. Molecular Biology (2013):David P. Clark, Nanette J. Pazdernik · 2nd edition (Elsevier Science).
13. Cell And Molecular Biology (2006) : S. C. Rastogi, 2nd edition ; New Age International (P) Limited.

Core Paper II-(Enzymology)

Duration: 4 hrs. per week

1 credit -25 Marks
4 credit- 100 Marks
External: 70 Marks
Internal: 30 Marks

Note: There will be two parts in end semester theory paper.
Part A of the paper shall contain 7 short answer questions of 14 marks. Each question willcarry one mark for correct answer.
Part B of the paper will consist of four questions, one question from each unit with internal choice. Each question will carry 14 marks.
Learning Objective: To build upon undergraduate level knowledge of biochemical principles with specific emphasis on Enzyme working and regulation.

Unit-I: Enzymes working
Acid-base catalysis, covalent catalysis, proximity, orientation effect, role of metal ion in enzyme catalysis.Strain & distortion theory. Measurement of enzyme activity - two-point assay, kinetic assay, using radiolabeled substrates. Determination of active site amino acids - chemical probe, affinity label, and site-directed mutagenesis, intrinsic and extrinsic regulations. Investigation of 3- D structure of active site. Mechanism of action of lysozyme, carboxypeptidase, serine proteases, nitrogenizes and examples from other classes of enzymes.

Unit-II: Enzyme regulation
General mechanisms of enzyme regulation, product inhibition. Reversible (glutamine synthase & phosphorylase) and irreversible (proteases) inhibition; Competitive, non-competitive, uncompetitive, linear-mixed type inhibitions and their kinetics, determination of Ki and numerical based on these. Importance of Kcat/Km; Suicide inhibitors; Covalent modifications of enzymes. Mono cyclic and multicyclic cascade systems with specific examples; feed forward stimulation. Allosteric enzymes, its physiological significance, qualitative description of "concerted" & "sequential" models for allosteric enzymes.

Unit-III: Kinetics and drug designs for enzymes
Use of initial velocity, Review of unisubstrate enzyme kinetics, multisubstrate enzyme kinetics, Co-operatively phenomenon, MWC and KNF models, Hill and Scatchard plots, protein-ligand binding and its measurement, analysis of binding isotherms, inhibition and exchange studies to differentiate between multi substrate reaction mechanism, Drug discovery, delivery and mechanism of action, specific emphasis on designing of drugs which can block the action of an enzyme or can activate it, catalytic antibodies, Ribozymes and DNAzymes, methods to improve biocatalysts.

Unit-IV: Industrial and clinical uses of enzymes
Industrial uses of enzymes - sources of industrial enzymes, thermophilic enzymes, amylases, glucose isomerases, cellulose degrading enzymes, lipases, proteolytic enzymes in meat and leather industry, detergents and cheese production, enzymes in textile industry, paper industry, food industry etc. biofuel cells, Bio refinery, Biosensors. Immobilized enzymesmethods, kinetics and their industrial applications. Nanomaterials for Enzyme immobilization.

Suggested Books as references:

1. Enzymes: Biochemistry, Biotechnology and Clinical Chemistry-(2008). Trevor Palmer, 11th edition. Est west publisher.
2. Principles of Biochemistry- (2017). Lehninger, David L. Nelson and Michael M. Cox.7 th edition.
3. Biochemistry-(2010).Donald Voet, Judith G. Voet.4th edition. John Wiley publication.
4. Fundamentals of Enzyme Kinetics: (2004) Athel Cornish and Bowden, Portland Press,
5. Understanding the control of metabolism: (1996) David Fell, Portland Press,
6. Fundamentals of Enzymology: (1999).Price and Stevens, OUP,
7. Industrial Enzymology: (1998). Tony Godfrey, Jon Reichel, 2 edition
8. Enzymology :(2010).T.Devsena. Oxford higher education, 3nd edition.
9. Enzymology and Enzyme Technology, (2014) S. M. Bhatt , Pub: S.Chand.

Core Paper III–Immunology

Duration: 4 hrs. per week

1 credit -25 Marks
4 credit- 100 Marks
External: 70 Marks
Internal: 30 Marks

Note: There will be two parts in end semester theory paper.
Part A of the paper shall contain 7 short answer questions of 7 marks. Each question will carry one mark for correct answer.
Part B of the paper will consist of four questions, one question from each unit with internal choice. Each question will carry 7 marks.

Learning Objective: Identify, access, and visualize immune system proteins playing key roles in innate and acquired immunity and describe how the structures of immune system molecules facilitate their functions.

Unit-I

Molecules of immune system Antigens: Antigenicity vs immunogenicity, Factors that influence immunogenicity, Antibodies: Structure, Antibody classes and biological activities, the immunoglobulin superfamily, organization and expression of immunoglobulin genes. Cytokines: Properties, cytokine receptors, Cytokine-related diseases, therapeutic uses of cytokines. MHC: General organization and inheritance of MHC, cellular distribution of MHC molecules.

