

Dr. BABASAHEB AMBEDKAR MARATHWADA UNIVERSITY, AURANGABAD



CIRCULAR NO.SU/ Sci. & Tech./Sub-Campus, Osmanabad/NEP/21/2023

It is hereby inform to all concerned that, the syllabus prepared by the Departmental Committee and recommended by the Dean, Faculty of Science & Technology, the Hon'ble Vice-Chancellor has accepted the syllabus of **M.Sc. Biotechnology Ist and IInd semester as per Norms of National Education Policy - 2020 under the Faculty of Science & Technology run at University Department, Dr.Babasaheb Ambedkar Marathwada University, Sub-Campus, Osmanabad** in his emergency powers under section 12(7) of the Maharashtra Public Universities Act, 2016 on behalf of the Academic Council as appended herewith.

This is effective from the Academic Year 2023-24 and onwards.

All concerned are requested to note the contents of this circular and bring the notice to the students, teachers and staff for their information and necessary action.

University Campus,
Aurangabad-431 004.

REF.NO.SU/NEP/2023/10101-09

Date:- 17.08.2023

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*Deputy Registrar,
Academic Section*

Copy forwarded with compliments to :-

- 1] **Head of the Department, Department of Biotechnology, Dr.Babasaheb Ambedkar Marathwada University, Sub-Campus, Osmanabad.**
- 2] **The Director, University Network & Information Centre, UNIC, with a request to upload this Circular on University Website.**

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- 1] **The Director, Board of Examinations & Evaluation, Dr.BAMU,A'bad.**
- 2] The Section Officer,[M.Sc.Unit] Examination Branch,Dr.BAMU,A'bad.
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**DR. BABASAHEB AMBEDKAR MARATHWADA
UNIVERSITY, AURANGABAD,
SUB-CAMPUS OSMANABAD**



NAAC Reaccredited with 'A' Grade



Faculty of Science and Technology

Department of Biotechnology
(for university Department)

2 Years P.G. Programme in Science
(M.Sc.)

As per National Education Policy-2020

Course Structure and Curriculum
(Outcome Based Credit System)

Subject : Biotechnology

(Effective from 2023-24)

Signature
11/08/2023

Dr. D. D. D.

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**DR. BABASAHEB AMBEDKAR MARATHWADA UNIVERSITY, AURANGABAD,
SUB-CAMPUS OSMANABAD**

Department of Biotechnology

Preamble

Welcome to the Biotechnology Program at Department of Biotechnology, Dr. Babasaheb Ambedkar Marathwada University, Sub-Campus Osmanabad

The recent pandemic has stirred up whole globe. It had impacted the world adversely in many aspects. However, it also has drawn attention of non-scientific world to the fascinating aspects of welfare biology- The biotechnology!. The new generation students are willing to take up biotechnology as a serious carrier option;. At this point of time we are presenting the students with a new pattern of study with updated curriculum

Biotechnology, at its core, represents the intersection of biology, technology, and creativity. It is a rapidly evolving field that has the potential to revolutionize industries, improve human health, and address pressing environmental challenges. As we stand on the brink of exciting possibilities, our Biotechnology Program strives to be a beacon of excellence in education, research, and practical application.

Our Mission:

The mission of the Biotechnology Program is to equip aspiring students with the knowledge, skills, and ethical values necessary to tackle real-world problems using cutting-edge biotechnological techniques. We are committed to fostering a collaborative, diverse, and inclusive learning environment that nurtures curiosity, critical thinking, and a passion for innovation.

Our Vision:

To develop the students of Dr. Babasaheb Ambedkar Marathwada University to be an Epitome of Excellence by creating and imparting Quality Education. to address Changing Scenario, keeping Research and Development at its core, for 'Anyone' at 'Anytime' and 'Anywhere'.

Program Highlights:

1. **Comprehensive Curriculum:** Our thoughtfully crafted curriculum offers a balanced blend of fundamental biological principles, molecular techniques, bioinformatics, and advanced biotechnological applications. You will be engage in hands-on laboratory experiences and gain insights into the latest industry trends, preparing you for a dynamic and fulfilling career in biotechnology.
2. **Renowned Faculty:** Our distinguished faculty members are experts in their respective fields, with extensive research backgrounds and a commitment to excellence in teaching. They will mentor and guide you on your academic journey, encouraging you to explore your potential and make meaningful contributions to the field.
3. **State-of-the-Art Facilities:** Department of Biotechnology, Dr. Babasaheb Ambedkar Marathwada University, Sub-Campus Osmanabad takes pride in providing state-of-the-art laboratory facilities and cutting-edge equipment to support your practical training. From PCR machines to gene sequencing technologies, you will have access to the tools essential for conducting groundbreaking research.
4. **Research Opportunities:** We believe that research is the cornerstone of progress in biotechnology. As a part of our program, you will have the chance to collaborate on exciting research projects, work on cutting-edge discoveries, and contribute to scientific publications.
5. **Industry Partnerships:** We maintain strong connections with leading biotechnology companies and research institutions, providing you with opportunities for internships, and potential career placements. These partnerships ensure that you are well-placed to have an on the job or in-plant training and are well equipped to thrive in a competitive job market.
6. **Community Engagement:** As a responsible science person one must work for socital development. This department has worked hard and developed an in-house technology to contribute to world food security. We have a strong outreach program that encourages community engagement. Students will have the chance to participate in activities that promote awareness of biotechnology's impact on society and work on projects with positive societal implications.

Eligibility

Being a welfare oriented branch of science, any student desirous to understand biology for its welfare application is welcomed to participate in the program. However an intricate nature of interdependence of various branches science in general and biology in particular put some limitations on admissions to the post graduate program in biotechnology at **Department of Biotechnology, Dr. Babasaheb Ambedkar Marathwada University, Sub-Campus Osmanabad.**

Currently under the NEP 2020 system a multiple entry and exit options are available. A science graduate with at least one biology subject studied at graduation is admitted to the M.Sc. in Biotechnology. Graduates with agriculture and pharmacy, are also eligible to take admission.

Program Duration

This is a **two year, four semester** program. It is interspaced with a summer training /on-job training between first and second year (in the period between second semester and third semester.

All other terms and conditions as specified by the university will be applicable to the program

Medium of Instructions

Though NEP-2020 encourages multilingual medium of instruction, as on today chief **medium of instruction is English**. However our faculty takes utmost precaution that no student is left lagging behind due to language barrier.

Attendance

The intricate nature of the program demands that a student must be regular and up-to-date. Ideally we demand a 100% attendance. However it is never possible to achieve. A statutory requirement 75% will be **strictly** adhered to!

**Credit distribution structure
for Two Years / One Year Programme
with Multiple Entry and Exit options
in the Subject of
BIOTECHNOLOGY**

Class: M.Sc.

Ist Semester to IVth Semester

Effective from 2023-2024

DEPARTMENT OF BIOTECHNOLOGY

AS PER NEP 2020

Credit distribution structure for Two Years/One Year Programme with Multiple Entry and Exit options

(Discipline Specific Core in the Subject of BIOTECHNOLOGY)

Class: M.Sc. First Year Semester: Ist

Course type	Course Code	Course Name	Teaching Scheme		Credits Assigned		Total Credits
			(Hrs./ week)				
			Theory	Practical	Theory	Practical	
DSC Major Mandatory	BIOT/UD/MJ/500 T	Microbiology and Virology	2	-	2	-	14
	BIOT/UD/MJ/501 T	Biomolecules and Bioenergetics	2	-	2	-	
	BIOT/UD/MJ/502 T	Inheritance Biology	2	-	2	-	
	BIOT/UD/MJ/503 T	Skills In Biotechnology I	2		2		
	BIOT/UD/MJ/500 P	Lab Course Based On BIOT/UD/MJ/500 T		4		2	
	BIOT/UD/MJ/501 P	Lab Course Based On BIOT/UD/MJ/501 T		4		2	
	BIOT/UD/MJ/502 P	Lab Course Based On BIOT/UD/MJ/502 T		4		2	
DSE (Choose any one from pool of courses)	BIOT/UD/DSE/504 A T	A-Plant Biotechnology I	2	-	2	-	4
	BIOT/UD/DSE/504 B T	B-Techniques In Biotechnology	2	-	2	-	
	BIOT/UD/DSE/504 C T	C-Cell and Developmental Biology	2	-	2	-	
	BIOT/UD/DSE/504 A P	Lab Course Based On BIOT/UD/DSE/504 A T		4		2	
	BIOT/UD/DSE/504 B P	Lab Course Based On BIOT/UD/DSE/504 B T		4		2	
	BIOT/UD/DSE/504 C P	Lab Course Based On BIOT/UD/DSE/504 C T		4		2	
	BIOT/UD/DSE/504 D	D-any Online certification course from NPTEL /SWAYM /MOOC of equivalent credits { with biology basis }	AS PER COURSE CONDUCTING AGENCY				
RM	BIOT/UD/RM/549	Research Methodology	4	-	4	-	4
			12	20	12	10	22 credits

AS PER NEP 2020

Credit distribution structure for Two Years/One Year Programme with Multiple Entry and Exit options

(Discipline Specific Core in the Subject of BIOTECHNOLOGY)

Class: M.Sc. First Year Semester: II

Course type	Course Code	Course Name	Teaching Scheme		Credits Assigned		Total Credits
			(Hrs./ wK)		Theory	Practical	
			Theory	Practical			
DSC Major Mandatory	BIOT/UD/MJ/550 T	Immunology	2	-	2	-	14
	BIOT/UD/MJ/551 T	Enzyme Technology	2	-	2	-	
	BIOT/UD/MJ/552 T	Molecular Biology	2	-	2	-	
	BIOT/UD/MJ/553 T	Skills In Biotechnology II	2		2		
	BIOT/UD/MJ/550 P	Lab Course Based On BIOT/UD/MJ/550 T		4		2	
	BIOT/UD/MJ/551 P	Lab Course Based On BIOT/UD/MJ/551 T		4		2	
	BIOT/UD/MJ/552 P	Lab Course Based On BIOT/UD/MJ/552 T		4		2	
DSE (Choose any one from pool of courses)	BIOT/UD/DSE/554 A T	A-Animal Biotechnology I	2	-	2	-	4
	BIOT/UD/DSE/554 B T	B-Advanced Techniques in Biotechnology	2	-	2	-	
	BIOT/UD/DSE/554 C T	C-Biofuels	2	-	2	-	
	BIOT/UD/DSE/554 A P	Lab Course Based On BIOT/UD/DSE/554 A T		4		2	
	BIOT/UD/DSE/554 B P	Lab Course Based On BIOT/UD/DSE/554 B T		4		2	
	BIOT/UD/DSE/554 C P	Lab Course Based On BIOT/UD/DSE/554 C T		4		2	
	BIOT/UD/DSE/554 D	D ² -any Online certification course from NPTEL /SWAYM /MOOC of equivalent credits { with biology basis }	AS PER COURSE CONDUCTING AGENCY				
OJT/FP	BIOT/UD /OJT/599	On The Job Training/ Field Project	4	-	4	-	4
			12	20	12	10	22 credits