Unit-II

Cells of immune system Granulocytes: Eosinophils, Basophils, Neutrophils; Natural killer cells, Macrophages; Antigen Processing and presentation pathways - the cytosolic and endocytic pathway, presentation of non-peptide antigens. B cells: Maturation, activation and proliferation, antigen induced B- cell differentiation, regulation of B-cell development. T cells: T cell maturation, Thymic selection of T cells, TH cell activation, T cell differentiation,Role of T – cells in cell death.

Unit-III

The immune response: The humoral response - primary and secondary response. Role of T_H cells in humoral response. The complement system: The components and functions of complements. Activation of complement, regulation of the complement pathways, complement deficiencies. Cell mediated response: Effector responses, General properties of effector T cells. Damage associated molecular mechanisms/platforms (DAMS); Pathogen associated molecular mechanisms/platforms (PAMS).

Unit-IV

Diseases related to immune system: Hypersensitive reactions- Gel and Coombs classification. Types of hypersensitive reactions. Primary immunodeficiencies- Severe combined immunodeficiency. Autoimmunity: Organ specific, systemic autoimmune disease, proposed mechanisms for autoimmunity; Treatment, Antibody Drug Conjugate (ADC), Immunotherapy.

Suggested Books as references:

1. Kuby Immunology (2007) 6th ed., Kindt, T.L., Goldsby, R.A. and Osborne, B.A., W.HFreeman and Company (New York),
2. Immunology: A Short Course (2009) 6th ed., Coico, R and Sunshine, G., John Wiley&sons, Inc (New Jersey),
3. Janeway'sImmunobiology (2012) 8th ed., Murphy, K., Mowat, A., and Weaver, C.T., Garland Science (London & New York).
4. Immunology: (1997). Jan Klain, 2 ndadition. Blackwell scientific
5. Immunology (2010). Ivan Roitt, (10th ed), Blackwell Scientific Press,
6. Microbiology (2008) Willey, Sherwood, Woolverton, Microbiology 7th ed. McGraw Hill

Elective Paper 1 of Group B (Virology)

Duration: 4 hrs. per week

1 credit -25 Marks
4 credit- 100 Marks
External: 70 Marks
Internal: 30 Marks

Note: There will be two parts in end semester theory paper.
Part A of the paper shall contain 7 short answer questions of 7 marks. Each question willcarry one mark for correct answer.
Part B of the paper will consist of four questions, one question from each unit with internalchoice. Each question will carry 7 marks.

Learning Objectives: Distinguish characteristics of normal cells and virus-infected cells. Explain and apply methods used in research and diagnosis of viral diseases. Describe cellular and therapeutic antiviral strategies. Explore social stigmas against infected individuals.

Unit –I: History and principles of Virology
Virus structure and morphology. Virus taxonomy, introduction to replication strategies. Principles of bio-safety, containment facilities, maintenance and handling of laboratory. viruses and requirements of virological laboratory. Plant viruses, plant virus propagation.

Unit II: Virological Methods
In vivo, in vitrocultivation of virus, estimation of yields, methods for purification of viruses with special emphasis on ultracentrifugation methods. Introduction to PCR, ELISA, RIA, IFA and Immunohistochemistry for viral enumeration.

Unit III: Virus Cell Structure
Interaction: Definition, structure and methods of discovery of viral receptors (herpes, HIV). Kinetics of receptor binding. Cellular interactions—clathrin coated pits, lipid rafts, caveolae, endocytosis and virus uncoating mechanisms. Nuclear localization signals and nuclear pore transit, virus –cytoskeletal interactions, chaperons.

Unit IV: Applied epidemiology
Types and methods of public health and infectious disease surveillance, establishing surveillance system. Case control and cohort studies. Needs and steps to be taken for outbreakinvestigations, collaboration with State and National health authorities.

Suggested Books as references:

1.Fields Virology Vol 1 and 2. B.N. Fields, D.M. Knipe, P.M. Howley, R.M. Chanock, J.L. Melnick, T.P. Monath, B. Roizman, and S.E. Straus, eds.), (1999). 3rd Edition.Lippincott- Raven, Philadelphia, PA.
2. Principles of Virology: Molecular Biology, Pathogenesis, and Control of Animal Viruses. S. J. Flint, V. R. Racaniello, L. W. Enquist, V. R. Rancaniello, A. M. Skalka.Latest edition / Pub. Date: December (2003) Publisher: American Society Microbiology.

3. Laboratory Animal Medicine: Principles and Procedures. Margi Sirois. Latest edition / Pub. Date: November (2004). Publisher: Elsevier Health Sciences.
4. Guides for the Care and Use of Laboratory Animals. National Research Council.Latest edition / Pub. Date: January (1996). Publisher: National Academy Press.
5.Laboratory Biosafety Manual,(2020).$thadition. WHO,
6. Virology: (1994). 3rd ed. FrankelConrat et al, Prentice Hall.
7. Introduction to Modern Virology. (2001)5th ed. Dimmock et al., Blackwell Scientific Publ.
8. Basic Virology,(1999). By Waginer and M. Hewlett, Blackwell Science Publ.it II.

Elective paper 2 of Group B (Communication Skills)

Duration: 4 hrs. Per week

1 credit -25 Marks
4 credit- 100 Marks
External: 70 Marks
Internal: 30 Marks

Note: There will be two parts in end semester theory paper.
Part A of the paper shall contain 7 short answer questions of 7 marks. Each question will carry one mark for correct answer.
Part B of the paper will consist of four questions, one question from each unit with internal choice. Each question will carry 7 marks.
Objective of Course: The primary objective of communication in management is to convey information—instructions, policies, procedures, decisions, etc., so the listener will hear.

Unit -I: Process of communication

Concept of effective communication- Setting clear goals for communication; Determining outcomes and results; Initiating communication; Avoiding breakdowns while communicating; Creating value in conversation; Barriers to effective communication; Nonverbal communication- Interpreting nonverbal cues; Importance of body language, Power of effective listening; recognizing cultural differences

Unit –II: Presentation skills

Formal presentation skills; Preparing and presenting using Over Head Projector, Power Point; Defending Interrogation; Scientific poster preparation & presentation; Participating in group discussions.

Unit –III: Technical Writing Skills

Types of reports; Layout of a formal report; Scientific writing skills: Importance of communicating Science; Problems while writing a scientific document; Plagiarism; Scientific Publication Writing: Elements of a Scientific paper including Abstract, Introduction, Materials & Methods, Results, Discussion, References; Drafting titles and framing abstracts

Unit IV: Computing Skills for Scientific Research

Web browsing for information search; search engines and their mechanism of searching; Hidden Web and its importance in scientific research; Internet as a medium of interaction between scientists; Effective email strategy using the right tone and conciseness

Suggested Reading

1. Mohan Krishna and N.P. Singh, Speaking English effectively, Macmillan, 2003.

Elective paper 3 of Group B (Food and Dairy)

Duration: 4 hrs. per week

1 credit -25 Marks
4 credit- 100 Marks
External: 70 Marks
Internal: 30 Marks

Note: There will be two parts in end semester theory paper.
Part A of the paper shall contain 7 short answer questions of 7 marks. Each question will carry one mark for correct answer.
Part B of the paper will consist of four questions, one question from each unit with internal choice. Each question will carry 7 marks.

Objective of Study: The Dairy Standard Agency executes its current statutory and non- statutory activities through the implementation of the following scientifically grounded and predetermined objectives, strategies and processes.

Unit I: Industrial and Food Biotechnology;
Introduction; History; Importance; Applications of biotechnology in food processing; Significant advances; Recent developments; Risk factors; Safety regulations etc.

UnitII: Industrial use of Microorganisms
Microbes exploited commercially- *Saccharomyces, Lactobacillus, Penecillium, Acetobactor, Bifidobacterium, Lactococcus, Streptococcus*etc; Fermentation-process, media and systems; Upstream and downstream processing; Product development; Dairy fermentation and fermented products.

Unit III: Microbial enzymes in food processing
Industrial production of enzymes - proteases and cellulases; Food and beverage fermentation-alcoholic and nonalcoholic beverages; Food additives and supplements – probiotics, health care products, vitamins and antibiotics; Fuels and industrial chemicals- Alkanes, industrial ethanol etc.

Unit IV: Modification of microbial enzymes
Modification in microbial enzymes production – Strain improvement, enzyme cofactor engineering, Technologies for microbial inactivation.Applications in product development and improvement.

Suggested Reading:

1. Gautam, N. C., Food Biotechnology in Comprehensive Biotechnology, Vol. 6., Shree Publishers, New Delhi, 2007
2. Gutierrez – Lopez, G. F. et. al., Food Science and Food Biotechnology. CRC Publishers, Washington, 2003
3. Maheshwari, D. K. et. al., Biotechnological applications ofmicroorganisms, IK . International, New Delhi, 2006
4. Stanbury, P. F. et. al., Principles of Fermentation Technology, 2nd Edition, Elsevier, UK, 1995.
6. Waites, M. J. et. al., Industrial Biotechnology: An Introduction, Blackwell publishing,UK, 2007.