SUMMARY
OF
COURSE STRUCTURE
FOR
M.Sc. BIOTECHNOLOGY
I AND II SEMESTER

DEPARTMENT OF BIOTECHNOLOGY

SUMMARY OF COURSE STRUCTURE FOR M.Sc. BIOTECHNOLOGY I SEMESTER

COURSE CODE	COURSE TITLE	Teaching Scheme (Hrs./ week)	Credits Assigned	NATURE OF COURSE	MODE OF INSTRUCTION
BIOT/UD/MJ/500 T	Microbiology and Virology	2	2	Core/Mandatory	Theory
BIOT/UD/MJ/501 T	Biomolecules and Bioenergetics	2	2	Core/Mandatory	Theory
BIOT/UD/MJ/502 T	Inheritance Biology	2	2	Core/Mandatory	Theory
BIOT/UD/MJ/503	Skills In Biotechnology I	4	2	Core/Mandatory	Practical/Lab work
BIOT/UD/MJ/500 P	Lab Course Based On BIOT/UD/MJ/500 T	4	2	Core/Mandatory	Practical/Lab work
BIOT/UD/MJ/501 P	Lab Course Based On BIOT/UD/MJ/501 T	4	2	Core/Mandatory	Practical/Lab work
BIOT/UD/MJ/502 P	Lab Course Based On BIOT/UD/MJ/502 T	4	2	Core/Mandatory	Practical/Lab work
BIOT/UD/DSE/ 504 A T	A-Plant Biotechnology I	2	2	DSE/ELECTIVE	Theory
BIOT/UD/DSE/ 504 B T	B-Techniques In Biotechnology	2	2	DSE/ELECTIVE	Theory
BIOT/UD/DSE/ 504 C T	C-Cell and Developmental Biology	2	2	DSE/ELECTIVE	Theory
BIOT/UD/DSE/ 504 /504 D	D-any Online certification course from NPTEL /SWAYM /MOOC of equivalent credits { with biology basis }			DSE/ELECTIVE	(IN CASE OF MOOC / NPTEL COURSE, RULES OF COURSE CONDUCTING AGENCY WILL BE BINDING)
BIOT/UD/DSE/ 504 A P	Lab Course Based On BIOT/UD/DSE/504 A T	4	2	DSE/ELECTIVE	Practical/Lab work
BIOT/UD/DSE/ 504 B P	Lab Course Based On BIOT/UD/DSE/504 B T	4	2	DSE/ELECTIVE	Practical/Lab work
BIOT/UD/DSE/ 504 C P	Lab Course Based On BIOT/UD/DSE/504 C T	4	2	DSE/ELECTIVE	Practical/Lab work
BIOT/UD/RM /549	Research Methodology	4	4	RESEARCH METHODS/ Mandatory	Theory

II SEMESTER

COURSE CODE	COURSE TITLE	Teaching Scheme (Hrs./ week)	Credits Assigned	NATURE OF COURSE	MODE OF INSTRUCTION
BIOT/UD/MJ/550 T	Immunology	2	2	Core/Mandatory	Theory
BIOT/UD/MJ/551 T	Enzyme Technology	2	2	Core/Mandatory	Theory
BIOT/UD/MJ/552 T	Molecular Biology	2	2	Core/Mandatory	Theory
BIOT/UD/MJ/553 T	Skills In Biotechnology II	4	2	Core/Mandatory	Theory
BIOT/UD/MJ/550 P	Lab Course Based On BIOT/UD/MJ/550 T	4	2	Core/Mandatory	Practical/Lab work
BIOT/UD/MJ/551 P	Lab Course Based On BIOT/UD/MJ/551 T	4	2	Core/Mandatory	Practical/Lab work
BIOT/UD/MJ/552 P	Lab Course Based On BIOT/UD/MJ/552 T	4	2	Core/Mandatory	Practical/Lab work
BIOT/UD/DSE/554 A T	A-Animal Biotechnology I	2	2	DSE/ELECTIVE	Theory
BIOT/UD/DSE/554 B T	B-Advanced Techniques in Biotechnology	2	2	DSE/ELECTIVE	Theory
BIOT/UD/DSE/554 C T	C-Biofuels	2	2	DSE/ELECTIVE	Theory
BIOT/UD/DSE/554 A P	Lab Course Based On BIOT/UD/DSE/554 A T	4	2	DSE/ELECTIVE	Practical/Lab work
BIOT/UD/DSE/554 B P	Lab Course Based On BIOT/UD/DSE/554 B T	4	2	DSE/ELECTIVE	Practical/Lab work
BIOT/UD/DSE/554 C P	Lab Course Based On BIOT/UD/DSE/554 C T	4	2	DSE/ELECTIVE	Practical/Lab work
BIOT/UD/DSE/554 D	D ² -any Online certification course from NPTEL /SWAYM /MOOC of equivalent credits { with biology basis }	--	--	DSE/ELECTIVE	IN CASE OF MOOC / NPTEL COURSE, RULES OF COURSE CONDUCTING AGENCY WILL BE BINDING
BIOT/UD/OJT/599	On The Job Training/ Field Project	4	4	Core/Mandatory (CHOICE BASED)	INDUSTRIAL TRAINING/FIELD WORK/ Practical/Lab work

Program Objectives and outcomes

Overall after completion of this course, students will acquire fundamental knowledge and basic understanding about applications of Biotechnology.

Program Objectives for M.Sc. Biotechnology Program:

1. To provide students with a strong foundation in the principles and concepts of biotechnology, including microbiology, cell biology, biochemistry, genetics, and molecular biology.
2. To familiarize students with advanced biotechnological techniques and technologies used in various fields, such as medicine, agriculture, and environmental science.
3. To develop critical thinking and problem-solving skills in the context of biotechnological research and applications.
4. To expose students to the latest advancements and emerging trends in biotechnology through seminars, workshops, and research projects.
5. To foster an understanding of the ethical considerations and societal implications of biotechnological research and its applications.
6. To prepare students for careers in research, development, and management roles in biotechnology industries, academia, and government agencies.

Program Outcomes for M.Sc. Biotechnology Program:

1. Demonstrate a comprehensive understanding of the fundamental principles and concepts of biotechnology.
2. Apply knowledge of microbiology, cell biology, biochemistry, genetics, molecular biology and other biotechnological disciplines to analyze and solve complex problems in the field.
3. Utilize advanced biotechnological techniques and methodologies to conduct research and experiments independently.
4. Critically evaluate scientific literature and research papers related to biotechnological topics and communicate findings effectively.
5. Design and execute biotechnological research projects, including hypothesis formulation, data collection, analysis, and interpretation.
6. Collaborate effectively in multidisciplinary teams to address biotechnological challenges and research questions.
7. Apply ethical principles and considerations in the conduct of biotechnological research and applications.
8. Demonstrate proficiency in the use of biotechnological instruments and equipment commonly used in research and industry.

9. Explore and adapt to new advancements and emerging technologies in biotechnology as they arise.
10. Present research findings and scientific concepts clearly and concisely in both written and oral formats.
11. Cultivate a passion for continuous learning and staying up-to-date with advancements in biotechnological research and industry

DEPARTMENT OF BIOTECHNOLOGY

Detailed curricula of courses

DEPARTMENT OF BIOTECHNOLOGY

M.Sc. Biotechnology

Semester I

BIOT/UD/MJ/500 T

**Microbiology and Virology
(DSC Major / Mandatory course)**

Credits Assigned--2

Marks---50

Contact Hours--30

Course Objectives for Basic Microbiology and Virology:

1. To introduce students to the fundamental concepts and principles of microbiology, including the study of microorganisms, their structure, classification, and growth.
2. To provide an understanding of the role of microorganisms in various ecological processes and their impact on human health, agriculture, and the environment.
3. To explore the diversity of microorganisms, including bacteria, archaea, fungi, protozoa, and algae, and their significance in different ecosystems.
4. To study the basic principles of virology, including the structure, replication, and genetics of viruses.
5. To examine the interaction between microorganisms and the human immune system, and the mechanisms of microbial pathogenesis.
6. To understand the principles of epidemiology and how microorganisms spread and cause infectious diseases.
7. To introduce students to the techniques and methodologies used in microbiological and virological research, including culturing, staining, and molecular techniques.
8. To discuss the applications of microbiology and virology in biotechnology, medicine, and other relevant industries.

Course Outcomes for Basic Microbiology and Virology:

1. Demonstrate a comprehensive understanding of the different types of microorganisms, their characteristics, and their classification.
2. Explain the growth and reproduction of microorganisms, including factors affecting their growth and how they adapt to different environments.
3. Analyze the roles of microorganisms in nutrient cycling, symbiosis, and their impact on human health and the environment.
4. Describe the structure, genetic material, and replication strategies of viruses, and how they interact with host cells.
5. Evaluate the mechanisms of microbial pathogenesis and the host immune response to infections.
6. Apply knowledge of microbiology to understand the epidemiology of infectious diseases and the principles of disease control and prevention.
7. Perform basic microbiological and virological techniques in the laboratory, including culturing, staining, and genetic analysis.
8. Discuss the applications of microbiology and virology in biotechnology, such as the production of vaccines, antibiotics, and genetically modified organisms.
9. Demonstrate awareness of biosafety and biosecurity measures when working with microorganisms in the laboratory and other settings.
10. Develop critical thinking and problem-solving skills to address current challenges and emerging issues in microbiology and virology, such as antimicrobial resistance and viral outbreaks.

11. Communicate scientific information effectively, both orally and in writing, related to microbiology and virology topics.

Course contents:

Unit I: Basics of Microbiology:

Brief history of Microbiology, (theory of Spontaneous generation, Scientists contribution), (HOME ASSIGNMENT on **Differences between prokaryotic and eukaryotic cells** to test the basic understanding of students. As this aspect is part of Junior college examination and undergraduate course in life sciences, students must have proper knowledge of this aspect). Distinguishing features of Types of Microorganisms- **Protozoa, Algae, Fungi, Bacteria, Viruses**

Introduction to basic techniques in microbiology

Microscopy: Introduction to microscopy, Light microscope, phase contrast microscope, and electron microscope.

Stain & staining: brief classification of stains, staining theories and staining techniques:

Negative, Monochrome and Differential Staining (Gram, capsule, spore & acid fast staining),

Pure culture techniques

Biochemical characterization. Bacterial taxonomy (conventional, adensonian, and molecular approaches to bacterial taxonomy including ribotyping, rRNA sequencing.), Microbial consortium, Identification of microbial communities by metagenome analysis.

The diversity of the microbial world:

Introduction to diversity among Microorganisms, Biogeochemical cycles with respect to the involvement of microorganisms, (for example- Sulphate reducers & Sulfur oxidizers)

Extremophiles- Survival mechanism and their importance (thermophiles, psycrophils, methanogens, alkalophiles, acidophiles, halophiles.)

Sporulating bacteria, stages of sporulation, cytological and macromolecular changes during sporulation. Spore germination

Unit II: Microbial growth and control

Definition of growth, Bacterial cell division, generation time, specific growth rate mathematical expression of growth, Monoauxic, diauxic & synchronized growth curves, various methods to obtain synchronized cultures, Direct & indirect methods of microbial growth assessment, Effect of environmental factors (solutes, temperature, pH, O₂.) on microbial growth;

Microbial Nutrition: Principles of microbial nutrition, nutritional classification of microorganisms :autotrophic, heterotrophic ,saprophytic & parasitic microbes,

Construction of microbial culture media: purpose and types of media (simple medium, complex medium, Selective medium,, Enrichment medium,, Differential medium, Techniques of culture collection: isolation, purification, cultivation & preservation of microbes.

Control of microorganisms by physical & chemical agents including antimicrobial chemotherapy.

UNIT III : General Virology & Bacteriophage:

Classification, Nomenclature, General Properties, Morphology, Ultra Structure, Types of Envelopes & Composition of *Viruses*

Cultivation, Purification & Enumeration of Viruses, Virioids & Prions.

Structure & Organization of Bacteriophage.;

Genome Organization , Infection, Multiplication, Replication of *T4 Phage*, (*ASSIGNMENTS ON OTHER PHAGES THAT INCLUDE BUT NOT LIMITED TO λ Phage, M13 Phage, Mu Phage;*)

Genetic Switch of λ Phage.

Major Animal & Plant Viruses:

Animal Viruses: Genome Organization & Replication of Arthropod, Retro, DNA (Adeno, Pox, SV40, Vaccinia, Hepatitis Viruses), Influenza.

Plant Viruses: Genome Organization & Replication of TMV, Cauliflower Mosaic, Potato, Gemini Viruses.