Lab 1 (Practicals on the basis of theory Paper I, II& III): 6 Credits

Duration: 8 hrs. Per week

1 credit -25 Marks
6 credit- 150 Marks
External: 90 Marks
Internal: 60 Marks

Learning objectives: LO molecular biology, immunology, and enzymology focus on understanding core concepts, mastering relevant experimental techniques, interpreting biological data, applying knowledge to solve problems, and critically analyzing scientific information. Specifically, you should aim to: explain gene expression and replication (molecular biology), describe immune responses and mechanisms of tolerance (immunology), and analyze enzyme kinetics, structure, and function (enzymology).

1. Demonstration of Southern Transfer technique.
2. Restriction digestion of Plasmid DNA.
3. DNA Ligation.
4. RNA Isolation
5. Estimation of Riboflavin by Arnold's fluorimetric method
6. Effect of environmental factors such as pH, and temperature inhibitors on amylase.
7. Preparation of Buffer (Acetate buffer/ phosphate buffer).
8. Isolation and purification of peroxidase.
9. Immobilization studies: Preparation of peroxidase entrapped in alginate beads anddetermination of percent entrapment
10. Study the immunodiffusion technique by Single Radial Immunodiffusion.
11. Study the reaction pattern of an antigen with a set of antibodies by Ouchterlony Double Diffusion method.
12. To learn the technique of Dot ELISA for the detection of an antigen.
13. Rocket immunoelectrophoresis.

Lab 2 (Practicals on the basis Elective Paper 1 of Group B Virology): 2 Credits

Duration: 4 hrs. Per week

1 credit -25 Marks
2 credit- 50 Marks
External: 30 Marks
Internal: 20 Marks

Learning Objective: Virology practical learning objectives include mastering virus identification and diagnostic techniques, such as virus isolation, quantification, and molecular methods, while also understanding biosafety practices. Students should be able to perform and interpret experimental results, critically analyze data, troubleshoot assays, and understand the clinical significance of viral infections to inform diagnosis and patient management.

1. Demonstrate the Principles of bio-safety for virus cultivation.
2. Demonstrate the morphology of different types of viruses (photographs).
3. Study of any two viral diseases of animal/ human (Specimens/ photographs).
4. Study any four disease symptoms produced in plant due to viral infection.
5. LJ media preparation for Mycobacterium tuberculosis
6. Identification of Mycobacterium.
7. Prepare a list of conventional and new vaccines.
8. Demonstration of ELISA
9. Demonstration of RIA
10. Any other practical based on theory papers

Lab 2: Practicals on the basis Elective paper 2 of Group B (Communication Skills)

Duration: 4 hrs. Per week

1 credit -25 Marks
2 credit- 50 Marks
External: 30 Marks
Internal: 20 Marks

Learning Objective: The Communication Skills practical aims to develop effective oral and written communication skills among students. Emphasis is placed on improving presentation skills, technical writing, interpersonal communication, and confidence in professional and academic settings.

1. Practice of oral presentation on scientific/technical topics
2. Group discussion on current science/biotech-related issues
3. Role-play to demonstrate communication in professional settings
4. Writing formal letters, emails, and applications
5. Preparation of curriculum vitae (CV) and resume
6. Practice of interview skills (mock interview sessions)
7. Preparation and presentation of seminar using PowerPoint
8. Listening comprehension exercises using audio clips
9. Reading comprehension and summary writing
10. Report writing on lab visits, seminars, or workshops attended

Lab2: Practicals on the basis Elective paper 3 of Group B (Food and Dairy)

Duration: 4 hrs. per week

1 credit -25 Marks
2 credit- 50 Marks
External: 30 Marks
Internal: 20 Marks

Learning Objective: To provide students with practical knowledge in food and dairy quality assessment, microbial safety analysis, chemical composition testing, and the principles of food preservation and processing. The course aims to develop analytical skills relevant to food microbiology, dairy chemistry, and food safety regulations.

1. Quantitative determination of lactose content in milk *(e.g., Fehling's or DNS method)*
2. Standard Plate Count (SPC) for microbial load in raw and pasteurized milk
3. MBRT (Methylene Blue Reduction Test) for milk quality assessment
4. Estimation of fat content in milk using the Gerber method
5. Detection of common adulterants in milk using chemical tests *(e.g., starch, urea, hydrogen peroxide)*
6. Analysis of preservatives in processed foods (e.g., benzoates, sorbates)
7. Estimation of protein content in milk using Kjeldahl or colorimetric method
8. Microbiological examination of fermented milk products (e.g., yogurt, cheese)
9. Evaluation of total solids, SNF (Solid-Not-Fat), and water content in milk
10. Demonstration of UHT (Ultra-High Temperature) processing and aseptic packaging (model/discussion-based)

Semester IV
Paper II- IPR & Bioethics

Duration: 4 hrs. per week

1 credit -25 Marks
4 credit- 100 Marks
External: 70 Marks
Internal: 30 Marks

Note: There will be two parts in end semester theory paper.
Part A of the paper shall contain 7 short answer questions of 14 marks. Each question willcarry one mark for correct answer.
Part B of the paper will consist of four questions, one question from each unit with internalchoice. Each question will carry 14 marks.

Learning objectives:
To discuss the ethical and safety concerns in the Biotechnology field with respect to Global and Indian standards and to highlight the current trends and issues of intellectual property rights

Unit I: Bioethics and Biosafety
Principles of bioethics (autonomy, beneficence, non-maleficence and justice), ethical issues in biotechnology research and applications legal and socioeconomic impact of biotechnology, biosafety regulation and national and international guidelines, r-DNA safety guidelines, experimental protocol approvals, levels of containment, regulatory bodies in biotechnology, biosafety committee informed consent and ethical clearance, bioethical issues in animal and human research.

Unit II: IPR in Biotechnology
Patent rights and Biotechnology R & D and industry: Business aspects of biotechnology, plant breeder's rights, patents related to genes, proteins, GMOs and biotechnological inventions, TRIPS agreement and WTO, Indian Patent Act 1970 and amendments, patent filing procedure in India and abroad, patent cooperation treaty (PCT), patent databases (USPTO, EPO, WIPO), case studies in biopiracy (Neem, Turmeric, Basmati rice).

Unit III: Biosafety, Biosecurity and Research Integrity

Chemical and biological hazards in research laboratories, laboratory biosafety practices, transport and handling of GMOs and infectious agents, dual-use research concerns, bioterrorism and biosecurity issues, research integrity and responsible conduct of research, plagiarism, falsification and fabrication of data, authorship and conflict of interest, ethical publishing practices, role of ethics committees and review boards

Unit IV: Innovation Management and Entrepreneurship
Technology transfer tools, Industry-Academia collaborations, Bio-incubators, Bio-accelerators, government schemes and funding for biotech innovation (BIRAC, DBT, DST, CSIR initiatives), basics of bio-entrepreneurship, stages in setting up a biotech enterprise, market research and product development in biotechnology, case studies of successful biotech startups in India and abroad.

Suggested Books as references:

1. Goel and Parashar(2013). IPR, Biosafety and Bioethics. Pearson Education India
2. Nambisan, P..(2017). An Introduction to Ethical, Safety and Intellectual PropertyRights Issues in Biotechnology, Academic Press.

3. Joshi R. (2007). Biosafety and Bioethics. Isha Book Publisher.
4. Sateesh M.K. (2010). Bioethics and Biosafety, I. K. International Pvt Ltd.
5. Sree Krishna V. (2007). Bioethics and Biosafety in Biotechnology, New Ageinternational publishers.

M.Sc. Biotech Sem IV

Paper III (Applied Environmental Biotechnology)

Duration: 4 hrs. per week

1 credit -25 Marks
4 credit- 100 Marks
External: 70 Marks
Internal: 30 Marks

Note: There will be two parts in end semester theory paper.
Part A of the paper shall contain 7 short answer questions of 14 marks. Each question will carry one mark for correct answer.
Part B of the paper will consist of four questions, one question from each unit with internal choice. Each question will carry 14 marks.

Course Objectives: Understand Core Concepts: Develop a solid understanding of environmental biotechnology principles and their applications in waste management, resource recovery, and bioenergy production.

Unit I:

Fundamentals of Environmental Biotechnology: Overview of Environmental Biotechnology: Definition and scope, Historical development and applications, Role in sustainable development. Microbial interactions (symbiosis, competition, predation). Biodegradation and Bioremediation: Mechanisms of biodegradation (aerobic vs. anaerobic), Bioremediation technologies (in situ vs. ex situ), Phytoremediation and mycoremediation..

Unit II:

Waste Management and Treatment Technologies: Waste Types and Sources: Municipal, industrial, and agricultural waste. Hazardous vs. non-hazardous waste. E-waste and its environmental impact. Biological Treatment Methods: Anaerobic digestion. Composting and vermicomposting. Advanced Wastewater Treatment: Activated sludge process, Membrane bioreactors and advanced oxidation processes.

Unit III:

Biomass as a Renewable Resource: Types of biomass (agricultural, forestry, municipal), Biomass production systems and sustainability. Resource Recovery from Waste: Nutrient recovery technologies (nitrogen, phosphorus), Circular economy concepts and applications, Recovery of metals and other valuable materials from waste.

Unit IV:

Monitoring Techniques: Environmental impact assessment (EIA), Microbial indicators of pollution (fecal coliforms, etc.), remote sensing and GIS applications in environmental monitoring. Regulatory Frameworks: Environmental laws and policies (local, national, international), Role of governmental and non-governmental organizations, Sustainable development goals (SDGs) and biotechnology.