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8. Harrigan W.E. , Laboratory methods in Food Microbiology, Academic Press
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10. Salley A.J Fundamental Principles of Bacteriology
11. Atlas R.M. Principles of Microbiology
12. Methods in Microbiology series
13. Bergys Manual Vol 1-4

14. S. B. Biswas, Amita Biswas Introduction to Viruses Vikas Publishing House Pvt Ltd; 4th edition
15. S.E. Luria General Virology

DEPARTMENT OF BIOTECHNOLOGY

M.Sc. Biotechnology

Semester I

BIOT/UD/MJ/500 P

**Microbiology and Virology
(DSC Major / Mandatory course)**

Credits Assigned--2

Marks---50

Contact Hours--60

Practicals (any 10 out of following list)

1. Preparation of liquid and solid media for growth of microorganisms.
2. Staining and Microscopic examination of **bacteria**-
Monochrome staining,
Negative staining,
Gram staining,
3. Staining and Microscopic examination of **Yeasts** by Methylene Blue staining ,
4. Staining and Microscopic examination of **Moulds** by Lactophenol Cotton blue staining
5. Isolation of pure cultures of bacteria
by plating techniques (streak/pour/spread) using serial dilution from soil
6. Storage & preservation of microorganisms
7. Growth curve of microorganisms
8. Micrometry
9. Measurement of bacterial population by turbidometry, serial dilution ,methods
10. Effect of temperature, pH on microbial growth.
11. Biochemical characterization (IMViC) of selected microorganism
12. Assay of antibiotics
13. Isolation of thermophiles from hot water spring
14. Studies on halophiles isolated from seawater.
15. Studies on alkalophiles isolated from Lonar water/sea water.
16. Isolation of *Thiobacillusferrooxidans* and *Thiobacillusthiooxidans* cultures from metal sulfides, rock coal and acid mine waters.
17. Cultivation and study of Coli phage and one step growth curve of coli phage.
18. Cultivation study of virus in embryonated chicken eggs, Hemagglutination assay

M.Sc. Biotechnology

Semester I

BIOT/UD/MJ/501 T

**Biomolecules and Bioenergetics
(DSC Major / Mandatory course)**

Credits Assigned--2

Marks---50

Contact Hours--30

Course Objectives for Biomolecules and Bioenergetics:

1. To introduce students to the fundamental biomolecules essential for life, including carbohydrates, lipids, proteins, and nucleic acids.
2. To provide an understanding of the structure, function, and properties of biomolecules and their roles in cellular processes.
3. To explore the biochemical pathways and metabolic reactions involved in the synthesis and breakdown of biomolecules.
4. To understand the principles of bioenergetics and the transfer and utilization of energy in biological systems.
5. To examine the different types of cellular respiration and fermentation, and their importance in energy production.
6. To discuss the role of biomolecules and bioenergetics in various physiological and biochemical processes, including signal transduction and gene expression.

Course Outcomes for Biomolecules and Bioenergetics:

1. Demonstrate a comprehensive understanding of the structure, properties, and functions of carbohydrates, lipids, proteins, and nucleic acids.
2. Explain the various biochemical pathways involved in the synthesis and degradation of biomolecules, and their regulation in response to cellular needs.
3. Apply knowledge of biomolecules and their interactions to understand cellular processes such as DNA replication, protein synthesis, and cellular signaling.
4. Describe the principles of bioenergetics and the flow of energy in biological systems, including thermodynamics and redox reactions.
5. Compare and contrast the different metabolic pathways for energy production, such as glycolysis, the citric acid cycle, and oxidative phosphorylation.
6. Apply quantitative and analytical skills to calculate energy yields and metabolic rates in biochemical reactions.
7. Discuss current research and advancements in the fields of biomolecules and bioenergetics, and their applications in biotechnology and medicine.
8. Develop critical thinking skills to evaluate and propose solutions to problems related to biomolecules and bioenergetics.

9. Communicate scientific information effectively, both orally and in writing, related to biomolecules and bioenergetics topics.

Course contents:

Units I Fundamentals of Bioenergetics

Structure of atoms, molecules and chemical bonds (bond strength, cleavage of C-C bond), Stabilizing interactions (Van der Waals, electrostatic, hydrogen bonding, hydrophobic interaction.).

Principles of biophysical chemistry (pH, pKa, titration curve, weak acids, bases) buffer, thermodynamics,(laws, concept of entropy, enthalpy, equilibrium constant, free energy change, free energy change for ATP hydrolysis) , colligative properties.

Bioenergetics of catabolism of Carbohydrates (Glycolysis, TCA cycle, HMP shunt pathway) for ATP generation [Kinetics of each reaction].

ATP consumption during Gluconeogenesis, Glycogen Synthesis

UNIT II Carbohydrates and Nucleic Acids

Structure, Function and Biosynthesis of Starch, Lactose & Sucrose.)

Regulation of Carbohydrate metabolism (with reference to glucose),

Metabolic Disorders.(Diabetes, Hypoglycemia, Diabetes as a factor for coronary disfunction, Lactose intolerance).

LIGNIN as natural recalcitrant compound

Composition, Structure (including Conformation of nucleic acids (A-, B-, Z-,DNA), t-RNA, rRNA & Ribosomes, Micro-RNA; and Stability of nucleic acid structures) and functions of nucleic acids

Metabolism of nucleotides-.Biosynthesis and Regulation of Purines and Pyrimidines by *de novo* and Salvage pathways,

UNIT III : Other Biomolecules of Significance

Proteins General reactions of amino acids, Biosynthesis,Degradation, Regulation and Metabolic disorders –Phenylketonuria.

Classification, Composition, Structure {Conformation (Ramachandran Plot examples, Secondary, Tertiary, & Quaternary Structure, Domains, Motifs & Folds.)} and function of Proteins, Stability of Protein Structures,

Lipids,:

Lipids: Definition, Composition, Classification, Structure, Function, Storage lipids, Membrane lipids, Essential & Non-essential fatty acids, {Good & Bad lipids (Cholesterol)}.

Metabolism of lipids: General reactions, Functions, Biosynthesis and Degradation {fatty acids [oxidation of saturated (α & β) and unsaturated], Triglycerides, Phospholipids, Cholesterol, Prostaglandins}, Metabolic disorders (Triglyceridemia, Tayman Sachs Disease)

Vitamines: Classification, Functions, Role in metabolism, metabolic Disorders of vitamins deficiencies –**A,B,C,D,K**. Vitamins as co-factors.

Hormones : Classification of hormones, Endocrine glands, basic mechanism of hormone action,

Brief introduction to :

Role of hormones in reproduction (Estrogen, Testosterone, hCG, FSH, LH), control of fertility (Prolactin, Progesterone, FSH, LH), gametogenesis,

human growth hormones ,

hormonal disorders {Thyroiditis (hypothyroidism, hyperthyroidism), Polycystic Ovarian Syndrome/Polycystic Ovarian Disorder(PCOS/PCOD), Insulin Dependent Diabetes,.}

References:

1. Cohn & Stump – Outline of Biochemistry Wiley Eastern Ltd.
2. Harpers Review of biochemistry – Prentice Hall
3. Cregnton – Protein Structure & Molecular Properties
4. A.L. Lehninger, D. L. Nelson & M M Cox – Principles of Biochemistry. Lubert Stryer – Biochemistry
5. David Meltzer – Biochemistry : The Chemical Reactions of living Cells –Academic Press, New York
6. Dixon & Webb –Enzymes
7. J. Jayaraman- Practical Biochemistry
8. Plummer. –Practical Biochemistry.
9. Horton; principles of biochemistry.
10. Hames; Instant Notes in Biochemistry.
11. Holme ; Analytical Biochemist
12. A.C.Deb Fundamentals of biochemistry
13. Ramakrishnan , Text book of Medical Biochemistry, Orient Longman
14. Zubay - Biochemistry 4th edition

15. Boyer- Concepts in Biochemistry

16. Cooper -The tools of Biochemistry

DEPARTMENT OF BIOTECHNOLOGY

M.Sc. Biotechnology		
Semester I		
BIOT/UD/MJ/501 P	Biomolecules and Bioenergetics	
Credits Assigned--2	(DSC Major / Mandatory course)	
	Marks---50	Contact Hours--60

Practicals (any 10 out of following list)

1. Preparation of buffers applying HH equation
2. Estimation of pKa values of amino acids
3. Demonstration of colligative properties
4. Estimation of carbohydrates by qualitative methods
5. Estimation of carbohydrates by DNSA method
6. Estimation of carbohydrates by GOD-POD)
7. Preparation / isolation of biomolecules from natural resource (Starch, glycogen, Lecithin, Cytochrome
8. Estimation of proteins –(Folin Lowry / Biurets method / UV-Vis/Bradford)
9. Determination of isoelectric pH of proteins / aminoacids
10. Isolation of proteins- casein from milk / hemoglobin (from RBC) / pulses
11. Estimation of DNA
12. Estimation of RNA
13. Acid values Iodine number& Saponification values of fats (commercial samples)
14. Isolation and purification of lipids from microbes and eukaryotes
15. Simple assays for vitamins
16. Simple assays for hormones

M.Sc. Biotechnology

Semester I

BIOT/UD/MJ/502 T

**Inheritance Biology
(DSC Major / Mandatory course)**

Credits Assigned--2

Marks---50

Contact Hours--30

Course Objectives for Inheritance Biology Course:

1. To introduce students to the principles of inheritance and genetics, including the study of genes, alleles, and genetic variation.
2. To provide an understanding of the mechanisms of heredity, including Mendelian inheritance, non-Mendelian inheritance, and sex-linked inheritance.
3. To study the role of mutations and genetic recombination in generating genetic diversity and their implications in evolution and disease.
4. To examine the genetic basis of human traits and diseases, and the ethical implications of genetic testing and genetic engineering.
5. To introduce students to modern techniques and tools used in genetic research and biotechnology.

Course Outcomes for Inheritance Biology Course:

1. Demonstrate a comprehensive understanding of the principles of inheritance and genetics, including the relationship between genes, alleles, and phenotypes.
2. Apply Mendelian and non-Mendelian principles to predict and analyze the inheritance patterns of traits in various organisms.
3. Analyze the role of mutations and genetic recombination in generating genetic variation and their significance in evolution and human diseases.
4. Evaluate the genetic basis of human traits and diseases, and discuss the potential benefits and ethical concerns of genetic testing and genetic engineering.
5. Interpret and critically analyze scientific literature and research papers related to inheritance biology and genetics.
6. Apply genetic principles to solve problems and make predictions related to genetic inheritance and variation.
7. Communicate scientific information effectively, both orally and in writing, related to inheritance biology concepts and research findings.
8. Develop critical thinking and analytical skills to assess the relevance and implications of genetic research in various fields, including medicine, agriculture, and conservation.

Course contents:

UNIT-1: Gene Concept, Mendelism and Extension of Mendelian Principles

- A. **Concept of Gene:** Allele, Multiple Alleles, Pseudo allele, Complementation tests.
- B. **Mendelian Principles:** Dominance, Segregation, Independent Assortment, Deviation from Mendelian Inheritance.
- C. **Extensions of Mendelian Principles:** Codominance, Incomplete Dominance (Partial Dominance), Gene Interactions, Pleiotrophy, Genomic Imprinting, Penetrance and Expressivity, Phenocopy, Linkage and Crossing over, Sex determination, Sex Differentiation, Sex Linkage, Sex limited and Sex influenced characters.
- D. **Extra Chromosomal Inheritance:** Inheritance of mitochondrial and chloroplast genes, Maternal Inheritance, Plasmid inheritance.

UNIT 2: Mutation and Structural Alterations of Chromosome

- A. **Mutation:** Types, Causes and detection, Mutant types –lethal, Conditional, Biochemical, Loss of Function, Gain of Function, Germinal verses Somatic mutants, Insertional Mutagenesis (Transposon based –biological mutagens).
- B. **Structural and Numerical alterations of Chromosome:** Deletion, Duplication, Inverstion, Transloaction, Ploidy and their genetic implications.

UNIT 3: Microbial Genetics and Gene Mapping Methods

Methods of genetic transfers –Transformation, Conjugation, Transduction, Sex-duction, Mapping genes by interrupted mating, Fine structure analysis of genes –S Benzes work.

Linkage maps, Tetrad analysis, Mapping with molecular markers, Mapping by using somatic cell hybrids, development of mapping population in plants.

References:

1. Principles of Genetics 8th edition, Eldon J. Gardner, Michael J. Simmons, and D. Peter Snustad, Wiley India Edition (Indian edition).
2. Molecular Genetics: An introductory Narrative (2nd Edition) Gunther S. Stent and Richard Calendar, CBS Publishers and Distributors (Indian Edition) –Reprint 2004.
3. Principles of Genetics, 7th Edition, Robert H Tamarin, Tata McGraw Hill Edition (Indian Edition) –Reprint 2004
4. Genetics 5th edition –Strickberger, Pearsons publisher –Low Price Edition (Indian Edition).
5. Modern Microbial Genetics –Editors Uldis N Streips and Ronald E. Yasbin Wiley –Liss publications, 1991.