Suggested Reading List

1. *Environmental Biotechnology: Principles and Applications* by Gareth M. Evans and Judith C. F. A. Smith
2. *Biotechnology for Waste and Wastewater Treatment* by C. M. Srivastava
3. *Bioremediation: Principles and Applications* by E. J. C. Bradshaw and H. L. Allen
4. *Biofuels: A Solution for the Energy Crisis* by P. L. K. Chaudhary and K. G. C. K. Patil
5. *Microbial Ecology: Fundamentals and Applications* by Paul H. B. B. Allen and J. E. C. Overman
6. *Waste Management: A Complete Guide* by K. M. S. R. K. Rao
7. *Biotechnology for Environmental Sustainability* by R. K. Gupta and A. K. S. Chaturvedi
8. *Environmental Biotechnology: Theory and Application* by R. E. H. G. H. G. M. Flórez and D. A. C. Rodriguez.

Semester IV

Elective Paper1 of Group D (Bio-processing and Engineering)

Duration: 4 hrs. Per week

1 credit -25 Marks
4 credit- 100 Marks
External: 70 Marks
Internal: 30 Marks

Note: There will be two parts in end semester theory paper.
Part A of the paper shall contain 7 short answer questions of 14marks. Each question willcarry one mark for correct answer.
Part B of the paper will consist of four questions, one question from each unit with internalchoice. Each question will carry 14 marks.

Learning objective: To provide the strong foundation in the areas of food engineering, post-harvest practices andvalue addition of food materials.

Unit I: Introduction to Bioprocess Engineering

Bioreactors and membrane Bioreactors and Membrane Bioreactors, Isolation Preservation and Maintenance of Industrial Microorganisms, Types of fermentation processes. Analysis of batch, Fedbatch and continuous bioreactors, analysis of mixed microbial populations, specialized bioreactors (pulsed fluidized, photobioreactors etc).

Unit II: Downstream processing

Introduction, Removal of microbial cells and solid matter, foam reparation, precipitation, filtration, centrifugation, cell disruptions, liquid-liquid extraction, chromatography, membrane process. Drying and crystallization, Treatment and disposal of effluents.Whole cell Immobilization and their Industrial Applications, bioconversion and Biotransformation.

Unit III: Industrial Production of chemicals

Alcohol (ethanol). Acids (citric, acetic), Solvents (acetone, butanol), Antibiotics (penicillin, tetracy6cline), Amino acids (lysine, glutamic acid), Single Cell Protein, Introduction to Food technology elementary idea of canning and packin-Fat-Based Edible products, Typical Food/ food products (bread, cheese, idli, Agro-products (oilseeds) Food preservation.

Unit IV:Biology of Industrial Microorganisms:

(*Saccharomyces, Aspergillus, Penicillia*).Idea of Fermentation, Cell growth, Regulation of Metabolism, Substrate Assimilation/Product Secretion.Different fermentative system; Fermentor Design, Surface and submerged liquid substrate fermentation. Bio-mass production (lactic acid, cheese making, health care products (antibiotics, steroids, vaccines), Production of Industrial solvents (alcohol, acetone, butanol), Industrial Enzymes (amylase, proteases, lipases).

Suggested Books as references:

1. Aneja. K.R. (2007). Laboratory Manual of Microbiology and Biotechnology, NewAge International Publisher.
2. GoelAndParashar (2013). IPR, Biosafety and Bioethics. Pearson Education India
3. Nambisan, P. (2017). An Introduction to Ethical, Safety and Intellectual PropertyRights Issues in Biotechnology, Academic Press.

4. Joshi R. (2007). Biosafety and Bioethics. Isha Book Publisher.
5. Sateesh M.K. (2010). Bioethics and Biosafety, I. K. International Pvt Ltd.
6. Sree Krishna V. (2007). Bioethics and Biosafety in Biotechnology, New Ageinternational publishers.

Elective Paper 2 of Group D (Plant Metabolite Engineering)

Duration: 4 hrs. per week

1 credit -25 Marks
4 credit- 100 Marks
External: 70 Marks
Internal: 30 Marks

Note: There will be two parts in end semester theory paper.
Part A of the paper shall contain 7 short answer questions of 7 marks. Each question willcarry one mark for correct answer.
Part B of the paper will consist of four questions, one question from each unit with internalchoice. Each question will carry 7 marks.
Learning objective: To understand the metabolism and biological oxidationreduction reactions.

Unit I: Metabolism and Metabolic Engineering
Carbon Assimilation; Light absorption and energy conversion; Calvin Cycle; Hatch-slack pathway; Reductive pentose phosphate pathway; Carbon dioxide uptake and assimilation; Photorespiration; Glycolate metabolism.

Unit II: Biological Oxidation and release of Energy
Enzyme Kinetics and analysis of Sequences of Reactions; Glycolate pathway; Kreb's cycle; High energy compounds; Oxidative phosphorylation; Chemiosmotic hypothesis; pentose phosphate shunt pathway.