M.Sc. Biotechnology

Semester I

BIOT/UD/MJ/502 P

**Inheritance Biology
(DSC Major / Mandatory course)**

Credits Assigned--2

Marks---50

Contact Hours--60

Practicals:

1. Study of one factor cross(multiple problems)[at least five problems]
2. Study of two factor cross(multiple problems)[at least five problems]
3. Study of three factor cross(multiple problems)[at least five problems]
4. Study of blood groups as genetic factor
5. Isolation of plasmid DNA

M.Sc. Biotechnology

Semester I

BIOT/UD/MJ/503 T

**Skills in Biotechnology I
(DSC Major / Mandatory course)**

Credits Assigned--2

Marks---50

Contact Hours--30

Course Objectives for Skills in Biotechnology (I and II) Course:

1. To introduce students to the fundamental principles and concepts of biotechnology and its applications in various fields.
2. To develop critical thinking and problem-solving skills in the context of biotechnology applications and challenges.
3. To foster an understanding of the importance of quality control and safety measures in biotechnology laboratories.
4. To expose students to cutting-edge biotechnological research and emerging trends in the field.

Course Outcomes for Skills in Biotechnology Course:

1. Demonstrate a thorough understanding of the principles and applications of biotechnology in various industries, such as agriculture, medicine, and environmental science.
2. Apply critical thinking and problem-solving skills to design and execute biotechnology experiments, troubleshoot issues, and interpret results.
3. Discuss and present current biotechnological research findings and advancements in a clear and concise manner.
4. Develop practical skills in project planning, experimental design, and data analysis relevant to biotechnological research.
5. Acquire the ability to adapt to new biotechnological techniques and technologies as they emerge.
6. Cultivate a passion for lifelong learning and staying up-to-date with the rapidly evolving field of biotechnology

Course contents:

The Comprehensive Biotechnology Skills Development course is designed to provide participants with a deep understanding of various biotechnology techniques, methodologies, and applications. This course will cover fundamental concepts in biotechnology, laboratory skills, data analysis, and current trends in the field. Through a combination of lectures, hands-on laboratory sessions, and interactive discussions, participants will gain practical skills and theoretical knowledge to excel in the biotechnology industry.

UNIT I : Genetic Engineering Techniques

Recombinant DNA technology and gene cloning

Polymerase Chain Reaction (PCR) and its applications
Plasmid isolation and manipulation
Introduction to CRISPR-Cas9 gene editing

UNIT II Cell Culture and Bioprocessing

Fundamentals of cell culture techniques
Aseptic techniques and media preparation
Scale-up of bioprocesses and fermentation
Downstream processing and product isolation

UNIT III Analytical Techniques in Biotechnology

Spectrophotometry and its applications
Chromatographic techniques (HPLC, GC)
Mass spectrometry for protein analysis
Introduction to flow cytometry

Current Trends and Future Directions

Emerging trends in biotechnology (synthetic biology, personalized medicine, etc.)
Guest lectures by industry experts
Career opportunities in the biotechnology sector
Final projects and presentations by participants

References: (additional references are cited at the end of Skills in Biotechnology II Course)

1. Genetics Peter J Russel, The Benjamin/ Qummin publishing Co.
2. Principles of Genetics by Gardner, Siemens.
3. Molecular Genetics by Friefeder.
4. Molecular biology laboratory manual 6th Edn, Cappuccino.
5. Molecular biology and the gene Watson.

M.Sc. Biotechnology		
Semester I		
BIOT/UD/DSE/504 A T	Plant Biotechnology I (DSE ELECTIVE Course)	
Credits Assigned--2	Marks---50	Contact Hours--30

Course Objectives for Plant Biotechnology(I and II) Courses:

1. To introduce students to the principles and techniques of plant biotechnology and its applications in agriculture, horticulture, and environmental conservation.
2. To provide an understanding of plant cell and tissue culture techniques, including plant regeneration and micropropagation.
3. To explore genetic engineering methods in plants, including the introduction of foreign genes and the development of genetically modified organisms (GMOs).
4. To study the applications of plant biotechnology in crop improvement, such as the development of disease-resistant, drought-tolerant, and high-yielding plant varieties.
5. To investigate the role of biotechnology in enhancing plant secondary metabolite production for pharmaceutical, nutraceutical, and industrial purposes.
6. To understand the ethical, social, and environmental implications of plant biotechnology research and its potential impact on biodiversity and ecosystems.
7. To expose students to the latest advancements and emerging trends in plant biotechnology research.

Course Outcomes for Plant Biotechnology Course:

1. Demonstrate a comprehensive understanding of the principles and concepts of plant biotechnology and its relevance in addressing global agricultural challenges.
2. Perform plant tissue culture techniques, such as callus induction, somatic embryogenesis, and shoot regeneration.
3. Apply genetic engineering methods to introduce desirable traits into plants and produce genetically modified plant lines.
4. Analyze and interpret experimental data related to plant biotechnology research, such as gene expression analysis and phenotypic characterization of transgenic plants.
5. Evaluate the potential applications of plant biotechnology in crop improvement and sustainable agriculture.
6. Discuss and present current research findings and advancements in plant biotechnology in a clear and concise manner.

7. Critically assess the ethical, social, and environmental considerations related to the use of genetically modified plants.
8. Collaborate effectively in group projects related to plant biotechnology research and applications.
9. Explore potential career paths and opportunities in the field of plant biotechnology and related industries.
10. Develop practical skills in experimental design, data analysis, and troubleshooting relevant to plant biotechnology research.

Course contents:

Unit I- Introduction to tissue culture

Cellular Totipotency

Media composition: Theory of limiting factor with respect to inorganic salts (Major and minor elements) organic chemicals (carbohydrates, vitamins)

Growth regulators (Auxin, cytokinin, gibberellins, ascorbic acid, ethylene) Amino acids (L-amino acids and its role in Tissue culture) Antibiotics (Ampicillin, Carbenicillin, Cefotaxime, Gentamycin sulphate, methylol urea, Polymixin B Ribavirin, Streptomycin) Uses

Chemically undefined constituents and natural complexes (gelling agents, activated charcoal, casein HL, coconut milk, corn milk, corn starch, potato extract, yeast extract, antioxidants)

Selection of media for specified application: Callus induction media, chlorate selection medium, Embryo culture medium, Green algae medium, Propagation medium

Standardization of media and glassware

UNIT-II-Methods in Plant Tissue Culture

Callus culture and dynamics of callus growth; Organogenesis and its applications; Somaclonal variation and its application; Micropropagation and its application (Micropropagation through shoot and bud meristem Tip culture, in vitro tuberization, somatic embryogenesis)

Unit III -PRINCIPLE, PROCEEDURE AND APPLICATIONS OF TRANSFORMATION METHODS

Organ culture: Root culture, shoot tip culture (meristem culture), flower bud culture, ovary culture, ovule culture, embryo culture, anther culture Callus culture and its dynamics Somatic embryogenesis and artificial seeds Protoplast culture, protoplast fusion and somatic hybridization –

Direct gene transfer: PEG mediated transfer, microinjection, protoplast and intact cell electroporation and gene gun, chloroplast transformation.

Indirect method: Agrobacterium mediated gene transformation

References

1. A text book of genetic engineering by Desmond Nicoll
2. Agrobacterium: From biology to Biotechnology by Tzvi Tzfira
3. Principles of gene manipulation by Primrose
4. Plant cell and tissue culture – A tool in Biotechnology- by Ashwani Kumar
5. Laboratory manual of Plant Biotechnology By Purohit-2
6. Methods in Plant tissue culture By U Kumar-1
7. Plant tissue culture Bhojwani:
8. Introduction to Plant Tissue Culture Kalyan Kumar DE
9. Practical application of Plant Molecular Biology R.J.Henry,Chapman and Hall

M.Sc. Biotechnology

Semester I

BIOT/UD/DSE/504 A P

**Plant Biotechnology I
(DSE ELECTIVE Course)**

Credits Assigned--2

Marks---50

Contact Hours--60

Practicals:

Plant Tissue Culture Techniques:

1. Preparation of sterile culture media
2. Callus induction media,
3. Chlorate selection medium,
4. Embryo culture medium,
5. Aseptic techniques for handling plant materials
6. Explant selection and preparation
7. Callus induction
8. Callus regeneration
9. Micropropagation of plants
10. Root culture,
11. shoot tip culture
12. flower bud culture,
13. ovary culture,
14. ovule culture,
15. embryo culture,
16. anther culture

M.Sc. Biotechnology

Semester I

BIOT/ UD/DSE/ 504 B T

**Techniques in Biotechnology
(DSE ELECTIVE Course)**

Credits Assigned--2

Marks---50

Contact Hours--30

Course Objectives for Techniques in Biotechnology Course:

1. To introduce students to a variety of techniques commonly used in biotechnology research and applications.
2. To provide hands-on training in laboratory skills and experimental procedures related to biotechnology, including DNA manipulation, protein analysis, and genetic engineering.
3. To familiarize students with the use of advanced biotechnological instruments and equipment.
4. To develop critical thinking and problem-solving skills in the context of biotechnological experiments and data analysis.
5. To explore the principles of quality control and safety measures in biotechnology laboratories.
6. To expose students to emerging trends and advancements in biotechnological techniques and research.

Course Outcomes for Techniques in Biotechnology Course:

1. Demonstrate proficiency in a range of biotechnological techniques, such as DNA extraction, PCR, gel electrophoresis, and Western blotting.
2. Perform laboratory experiments independently and accurately, ensuring proper documentation of procedures and results.
3. Analyze and interpret experimental data, draw meaningful conclusions, and present findings effectively.
4. Utilize advanced biotechnological instruments and equipment competently and troubleshoot technical issues.
5. Apply critical thinking skills to design and modify biotechnological experiments based on research objectives.
6. Demonstrate awareness of safety protocols and ethical considerations in biotechnological research.
7. Collaborate effectively in a team environment, contributing to the success of group projects and experiments.
8. Evaluate and critically analyze scientific literature related to biotechnological techniques and research.
9. Adapt to new and emerging biotechnological techniques and methodologies as they arise.
10. Develop practical skills in experimental design, data analysis, and troubleshooting relevant to biotechnological research.
11. Gain insight into potential career paths and opportunities in the field of biotechnology.
12. Foster an appreciation for the significance of biotechnological techniques in various industries, including medicine, agriculture, and environmental science.
13. Cultivate a passion for continuous learning and staying up-to-date with advancements in biotechnology

Course contents:

Unit I: NUCLEIC ACID STUDY TECHNIQUES

ISOLATION DNA: Principles, protocols, chemicals, methods, and problems in isolation of DNA from mitochondria, bacterial cell (genomic DNA, plasmid), fungal cell, plant cells animal cells. Quantification of DNA (UV/ Vis) and analysis of purity

ISOLATION OF RNA: Principles, protocols, chemicals, methods, and problems in isolation of RNA

ELECTROPHORESIS: Introduction to electrophoresis. Starch-gel, polyacrylamide gel (native and SDS-PAGE), agarose-gel electrophoresis, pulse field gel electrophoresis, immuno- electrophoresis, isoelectric focusing, Blotting techniques

Unit II: PROTEIN STUDY TECHNIQUES

Protein Sample Preparation: Techniques and applications:

Total protein extraction; cell disruption methods: (reagent-based and physical); subcellular fractionation; sample preparation for downstream assays such as Western blotting, , Mass spectrometry

Chromatography in Protein Studies: Hydrophobic interaction chromatography (HIC); size exclusion chromatography (SEC); ion exchange chromatography (IEX); affinity chromatography (AC);

Protein cleanup methods: Desalting, Buffer exchange, Dialysis

Unit III: Gene Recombination, Gene Transfer and Transformation, Competent cells preparation, Transformation, Selection of recombinants – (Antibiotic sensitivity assay/ blue –white screening)

Other methods for gene transfer: Microinjection, Electroporation, Ultrasonication, (brief introduction that include principle, short method, applications)

PCR Techniques

Principle, types, instrumentation, primer-designing and applications of: Polymerase chain reaction (PCR), RT- (Reverse transcription) PCR.

References:

1. Genetics Peter J Russel, The Benjamin/ Qummin publishing Co.
2. Principles of Genetics by Gardner, Siemens.
3. Molecular Genetics by Friefeder.
4. Molecular biology laboratory manual 6th Edn, Cappuccino.
5. Molecular biology and the gene Watson.

M.Sc. Biotechnology

Semester I

BIOT/ UD/DSE/ 504 B P

**Techniques in Biotechnology
(DSE ELECTIVE Course)**

Credits Assigned--2

Marks---50

Contact Hours--60

Practicals

DNA Extraction methods :Isolation of DNA from plant tissues/bacterial cultures/animal tissue using various extraction methods such as

- i. Phenol-Chloroform Extraction:.
- ii. CTAB (Cetyltrimethylammonium Bromide) Method:
- iii. Salting Out Method:
- iv. Chelex® Resin Method:
- v. Silica Column-based Method:
- vi. Detergent and Enzyme-based Method:
- vii. Magnetic Bead-based Method:
- viii. **Polymerase Chain Reaction (PCR):**Amplification of specific DNA sequences using DNA polymerases and primers. **Bacterial Transformation**
- ix. Competent cells preparation,
- x. Transformation,
- xi. Selection of recombinants by Antibiotic sensitivity assay
- xii. Selection of recombinants by blue –white screening)
- xiii. **Restriction Enzyme Digestion:** Cleavage of DNA at specific recognition sites using restriction enzymes.
- xiv. **RNA Extraction and Reverse Transcription (RT-PCR):** Isolation of RNA from cells or tissues
- xv. conversion of RNA to cDNA for PCR analysis.

M.Sc. Biotechnology

Semester I

BIOT/ UD/DSE/ 504 C T

**Techniques in Biotechnology
(DSE ELECTIVE Course)**

Credits Assigned--2

Marks---50

Contact Hours--30

Course Objectives for Cell and Developmental Biology:

1. To introduce students to the fundamental concepts and principles of cell biology, including cell structure, function, and organization.
2. To provide an understanding of the molecular mechanisms governing cellular processes such as DNA replication, transcription, translation, and cell signaling.
3. To explore the diversity of cell types and their specialized functions in various organisms, including prokaryotes, eukaryotes, and unicellular organisms.
4. To examine the role of cell biology in the context of health and disease, including the study of cancer, immunology, and infectious diseases.
5. To introduce students to developmental biology, focusing on the processes that guide embryonic development and the formation of tissues and organs.
6. To explore the genetic and environmental factors that influence developmental processes and lead to the diversity of multicellular organisms.
7. To understand the ethical implications of cell and developmental biology research, particularly in the fields of genetic engineering and reproductive technologies.

Course Outcomes for Cell and Developmental Biology:

1. Demonstrate a comprehensive understanding of cell biology, including the structure and function of cellular organelles, cellular metabolism, and cellular communication.
2. Explain the molecular mechanisms involved in DNA replication, transcription, and translation, and how they contribute to cellular processes.
3. Identify and differentiate various cell types, tissues, and organs, and explain their specialized functions in different organisms.
4. Analyze the cellular basis of diseases, including cancer and infectious diseases, and discuss potential therapeutic approaches.
5. Describe the processes involved in embryonic development and tissue differentiation, as well as the underlying genetic and environmental influences.
6. Critically assess ethical issues related to cell and developmental biology research, including genetic manipulation and assisted reproductive technologies.
7. Apply scientific principles and methodologies to conduct laboratory experiments related to cell and developmental biology, and effectively communicate experimental findings.
8. Demonstrate the ability to synthesize and integrate knowledge from various sources to address complex questions and challenges in cell and developmental biology.
9. Develop a broader appreciation for the importance of cell and developmental biology in various scientific fields and its impact on human health and society

Course contents:

Home assignments to students on

Definition of cell, Diversity of cell size and shape, Structure of prokaryotic and Eukaryotic cells
Organization, Structure and Functions of subcellular organelles of bacteria, yeast, plant and animal cell. (Cell wall, plasma membrane, cilia, flagella, capsule, pili nucleus, mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, plastids, vacuoles, chloroplast,)

structure & function of cytoskeleton and its role in motility (actin, myosin, microtubules and intermediate filaments)

UNIT 1: Study of Cell and Cell division

1.1 cell size and shape, History & Evolution, Cell as the basic unit of life, cell theory, Structural organization of prokaryotes and eukaryotes.

1.2 Biogenesis of Mitochondria, Chloroplast. Structure of model membrane, lipid bilayer and membrane

1.3 protein diffusion, osmosis, ion channels, active transport, membrane pumps, mechanism of sorting and regulation of intracellular transport, electrical properties of membranes.

1.4 Mechanism of cell division mitosis, meiosis and genetic recombination; regulation of cell cycle; factors and genes regulating cell cycle.

UNIT 2: Cell-Cell interactions and Cancer genetics

2.1 General principles of cell communication cell adhesion and roles of different adhesion molecules, gap junctions, extracellular matrix, integrins.

2.2 Neurotransmission and its regulation. Hormones and their receptors, cell surface receptor, signaling through G- protein coupled receptors, signal transduction pathways, second messengers, regulation of signaling pathways

2.3 Bacterial and plant two component systems, light signaling in plants, bacterial chemotaxis and quorum sensing. Regulation of, hematopoiesis

2.4 Genetic rearrangements in progenitor cells, oncogenes, tumor suppressor genes, cancer and the cell cycle,

2.5 Virus-induced cancer, metastasis, interaction of cancer cells with normal cells, apoptosis, therapeutic interventions of uncontrolled cell growth

UNIT 3: Developmental Biology

3.1 Gametogenesis, Fertilization, cleavage, blastulation, Gastrulation & formation of germ layers in animals,

3.2 Concepts of competence, determination, commitment and differentiation

(dedifferentiation, re-differentiation, trans- differentiation) developmental plasticity in plant. Sex determination in plants & animals.

3.3. Programmed cell death-mechanism and significance;

3.4 Genes and ageing; Insulin signaling cascade in c. Elegans; Environmental and epigenetic causes of ageing; Plant senescence

3.5 Role of gene/s in patterning and development e.g. *Arabidopsis thaliana* (root, shoot, leaf & flower) & *Drosophila melanogaster* (maternal genes, bicoid, gap genes), Stem cells.

Text and Reference:

1. David Sadava; Cell and Molecular biology- Jones & Bartlett Publishers
2. Cell & molecular biology - Gerald karp :John Wills
3. Developmental biology- SF Gilbert Sinauer associates.
4. T.A. Brown – Genomes – Garland Science
5. Molecular Biology of the Cell- Alberts, B –Garland Science
6. Molecular cell Biology - Darnell, Lodish, Baltimore,-W.H. Freeman
7. Reproduction in Eukaryotic cells- DM Prescott, Academic Press.
8. Cell in Developmental and Inheritance- EB Wilson, MacMilan New York.
9. Fertilization-F T logo-Chapman and Hall
10. Molecular Biology of Steroid and Nuclear Hormone Receptors- LP Freedman,
11. Molecular Cloning: a Laboratory Manual- J. Sambrook, -CSHL Press,

M.Sc. Biotechnology		
Semester I		
BIOT/ UD/DSE/ 504 C P	Techniques in Biotechnology (DSE ELECTIVE Course)	
Credits Assigned--2	Marks---50	Contact Hours--60

PRACTICALS

1. Observation of different types of cells using light microscopy.
2. Examination of cellular structures and organelles.
3. Culturing of different cell lines *in vitro*.
4. Maintenance of different cell lines *in vitro*.
5. Observation of cell growth,
6. Observation of cell division,
7. Observation of cell morphology.
8. Determination of cell viability using trypan blue exclusion or MTT assay.
9. Assessment of cell viability under different experimental conditions (e.g., drug treatments, stress conditions).
10. Isolation of nuclei using cell fractionation techniques
11. Isolation of Chloroplast using cell fractionation techniques
12. Isolation of mitochondria using cell fractionation techniques.
13. Examination of cancer cell properties, metastasis, and drug responses.
14. Study of tissue and organ formation during development.
15. Cell cycle analysis and apoptosis detection using flow cytometry.

(Any available resource should be used to conduct these practicals)

M.Sc. Biotechnology

Semester I

DSE ELECTIVE Course

BIOT/ UD/DSE/ 504 D

An Online certification course from NPTEL /SWAYM /MOOC of equivalent credits { with biology basis }(DSE ELECTIVE Course)

Credits Assigned--4

Marks---100

Contact Hours--60

In case, a student opts online course as, **BIOT/UD/DSE/504 D** the curriculum, rules, regulations, and scheme of assessment etc of the course conducting agency will be binding of the student. The student should submit the course completion certificate to the department and deposit his earned credits in ABC.

DEPARTMENT OF BIOTECHNICAL ENGINEERING

M.Sc. Biotechnology		
Semester I		
BIOT/UD /RM/505	Research Methodology (Research Methodology Course)	
Credits Assigned--4	Marks---100	Contact Hours--60

Course Objectives:

1. To define research and describe the research process and research methods
2. To understand qualitative research and methods used to execute and validate qualitative research
3. To know how to apply the basic aspects of the research process in order to plan and execute a research project.
4. To provide insight into the processes that lead to the publishing of research.
5. To be able to present, review and publish scientific articles

Course Outcomes:

Students will be able to -

1. understand and explain research process
2. do systematic literature survey, formulation of a research topic, study design, analysis and interpretation of data.
3. to design a research approach for a specific research issue of their choice.
4. select a suitable analytical method for a specific research approach.
5. demonstrate a good understanding of how to write a research report.
6. critically assess published quantitative research with regard to the statistical methods and approaches adopted
7. create a research document for implementation research project

Course Contents:

Part – 1 (02 credit : 30 Contact Hours)

Unit - I: Research Fundamentals and Identification of Research Problem: (10 Hrs.)

Research Fundamentals

Introduction: Definition, objectives of the research, characteristics of the research, what makes people to do research, importance of research, Qualitative and Quantitative Research: Qualitative research - Quantitative research - Concept of measurement, causality, generalization, and replication. Merging the two approaches.

Identification of Research Problem

Defining the research problem: Identification of research problems, selection of research problem, facts one should know regarding selection of research problem, the process of

research problem definition, some facts involved in defining research problem, Research Design: Concept and Importance in Research - Features of a good research design - Exploratory Research Design - concept, types and uses, Descriptive Research Designs - concept, types and uses. Experimental Design: Concept of Independent & Dependent variables, Case Studies,

Unit - II: Formulation of Research Problem

(10 Hrs.)

Formulation of the problems: steps involved in defining a problem, formulation of the problems, Formulation of hypothesis: Concept of hypothesis, hypothesis testing, developing the research plan: implementation, interpreting and reporting the findings, Importance of hypothesis in decision making, Case Studies. Interpretation of Data. Measurement: Concept of measurement- what is measured? Problems in measurement in research- Validity and Reliability. Levels of measurement Nominal, Ordinal, Interval, Ratio.

Unit – III : Research Report and Proposal Writing

(10 Hrs.)

Introduction, research proposal writing: costing, the research proposal, rationale for the study, research objectives, research methodology, target respondents, research Centres, sample size and sample composition, sampling procedures, research project execution, research units; An insight into research report and proposal, research project synopsis, research report writing : types of research reports, guidelines for writing reports; Steps in writing report, report presentation, typing the report, documentation and bibliography, formatting guidelines for writing a good research report / research paper, Paper Writing- Layout of a Research Paper, Journals in Computer Science, Impact factor of Journals, When and where to publish ? Ethical issues related to publishing, Plagiarism and Self-Plagiarism. Case Studies.

Part – II (02 credit : 30 Contact Hours)

Presentations, case studies, Assignments, Tutorials based on Module I to III **(30 Hrs.)**

Students are expected to do the Followings

- i) Select Broad topic of Research Project (to be implemented from second semester onwards)
- ii) Read the Basic concepts / fundamentals of broad topic
- iii) Identify 10 SCOPUS / WEB OF SCIENCE Indexed Journals related to broad topic
- iv) Search and download 20 research articles from above research Journals
- v) Do systematic review of above 20 research articles
- vi) While doing review of each of above mentioned 20 research articles, students are expected prepare notes on following points
 - a) What are the objectives of the research article?
 - b) What methodology has been adopted?
 - c) What are prominent results?
 - d) How these results of relevant to the latest development of the subject?
 - e) What is novelty of research article?
 - f) What are prominent shortcomings of this research a presented in this research article?
 - g) What are your plans to address those shortcoming?