Unit III: Metabolism of Macromolecules
Biosynthesis and inter-conversion of carbohydrates; Biosynthesis, inter-conversion and degradation of lipids; Regulation of Metabolic Networks, Metabolic Flux Analysis; Metabolic Control analysis.

Unit IV: Secondary Metabolism
Introduction to Secondary metabolism. Importance and types of Secondary Metabolites; Biosynthesis of phenolic compounds, isoprenoids, alkaloids and flavonoids. Various applications of Secondary Metabolites. Antimicrobial activity of Secondary Metabolites.

Suggested Readings:

1. Metabolic Engineering in Plants (2022) edited by Tariq Aftab and Khalid Rehman Hakeem:
2. Plant Metabolic Engineering: Methods and Protocols (2021) edited by Vladimir Shulaev:
3. Plant Metabolism and Biotechnology (2010) edited by Hiroshi Ashihara, Alan Crozier, and Atsushi Komamine.
4. Secondary Metabolites and Biotherapeutics (2024) edited by Awanish Kumar and Sunil Kumar.
5. In Vitro Production of Plant Secondary Metabolites: Theory and Practice (2025) edited by M. Anuradha and S. Balasubramanya

Elective Paper 3 of Group D (Pharmaceutical Biotechnology)

Duration: 4 hrs. Per week

1 credit -25 Marks
4 credit- 100 Marks
External: 70 Marks
Internal: 30 Marks

Note: There will be two parts in end semester theory paper.
Part A of the paper shall contain 7 short answer questions of 7 marks. Each question willcarry one mark for correct answer.
Part B of the paper will consist of four questions, one question from each unit with internalchoice. Each question will carry 7 marks.

Unit I: Biotechnology in pharmaceutical perspective:

Biology in drug discovery; Traditional drug discovery vs. rational drug discovery, rational drug discovery pipeline, concept of target based drug design and target discovery, role of plant biotechnology in edible vaccine development. Definition: Generics and its advantages; Biogenerics and Biosimilar; Why biosimilar are not (bio) generics; The advent of Biosimilar.

Unit II: Biotechnology in pharmaceutical industry

Major areas for biotechnology in the pharmaceutical industry such as antibiotics, vaccines, diagnostics, antibodies,biopharmaceuticals (insulin, interferon, GSF, CSF & therapeutic proteins etc.);Commercial aspects, priorities for future biotechnological research

Unit III:Industrial enzymes in drug development.

Penicillin amidase, lipase, oxidoreductase, nitrilase, protease etc.Use of all these enzymes for enantioselective synthesis of pharmaceutically important drugs / drug intermediates, future directions.

Unit IV: Approved follow-on proteins/Bio-similar

Characteristics of high-selling peptides and proteins; Products with expired patents; Challenging originator's patents; Target products for FOB (follow-on biologicals)/ Biosimilars development peptides; Recombinant non-glycosylated proteins; Recombinant glycosylated proteins; Industries dealing with biogenerics and its market value; World scenario; Indian scenario.

Suggested Readings:

1. Pharmaceutical Biotechnology (2016) Helmer E, Syrawood Publishing House, ISBN:978- 1682861066.
2. Pharmaceutical Biotechnology (2014) Sreenivasulu V, Jayaveera KN and Adinarayana K, S Chand & Company, ISBN: 978-8121942478.
3. Pharmaceutical Biotechnology Fundamentals and Application (2013) Kokare C, Nirali Prakashan, Educational Publishers, ISBN: 978-8185790688.

4. Pharmaceutical Biotechnology: Concepts and Applications (2011) Walsh G, WileyIndia Pvt Ltd, ISBN: 978-8126530250.
5. Pharmaceutical Biotechnology (2002) 2nd ed. Cromelin DJA and Sindelar RD, Taylorand Francis Group, ISBN: 978-3-527-65125-2.

Lab 1 (Practicals on the basis of theory Paper I, II & II) 6 Credits

Duration: 8 hrs. per week

1 credit -25 Marks
6 credit- 150 Marks
External: 90 Marks
Internal: 60 Marks

Learning objectives : The learning objectives for The objectives of plant and biotechnology practicals are to equip students with hands-on skills in plant tissue culture, genetic engineering, and analytical techniques; to impart knowledge of plant biology, biochemistry, and the application of these methods to real-world problems in agriculture and human welfare "IPR & Bioethics" in a practical Environmental Biotechnology course include developing an understanding of intellectual property rights (IPR) in biotechnology, recognizing ethical dilemmas and the importance of professional ethics in biotech applications, practicing ethical laboratory protocols and data handling, and applying IPR principles to protect biotechnological innovations with environmental benefits, all while fulfilling the program's broader goals of fostering professional responsibility, societal awareness, and research aptitude.