- vii) Draft the fine-tuned title of research project
- viii) Draft hypothesis
- ix) Draft Objectives and Methodology
- x) Draft expected outcome of the research project

At the end of the assignment, students are expected to prepare a report having following points

- i) Fine-tuned title of Research Project
- ii) Fundamental aspects of the fine-tuned research topic
- iii) Hypothesis
- iv) Objectives
- v) Methodology
- vi) Detailed Experimental plan
- vii) Expected outcome
- viii) References

References:

1. Research Methodology by Dr. S. L. Gupta, Hitesh Gupta; International Book House Pvt Ltd (**2013**), ISBN-10: 8191064278, ISBN-13: 978-8191064278
2. Basic Research Methods-Gerard Guthrie SAGE Publications, India, Pvt Ltd, New Delhi (**2010**), ISBN-10: 8132104579, ISBN-13: 978-8132104575
3. Research Methodology-methods and techniques By C. R. Kothari, New Age International Publishers (**2011**) ISBN 978-81-224-1522-3
4. Principles of Research Methodology- Phyllis G. Supino, Jeffrey S. Borer; Springer, Verlag New York (**2012**), ISBN-ebook: 1461433592, ISBN (Hardcover): 978-1461433590
5. Research Design Qualitative, Quantitative. and Mixed Methods Approaches- John W. Creswell; SAGE Publications Ltd, UK (**2011**), ISBN-9780857023452
6. Research Methodology -A Step-by-Step Guide for Beginners- Ranjit Kumar; Sage Publications Ltd(**2010**), ISBN- 1849203016.
7. Scientific Writing and Communication- Angelika Hofmann; Oxford University Press, US (**2010**), ISBN-13-: 978-0 199947560, ISBN-10: 01 99947562
8. Writing Science: How to Write Papers That Get Cited and Proposals That Get Funded- Joshua Schimel, Oxford University Press, (**2011**), ISBN: 9780199760237
9. Handbook of Scientific Proposal Writing- A.YavuzOruc; CRC Press, Taylor & Francis group (**2011**), ISBN: 9781439869185

M.Sc. Biotechnology

Semester II

BIOT/UD/MJ/550 T

**Immunology
(DSC Major / Mandatory course)**

Credits Assigned--2

Marks---50

Contact Hours--30

Course Objectives for Immunology Course:

1. To introduce students to the basic concepts and principles of immunology, including the immune system's structure and function.
2. To provide an understanding of the different components of the immune system, such as antibodies, antigens, and immune cells.
3. To explore the mechanisms of immune responses, including innate immunity, adaptive immunity, and the generation of memory responses.
4. To study the role of the immune system in defending against infectious agents, such as bacteria, viruses, and parasites.
5. To examine the immune system's involvement in various diseases, including autoimmune disorders, allergies, and immunodeficiencies.
6. To introduce students to the principles of vaccination.
7. To understand the ethical considerations and social implications of immunology research and applications.
8. To encourage critical thinking and problem-solving skills through the analysis of immunological research and case studies.

Course Outcomes for Immunology Course:

1. Demonstrate a comprehensive understanding of the immune system's structure, organization, and function.
2. Explain the mechanisms of immune responses, including the recognition and elimination of foreign invaders and the development of immune memory.
3. Identify and differentiate various immune cells and molecules, and explain their roles in specific immune processes.
4. Analyze the immune responses to different types of pathogens, including bacteria, viruses, and parasites.
5. Describe the underlying immunological mechanisms involved in various diseases, such as autoimmune disorders, allergies, and immunodeficiencies.
6. Discuss the principles of vaccination
7. Evaluate the ethical considerations related to immunology research, such as the use of animal models and the testing of new therapies.

8. Apply knowledge of immunology to analyze and interpret experimental data and research findings.
9. Work collaboratively in group discussions and laboratory settings to address immunology-related challenges and research questions.
10. Demonstrate the ability to critically assess scientific literature and research papers related to immunology.
11. Develop a broader appreciation for the importance of immunology in various scientific fields and its impact on human health and disease prevention

Course contents:

UNIT I Basic Concepts

- 1.1 Basic concepts of Immune System Cells and organs of immune system, Immunity Humoral and cell mediated, Hematopoiesis and differentiation.
- 1.2 Antigens- General properties, types, epitope, hapten, adjuvant.
- 1.3 Antibodies- Types, biological functions. Biology of Superantigen. BCR & TCR (structure & properties), MHC Antigen processing and presentation
Maturation and Activation of B-cells Maturation and Activation of T-cells
- 1.4 Complement system; complement activation pathways, biological consequences of complement activation.

UNIT II Vaccine and Immunological reactions:

- 2.1 **Vaccine** technology and recombinant vaccines, Identifications of B and T epitopes for vaccine development. *in situ* characterization of cells in tissues. Hybridoma technology, monoclonal antibody production and applications. Catalytic antibodies, FACS.
- 2.2 **Immunological reactions** Precipitation. Agglutination, Radioimmunoassay,
- 2.3 Techniques based on immunological reactions ELISA, Western Blotting, Flow cytometry and Fluorescence. Immunoelectron microscopy, RIA

UNIT 3 Hypersensitivity Autoimmunity and Immunodeficiency

- 3.1 **Hypersensitivity:** Components, Mechanisms of degranulation, Mediators, Consequences, Transfusion reactions, Localized reactions, generalized reactions, Delayed type hypersensitivity
- 3.2 **Autoimmunity:** Organ specific autoimmune diseases (Hashimoto's thyroiditis, Autoimmune anemia, Insulin dependent diabetes mellitus) Systemic autoimmune diseases (SLE,

Multiple sclerosis, Rheumatoid arthritis) Treatment of autoimmune diseases

3.3 Transplantation Immunology: Types of graft, Specificity and memory of rejection response, Mechanisms involved in graft rejection, Clinical manifestations of graft rejection Immunity to infectious diseases, Tumor Immunology

3.4 Immunodeficiency: Primary immunodeficiency (SCID, X-linked agammaglobulinemia, Defects in complement system),

Secondary immunodeficiency (AIDS), Treatment of immunodeficiency diseases.

Immunity to Infectious Agents Bacteria Viruses Malaria Anthrax

References:

1. Roitt I M, Essential Immunology , Blackwell Scientific Publications, Oxford
2. Weissman I L Wood, Immunology, Benjamin Cummings
3. Kuby - Immunology , 4th ed Freeman press
4. Stites DP Basic & Clinical Immunology, Appleton & Lang press
5. Ellis, Vaccines, A new approach to Immunology
6. W E Paul, Fundamental Immunology, Raven Press
7. D M Weir Experimental Immunology 4 volumes
8. William Paul Fundamentals of Immunology
9. Abbas- Cellular and Molecular Immunology
10. Rose- Manual of Clinical and Laboratory immunology
11. Benjamini- Immunology :A short Course
12. Brooks – Medical Microbiology 21st ed
13. Joshi – Immunology
14. Janeway -Immunobiology

M.Sc. Biotechnology

Semester II

BIOT/UD/MJ/550 P

**Immunology
(DSC Major / Mandatory course)**

Credits Assigned--2

Marks---50

Contact Hours--60

Practicals (any 10 out of following list)

Practical:

1. Determination of ABO Blood group
2. Determination of total leukocyte count
3. Determination of differential leukocyte count
4. Study of anatomy of thymus, spleen & lymph nodes
5. Radial immunodiffusion,
6. double diffusion
7. Study of Ag-Ab reactions Widal,
8. Study of Ag-Ab reactions VDRL
9. Immuno electrophoresis
10. Latex agglutination
11. ELISA,
12. Western Blotting
13. Rocket immuno electrophoresis
14. Radioimmunoassay
15. CD4 Count assay (at least demonstration)

M.Sc. Biotechnology		
Semester II		
BIOT/UD/MJ/551T	Enzyme Technology (DSC Major / Mandatory course)	
Credits Assigned--2	Marks---50	Contact Hours--30

Course Objectives:

1. Understand the fundamental principles of enzymology:
 - a. Define enzymes and their role in catalyzing biological reactions.
 - b. Explain enzyme kinetics and the factors that influence enzymatic activity.
 - c. Describe enzyme structure and function.
2. Explore enzyme isolation and purification techniques:
 - a. Analyze different methods used for isolating and purifying enzymes.
 - b. Apply chromatographic and electrophoretic techniques for enzyme separation.
3. Study enzyme immobilization methods:
 - a. Assess various immobilization techniques and their advantages in biotechnological applications.
 - b. Describe the principles of enzyme immobilization and their impact on enzyme stability and reusability.
4. Investigate enzyme engineering and protein modification:
 - a. Learn techniques for altering enzyme properties through genetic engineering and protein modification.
 - b. Discuss the impact of enzyme engineering on catalytic efficiency and specificity.
5. Examine industrial applications of enzymes:
 - a. Explore the use of enzymes in food processing, brewing, and agriculture.
 - b. Investigate enzyme applications in pharmaceuticals, biofuels, and other biotechnological industries.
6. Discuss enzyme technology in healthcare and diagnostics:
 - a. Understand the role of enzymes in clinical diagnostics and disease detection.
 - b. Explore enzyme-based therapies and their potential in medical treatments.
7. Evaluate the environmental applications of enzymes:
 - a. Analyze the use of enzymes in waste management, bioremediation, and pollution control.
 - b. Understand the potential of enzymes for sustainable and eco-friendly processes.

Course Outcomes:

1. Students will demonstrate a thorough understanding of enzymology, including enzyme structure, function, and kinetics.
2. Students will gain practical skills in enzyme isolation, purification, and characterization techniques.
3. Students will be able to evaluate different methods of enzyme immobilization and understand their applications in biotechnological processes.
4. Students will be familiar with enzyme engineering techniques and the potential for improving enzyme performance.
5. Students will be able to identify and analyze the industrial applications of enzymes in various sectors.
6. Students will understand the significance of enzyme technology in healthcare and its applications in diagnostics and medical treatments.

7. Students will comprehend the role of enzymes in environmental management and their potential for sustainable solutions.
8. Students will be able to critically assess research papers and scientific literature related to enzyme technology.
9. Students will have practical experience in designing and conducting experiments involving enzymes.
10. Students will be aware of the ethical and safety considerations related to working with enzymes in various applications.

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Course contents:

HOME ASSIGNMENTS TO STUDENTS ABOUT Enzymes as biocatalysts, Theories & Mechanism of enzyme action, specificity of enzyme action (lock and key and induced fit model of enzyme activity),

Unit I Enzymology: an Introduction:

Classification and nomenclature of enzymes

Types of Enzymes (A. Simple enzymes B. Complex enzymes, multienzyme complex, allosteric enzymes, isozymes; Multi-substrate enzymes; Coenzymes and their role in enzyme action

mechanisms of enzyme catalysis, units of enzyme activity, turnover number, activation energy

Experimental Measures of Enzyme Activity: Enzyme induction, active site determination, detection methods, separation methods in enzyme assays, , reporting enzyme activity data, enzyme stability

Unit II: Enzyme Kinetics and Inhibition Initial velocity measurements factors affecting the velocity of enzymatic reactions

Michaelis- Menton kinetics (Pre-steady state, Steady state, Derivation of M-M equation) Determination and significance of V_{max} and K_m ; Linear plots for enzyme kinetic studies

Enzyme inhibition: A. Competitive inhibition B. Uncompetitive inhibition C. Noncompetitive inhibition and kinetics of these types of inhibitions; Importance of studying enzyme inhibition

Unit III: Enzyme Immobilization and Applied Enzymology

Introduction; aim of Enzyme Immobilization; effect of immobilization on [a] Physical properties [b] Chemical properties [c] Stability [d] activity of enzyme; Advantages of Immobilization; Limitations of immobilized enzyme; Methods of immobilizations-Carrier matrices, Adsorption of enzymes, Covalent coupling (Functional groups that affects the covalent coupling, use of cyanogen bromide Ethyl chloroformate, Carbodiimide, Glutaraldehyde, 3-aminopropyltriethoxysilane) Entrapment and Encapsulation of Enzymes Crosslinking, Application of immobilized enzymes in the industries,

Use of enzymes in industries, textile, leather, food, industries.

Purification of enzymes , Use of purified enzymes in biosensors for clinical diagnosis, environmental analysis,

Enzyme Stability and Activity in Non-Aqueous Reaction Systems;.,

REFERENCES:

1. Dixon & Webb –Enzymes; Academic press New York
2. A.L. Lehninger- Biochemistry
3. Cohn & Stump – Outline of Biochemistry; Wiley Eastern Ltd.
4. Lubert Stryer – Biochemistry
5. R.L. Foster – The nature of Enzymology; Croom-Helm London
6. Harpers -Review of biochemistry –;Prentice Hall New york
7. R.A. Copeland -Enzymes: A Practical Introduction to Structure, Mechanism and Data Analysis;; John Wiley and Sons Inc.
8. Zubby,Parson, and Vanse –principles of Biochemistry; Wm.C. Brown Publishers
9. J. Jayraman- Practical Biochemistry New age Publishing house, Bangalore
10. Plummer. –Practical biochemistry; TMH New Delhi
11. Cregnton – Protein Structure & Molecular Properties
12. A.L. Lehninger, D. L. Nelson & M M Cox – Principles of Biochemistry.Lubert Stryer – Biochemistry
13. David Meltzer – Biochemistry : The Chemical Reactions of living Cells –Academic Press, New York
14. J. Jayraman- Practical Biochemistry
15. Horton; priciples of biochemistry.
16. Hames; Instant Notes in Biochemistry.
17. Holme ; Analytical Biochemist
18. A.C.Deb Fundementals of biochemistry
19. Ramakrishnan , Text book of Medical Biochemistry, Orient Longman
20. Zuby - Biochemistry 4th edition
21. Boyer- Concepts in Biochemistry
22. Cooper -The tools of Biochemistry
23. <https://www.mdpi.com/2073-4344/6/2/32>

M.Sc. Biotechnology

Semester II

BIOT/UD/MJ/551 P

**Enzyme Technology
(DSC Major / Mandatory course)**

Credits Assigned--2

Marks---50

Contact Hours--60

Practicals (any 10 out of following list)

1. Hydrolytic extracellular Enzyme production from microbes and seeds (3 microbes and 3 seeds)
Amylase/protease/lipase
2. Enzyme purification by salting out
3. Effect of pH as an enzyme parameters on enzyme activity
4. Effect of temperature, as an enzyme parameters on enzyme activity
5. Effect of different salts as an enzyme parameters on enzyme activity
6. Effect of substrates on enzyme activity
7. Determination of V_{max}
8. Determination of K_m ,
9. Calculating reciprocal plots
10. Effect of inhibitors on enzyme activity (heterocyclic compounds)
11. Immobilization of enzymes
12. study of effect of pH on immobilized enzyme preparation
13. study of effect of substrate, on immobilized enzyme preparation
14. study of effect of temp, on immobilized enzyme preparation
15. study of effect of salts, on immobilized enzyme preparation

M.Sc. Biotechnology

Semester II

BIOT/UD/MJ/552 T

**Molecular Biology
(DSC Major / Mandatory course)**

Credits Assigned--2

Marks---50

Contact Hours--30

Course Objectives for Molecular Biology Course:

1. Understand the fundamental principles of molecular biology, including the structure and function of biomolecules such as DNA, RNA, and proteins.
2. Explore the processes of DNA replication, transcription, and translation, and their roles in gene expression and regulation.
3. Gain insights into the techniques used in molecular biology research, such as PCR (Polymerase Chain Reaction), gel electrophoresis, and DNA sequencing.
4. Explore the applications of molecular biology in various fields, such as biotechnology, medicine, agriculture, and environmental sciences.
5. Develop critical thinking and problem-solving skills related to molecular biology research and experimental design.
6. Discuss the ethical and societal implications of advancements in molecular biology, including genetic testing and gene therapy.

Course Outcomes for Molecular Biology Course:

By the end of the course, students should be able to:

1. Describe the structure and function of key biomolecules and explain how they contribute to cellular processes.
2. Demonstrate an understanding of the central dogma of molecular biology and the flow of genetic information within a cell.
3. Perform basic laboratory techniques commonly used in molecular biology research,
4. Interpret experimental data and draw conclusions about molecular biology phenomena.
5. Assess the potential applications of molecular biology in various fields and industries.
6. Design and propose experiments to investigate specific molecular biology research questions.
7. Evaluate the ethical implications of using molecular biology techniques in research and applications.

These course objectives and outcomes provide a comprehensive framework for students to gain a strong foundation in molecular biology and its applications, enabling them to pursue further studies or careers in related fields

Course contents:

UNIT I : DNA Repair Mechanisms and Recombination

Factors involved in DNA damage Types of DNA repair-- Excision, Mismatch, SOS, Photoreactivation, Recombination repair, Eukaryotic repair Mechanisms.

Recombination between heteroduplex, Holiday intermediate, Proteins involved in Recombination, Role of recA, recBCD pathway in *E.coli*, single strand assimilation in Bacteria.

UNIT II : DNA Replication

Unit of Replication (Replicon : Bacterial, Eukaryotic and Extrachromosomal-

Bacterial Replication is connected to cell cycle, Enzymes involved in replication (DNA Polymerases of *E.coli* and Eukaryotes) Replication origin and Replication fork, Fidelity of Replication. Replication of telomeres and enzymes involved in telomere replication

UNIT III : Transcription and Translation

Prokaryotic transcription: RNA Polymerases, Sigma factor and specificity binding to DNA, Promoters and their consensus sequences, Initiation of transcription, Elongation of transcription, Termination of transcription (Rho dependent ,Rho independent termination, Antitermination) Chemical Modification of histones, Eukaryotic transcription: RNA Polymerases, types & subunits, Promoter elements for three polymerases, Transcription factors as a Activators, Enhancers, Repressors. Mechanism of transcriptional initiation, elongation and termination. Posttranscriptional modifications- RNA editing, splicing, polyadenylation. Nuclear export of RNA. Regulatory RNAs and noncoding RNAs -Si RNA, Micro RNA, Pi RNA (PIWI interacting RNAs)

Translation

tRNA activation, Ribosome, genetic code, deviations of genetic code

Prokaryotic and Eukaryotic translation- formation of initiation complex, initiation factors and their regulation, elongation and elongation factors, termination, Regulation of protein synthesis, translational proof-reading, post translational modification of proteins- Protein folding, Chemical modification, intein splicing , Ubiquitination of condemned proteins and degradation by Proteosome; structure and features of Proteosome and the mechanism of degradation

References:

1. Benjamin Lewin -Gene VI, Gene VII, Gene IX, Gene X Oxford University press2

David Friefieder Essentials of Molecular Biology, Jones & Barlett publications

3. Lodish, H. F. (2016). Molecular Cell Biology (8th Ed.). New York: W.H. Freeman.

4. Weaver R., (2007) Molecular Biology, 4th Edition, McGraw Hill Science.

5. Bruce Albert et. al., Molecular Biology of the Cell, 6th Ed., Garland Sciences.

6. J. Kendrew Encyclopedia of Molecular Biology Blackwell Scientific publications.

7. J.D. Watson, N.H. Hopkins, J.W. Roberts, et al Molecular Biology of the Gene,
Benjamin Cummings publ.co.inc., California

8 J.Darnell., et al molecular biology of the cell (2nd edition) Garland Publishing Inc.9

Malacinski; Essentials of Molecular Biology.

10 Stansfield; Molecular and cell biology.

11 Walker Molecular biology and Biotechnology.

12 Brown T.A Essential of Molecular biology Vol 1 and 2 each.

DEPARTMENT OF BIOTECHNOLOGY

M.Sc. Biotechnology

Semester II

BIOT/UD/MJ/552 P

**Molecular Biology
(DSC Major / Mandatory course)**

Credits Assigned--2

Marks---50

Contact Hours--60

Practicals:

Practicals

1. Spontaneous mutation in bacteria
2. Induced mutation using chemical mutagens
3. Induced mutation using physical mutagens
4. Scoring and enrichment of mutants
5. Ampicillin enrichment of Auxotrophs
6. Isolation of different auxotrophic mutants by using selective plates
7. Chromosomal aberration due to radiations
8. Repair mechanisms in E.coli –dark,repairs
9. Study of photoreactivation
10. Repair mechanisms in Yeast
11. Study of genotypes and its conformation
12. DNA Separation by agarose gel electrophoresis
13. Study prokaryotic gene transcription by
 - i. Primer Extension Assay:
 - ii. RNA Mapping or S1 Nuclease Protection Assay:
 - iii. Gel Shift (Electrophoretic Mobility Shift Assay, EMSA):
 - iv. Reporter Gene Assays:
 - v. Chromatin Immunoprecipitation (ChIP):

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Semester II

BIOT/UD/MJ/553 T

**Skills in Biotechnology II
(DSC Major / Mandatory course)**

Credits Assigned--2

Marks---50

Contact Hours--30

Course objectives and outcomes for the skill in biotechnology II are as per defined earlier

COURSE Skills in Biotechnology I (during semester I)

Course contents:

Course Overview: The Advanced Topics in Biotechnology course is designed for participants who already possess a strong foundation in biotechnology and are looking to delve deeper into cutting-edge theories, methodologies, and applications. This course will cover advanced concepts in molecular biology, genetic engineering, bioinformatics, and emerging fields within biotechnology. Through in-depth lectures, critical discussions, and case studies, participants will gain a comprehensive understanding of the latest advancements in the field.

UNIT I

Next-Generation Sequencing and Genomics

- Principles of next-generation sequencing (NGS)
- Genomic library construction and sequencing technologies
- Data analysis and interpretation of NGS data
- Functional genomics and comparative genomics

Systems Biology and Synthetic Biology

- Systems biology approaches and network analysis
- Design principles in synthetic biology
- Synthetic gene circuits and genetic modules
- Application of synthetic biology in biotechnology

UNIT II

Advanced Protein Engineering

- Rational design and directed evolution of proteins
- Protein structure prediction and modeling
- Engineering enzymes for specific applications
- Therapeutic and industrial applications of engineered proteins

Advanced Bioprocessing and Upstream Techniques

- Advanced fermentation strategies and optimization
- Metabolic engineering for bioprocess improvement
- Upstream processing in biopharmaceutical production
- Bioreactor design and scale-up considerations

UNIT III

Emerging Trends and Special Topics

- CRISPR-based technologies beyond gene editing
- Nanobiotechnology and its applications
- Personalized medicine and biomarker discovery
- Ethical considerations in advanced biotechnology

References

1. A text book of genetic engineering by Desmond Nicoll

2. Agrobacterium: From biology to Biotechnology by Tzvi Tzfira
3. Principles of gene manipulation by Primrose
4. Animal cell culture by Jon Masters
5. Plant cell and tissue culture – A tool in Biotechnology- by Ashwani Kumar
6. Laboratory manual of Plant Biotechnology By Purohit-2
7. Methods in Plant tissue culture By U Kumar-1
8. Plant tissue culture Bhojwani:
9. Introduction to Plant Tissue Culture Kalyan Kumar DE
10. Practical application of Plant Molecular Biology R.J.Henry,Chapman and Hall
11. Culture of Animal cells-3rd Edition Freshney Wiley liss
12. Mammalian Cell Biotechnology-Apractical Approach, M,Butler Oxford University press ,New York
13. Animal Cell culture techniques, Martin Springer
14. Genetics Peter J Russel, The Benjamin/ Qummin publishing Co
15. Principles of Genetics by Gardner, Siemens.
16. Molecular Genetics by Friefeder.
17. Molecular biology laboratory manual 6th Edn, Cappuccino.
18. Molecular biology of the gene Watson.

DEPARTMENT OF BIOTECHNOLOGY

M.Sc. Biotechnology

Semester II

BIOT/UD/MJ/554 A T

**Animal Biotechnology I
(DSE ELECTIVE Course)**

Credits Assigned--2

Marks---50

Contact Hours--30

Course Objectives for Animal Biotechnology (I and II) Courses:

1. To introduce students to the principles and applications of animal biotechnology in various fields, including agriculture, medicine, and biomedicine.
2. To provide an understanding of animal cell culture techniques and their applications in producing biopharmaceuticals and studying cellular processes.
3. To explore advanced reproductive biotechnologies used in animal breeding and genetic improvement.
4. To study the principles of transgenic animal technology and its applications in biomedical research and agriculture.
5. To examine the use of gene editing techniques, such as CRISPR/Cas9, in modifying animal genomes.
6. To understand the ethical considerations and societal implications of animal biotechnology research and applications.
7. To expose students to the latest advancements and emerging trends in animal biotechnology.