1. Preparation of stock solutions for MS medium.
2. Preparation & sterilization of MS medium.
3. Surface sterilization and organ/ nodal/shoot tip culture.
4. Isolation of genetic DNA from plant tissue.
5. Anther culture or Ovary culture.
6. Establishment of shoot tip culture using MS medium
7. Isolation of protoplasts using enzymatic/mechanical method.
8. Establishment and maintenance of somatic embryogenesis.
9. Cytological examination of regenerated Plant.
10. Preparation of synthetic seeds (Entrapment method).
11. Extraction & Separation of Chlorophyll A & B using Column Chromatography.
12. Write various steps to Set up a Biotechnological industry plan.
13. **Students have to present power point presentation of their project/dissertation in front of the external and internal examiners.**

Lab 2 of Elective Paper 2 of Group D (Bio-processing and Engineering) (2+4 credits)

Duration: 8 hrs. per week

1 credit -25 Marks
6 credit- 150 Marks
External: 90 Marks
Internal: 60 Marks

Learning objectives: Bioprocessing engineering practical learning objectives include developing hands-on skills in equipment operation and data analysis, understanding and applying principles of upstream (cell cultivation) and downstream (product recovery) processing, designing and evaluating bioprocesses, assessing system performance and troubleshooting, collaborating in teams, and communicating findings effectively through written reports and presentations

1.Assay of any two common enzymes (amylase, protease, pactinase, lipase).
2.Production of ginger wine.
3.Production of grape wine.
4.Estimation of lactic acid percentage by Saurcouret production.
5.Immobilization of enzymes/ whole cells by adsorption, covalent linkage.
6.Production of Citric acid *Aspergillus niger*.
7.Effect of pH on citric acid production.
8.Effect of temperature on citric acid production.
9.Industrial visit and report have to submit in college by student.

Note: Dissertation is mandatory for all the students with Lab 2 of Sem IV (4 Credits)

Students have to prepare dissertation report and their PPT of their 10 weeks Project and present in front of the external and internal examiners.

Lab 2 of Elective Paper 2 of Group D (Plant Metabolite Engineering) (2+4 credits)

Duration: 8 hrs. per week

1 credit -25 Marks
6 credit- 150 Marks
External: 90 Marks
Internal: 60 Marks

Learning Objectives:

The practicals aim to provide students with hands-on skills in analyzing primary and secondary plant metabolites through pigment extraction, chromatography, enzyme kinetics, and biochemical assays. Students will learn methods for carbohydrate, lipid, and protein analysis along with qualitative and quantitative evaluation of secondary metabolites.

1. Demonstration of photosynthetic pigment extraction and absorption spectra using spectrophotometer
2. Estimation of total chlorophyll and carotenoid content in plant leaves
3. Separation of photosynthetic pigments by paper/thin layer chromatography (TLC)
4. Demonstration of enzyme kinetics using peroxidase or amylase
5. Qualitative test for carbohydrates, proteins, and lipids in plant tissue extracts
6. Estimation of reducing sugars by DNSA method (relevance to carbohydrate metabolism)
7. Extraction and estimation of plant lipids using Soxhlet apparatus / gravimetric method
8. Qualitative analysis of secondary metabolites (alkaloids, flavonoids, tannins, phenolics)
9. Antimicrobial activity assay of plant extract (agar well diffusion method)
10. Case study or data analysis exercise on metabolic flux analysis and secondary metabolite pathways

Note: Dissertation is mandatory for all the students with Lab 2 of Sem IV (4 Credits)

Students have to prepare dissertation report and their PPT of their 10 weeks Project and present in front of the external and internal examiners.

Lab 2 of Elective Paper 3 of Group D (Pharmaceutical Biotechnology) (2+4 credits)

Duration: 8 hrs. per week

1 credit -25 Marks
6 credit- 150 Marks
External: 90 Marks
Internal: 60 Marks

Learning Objectives: The practicals aim to train students in basic techniques of drug discovery, microbial screening, enzyme assays, plant tissue culture, protein estimation, and case study analysis. Through these exercises, students will gain hands-on exposure to pharmaceutical biotechnology applications in antibiotics, vaccines, therapeutic proteins, industrial enzymes, and biosimilars.

1. Comparative study of traditional vs. rational drug discovery approaches
2. Bioinformatics-based target discovery (in silico docking/demo)
3. Plant tissue culture techniques relevant to edible vaccine development
4. Screening of microorganisms for antibiotic production
5. Preparation of heat-killed bacterial suspension as model vaccine
6. Protein estimation from culture supernatant (Lowry/Bradford method)
7. Assay of Penicillin amidase activity
8. Lipase activity assay using p-nitrophenyl palmitate
9. Protease activity assay by casein hydrolysis
10. Case study analysis of originator vs. biosimilar products

Note: Dissertation is mandatory for all the students with Lab 2 of Sem IV (4 Credits)

Students have to prepare dissertation report and their PPT of their 10 weeks Project and present in front of the external and internal examiners.