Course Outcomes for Animal Biotechnology (I and II) Courses:

1. Demonstrate a comprehensive understanding of the principles and concepts of animal biotechnology and its applications in various industries.
2. Perform animal cell culture techniques and demonstrate proficiency in the handling of animal cells and tissues.
3. Apply advanced reproductive biotechnologies, such as artificial insemination, in vitro fertilization, and embryo transfer, to improve animal breeding and production.
4. Analyze and interpret experimental data related to animal biotechnology research, including gene expression analysis and genetic modification of animals.
5. Discuss and present current research findings and advancements in animal biotechnology in a clear and concise manner.
6. Critically assess the ethical considerations related to the use of animal biotechnology, including the welfare of genetically modified animals.
7. Collaborate effectively in group projects related to animal biotechnology research and applications.
8. Explore potential career paths and opportunities in the field of animal biotechnology and related industries.
9. Develop practical skills in experimental design, data analysis, and troubleshooting relevant to animal biotechnology research.
10. Cultivate a passion for continuous learning and staying up-to-date with advancements in animal biotechnology and related disciplines

Course contents:

Unit I- Introduction to tissue culture

Animal Tissue culture: Media, Natural, artificial, serum containing, serum free media, chemically defined media and protein free media

Primary culture, Tissue disaggregation, secondary culture, cell lines and maintenance, Assessment of growth, measurement of cell death

Unit II Methods in Animal Tissue Culture

Monolayer culture: Roux bottle, roller bottle, multitray, synthetic hollow fiber, bead bed reactors, continuous flow cultures, Airlift fermentors

Immobilized cultures

Entrapment cultures, Porous carriers, Fixed bed (Parosphere and fluidized beds)

Establishment of primary culture, secondary culture. Preservation of cell lines.

MTT assay

Unit III Transformation methods and Application of Cell Science

Animal cell: DNA calcium phosphate coprecipitation method, Lipofection, electroporation, DEAE dextran method, Microinjection

Production of vaccines, interferons, antibiotics, embryonic stem cell, gene therapy, transgenic mice, cattles, sheep, fish. Tissue engineering,

Ethical issues

1. Regeneration of frozen cells in vitro
2. Marker gene assay.

References

1. Principles of gene manipulation by Primrose
2. Animal cell culture by Jon Masters
3. Culture of Animal cells-3rd Edition Freshney Wiley liss
4. Mammalian Cell Biotechnology-Apractical Approach, M,Butler Oxford University press ,New York
5. Animal Cell culture techniques, Martin Springer

M.Sc. Biotechnology

Semester II

BIOT/UD/MJ/554 A P

**Animal Biotechnology I
(DSE ELECTIVE Course)**

Credits Assigned--2

Marks---50

Contact Hours--60

Practicals

- i. Introduction to aseptic technique and proper laboratory procedures for handling cell cultures.
- ii. Preparation of culture media and sterilization of equipment.
- iii. Sub culturing cells by passaging them from one culture vessel to another to maintain their growth and prevent over-confluence.
- iv. Calculating cell concentration
- v. Freezing and preserving cells for long-term storage using cryoprotective agents and liquid nitrogen.
- vi. Evaluating cell viability using trypan blue exclusion,
- vii. Evaluating cell viability using MTT assay.
- viii. Staining cells with dyes (e.g., Hematoxylin & Eosin) to visualize cell structures.
- ix. Detecting and quantifying cell apoptosis and necrosis using Annexin V/propidium iodide staining or other methods.
- x. Analyzing and sorting cells based on their size, granularity, and fluorescence properties.

M.Sc. Biotechnology		
Semester II		
BIOT/UD/MJ/554 B T	Advanced Techniques in Biotechnology (DSE ELECTIVE Course)	
Credits Assigned--2	Marks---50	Contact Hours--30

Course Objectives for Advanced Techniques in Biotechnology Course:

1. To provide an in-depth understanding of advanced biotechnological techniques used in cutting-edge research and industry applications.
2. To familiarize students with advanced laboratory instrumentation and equipment used in biotechnology research.
3. To explore advanced molecular biology techniques, such as next-generation sequencing, gene editing, and proteomics.
4. To study advanced cell culture and tissue engineering methods for biopharmaceutical and regenerative medicine applications.
5. To examine advanced tools and data analysis techniques used in biotechnological research.
6. To understand the principles of systems biology and its applications in understanding complex biological processes.
7. To introduce students to the principles and applications of synthetic biology and metabolic engineering.
8. To foster critical thinking and problem-solving skills in the context of advanced biotechnological research.

Course Outcomes for Advanced Techniques in Biotechnology Course:

1. Demonstrate an advanced understanding of the principles and techniques of biotechnological research, including molecular biology, cell culture, and bioinformatics.
2. Utilize advanced laboratory instrumentation and equipment competently, troubleshooting technical issues as needed.
3. Perform advanced molecular biology techniques, such as gene editing, RNA interference, and high-throughput sequencing.
4. Analyze and interpret complex biological data using advanced tools and software.
5. Discuss and present advanced biotechnological research findings and advancements in a clear and concise manner.
6. Apply critical thinking skills to design and modify experimental protocols and troubleshoot research challenges.
7. Collaborate effectively in multidisciplinary teams to carry out advanced biotechnological projects.
8. Explore the ethical considerations and regulatory aspects related to advanced biotechnological research and applications.
9. Develop practical skills in experimental design, data analysis, and presentation relevant to advanced biotechnological research.
10. Gain insights into potential career paths and opportunities in the field of advanced biotechnology and related industries.

Course contents:

Unit I: CRISPR TECHNOLOGY

Origins of CRISPR (Discovery, Implementation, Zhang vs Doudna Debate), **Cas 9 (CRISPR Knockout Basics)** (Experimental Design, GuideRNA design, Delivery into Cells, Genotyping, Validation) **CRISPR Knock-in** (Inserting or Mutating DNA Sequences in the Genome), **CRISPR Editing in Animal Models** (Knockout and Knockin Strategies in Mice) **CRISPR Screens** (High throughput applications of CRISPR), **CRISPR Interference** (dCas9 Fusions Inhibition or Activation) **CRISPR to target RNA and Other Cas Proteins, The Future of CRISPR and Ethical Considerations** (CRISPR in the Clinic, CRISPR Babies, Case-Studies)

Unit II: DNA BARCODING

_Background _Methods _Sampling and preservation _DNA extraction, amplification and sequencing
Marker selection _**Reference libraries and bioinformatics** _Bioinformatic analysis _Species
identification and taxonomic assignment _Applications _Potentials and shortcomings
Potentials and shortcomings subsection _Megabarcoding Megabarcoding subsection Metabarcoding

Unit III MACROMOLECULAR ANALYSIS

protein purification and identification,
DNA cloning, and
Recombinant Protein expression.

References:

1. Genetics Peter J Russel, The Benjamin/ Qummin publishing Co.
2. Principles of Genetics by Gardner, Siemens.
3. Molecular Genetics by Friefeder.
4. Molecular biology laboratory manual 6th Edn, Cappuccino.
5. Molecular biology and the gene Watson.
6. Principles and Techniques of Biochemistry and Molecular Biology (Seventh edition) EDITED BY KEITH WILSON AND JOHN WALKER CAMBRIDGE UNIVERSITY PRESS
(<https://www.kau.edu.sa/Files/0017514/Subjects/principals%20and%20techniques%20of%20biochemistry%20and%20molecular%20biology%207th%20ed%20wilson%20walker.pdf>)
7. CRISPR Technology: The Revolutionary Breakthrough for Genetics and Evolution Paul F. Kisak CreateSpace Independent Publishing Platform, 2017 ISBN 1548451517, 9781548451516

M.Sc. Biotechnology		
Semester II		
BIOT/UD/MJ/554 B.P	Advanced Techniques in Biotechnology	
	(DSE ELECTIVE Course)	
Credits Assigned--2	Marks---50	Contact Hours--60

Practicals

1. Homogenization or sonication of cells or tissues to break open cell membranes and release cellular contents.
2. Subcellular fractionation to isolate specific organelles or cellular components.
3. Precipitation of proteins at different salt concentrations or by adding ammonium sulfate to fractionate proteins based on their solubility.
4. Ion-exchange chromatography to separate proteins based on their net charge.
5. Size-exclusion chromatography (gel filtration) to separate proteins by their size.
6. Affinity chromatography to isolate proteins based on specific interactions with ligands.
7. Separation of proteins based on their isoelectric points, which is the pH at which they have no net charge.
8. Determination of protein 3D structures by analyzing the diffraction pattern from X-ray-irradiated protein crystals.
9. CRISPR-Cas9 Gene Knockout:
10. Gene Mutation with CRISPR-Cas9:
11. CRISPR-Cas9 Gene Activation:
12. CRISPR-Cas9 Gene Repression:
13. Handling of biological databases.(minimum three)

M.Sc. Biotechnology

Semester II

BIOT/UD/MJ/554 C T

**Biofuels
(DSE ELECTIVE Course)**

Credits Assigned--2

Marks---50

Contact Hours--30

Course Objectives for Biofuels Course:

1. To introduce students to the principles and importance of biofuels as a renewable and sustainable energy source.
2. To provide an understanding of different types of biofuels, including biodiesel, bioethanol, biogas, and biohydrogen, and their production processes.
3. To explore the technologies and methods used in the conversion of biomass into biofuels.
4. To study the environmental and economic implications of biofuel production and usage.
5. To examine the role of biofuels in reducing greenhouse gas emissions and mitigating climate change.
6. To understand the challenges and opportunities in the large-scale implementation and commercialization of biofuels.
7. To introduce students to the policies and regulations related to biofuel production and utilization.

Course Outcomes for Biofuels Course:

1. Demonstrate a comprehensive understanding of the principles and concepts of biofuels as a sustainable energy source.
2. Describe the different types of biofuels and their characteristics, including their energy content and combustion properties.
3. Analyze the production processes and technologies used in converting biomass into biofuels.
4. Evaluate the environmental and economic impacts of biofuel production and usage, including life cycle assessments.
5. Discuss the potential role of biofuels in reducing greenhouse gas emissions and contributing to global climate change mitigation efforts.
6. Examine the challenges and opportunities in the large-scale implementation and commercialization of biofuels.
7. Understand the policies, regulations, and incentives related to biofuel production and utilization at local, national, and international levels.
8. Critically assess the advantages and limitations of different biofuel feedstocks and production methods.
9. Apply knowledge of biofuels to propose sustainable and efficient biofuel production strategies.
10. Communicate scientific information effectively, both orally and in writing, related to biofuels concepts and research findings.
11. Collaborate in group discussions and projects related to biofuels research and applications.
12. Foster an appreciation for the importance of biofuels as a renewable energy source and its potential role in transitioning to a more sustainable energy future

Course contents :

Unit I: BIO-ETHANOL

Introduction, Industry Overview , Raw Materials Requirement, Machinery Required,; Process Flow & Control Parameters ; Production Process ; Downstream processes, Investment ;Project Components ; Government Schemes ; Ethanol Economic & SWOT Analysis ;Current Scenario

Unit II BIOHYDROGEN

Properties of hydrogen, global status of supply and demand, methods of hydrogen production,

Hydrogen production from methane decomposition,

Hydrogen separation and purification, , fundamentals for electrolysis of water

Photo- electrochemical hydrogen production, technical and economic comparison of different production methods and global status, cost analysis,

Algae as source of hydrogen production

Introduction to hydrogen storage, underground hydrogen storage, fundamentals of hydrogen compression and expansion

fundamentals of hydrogen storage

Use of hydrogen in internal combustion engines, fuel cells, hydrogen sensing

Properties of hydrogen associated with hazards, classification of hydrogen hazards, compressed and liquid hydrogen related hazards, regulation, codes and standards, utilization of hydrogen in various sectors, global status and future directions

Unit III BIOGAS AND BIOMETHANE

Biogas Production; Biogas Composition,

The Biogas Production: From Substrate to Biomethane;

Technologies in Biogas and Biomethane Production;,. Anaerobic Digestion

Biogas Usage

Economic Perspectives of Biogas Production

Up-Flow Anaerobic Sludge Blanket (UASB) Technology

Biogas Purification and Upgrading (Technologies for Biogas Upgrading to Biomethane)

Books and references

1. Introduction to Bioenergy (Energy and the Environment) by Vaughn C. Nelson (Author), Kenneth L. Starcher (Author)
2. Bioenergy: Biomass to Biofuels by Anju Dahiya
3. Bioenergy: Principles and Applications by Yebo Li and Samir Kumar Khanal
4. Bioenergy by Judy D. Wall and Caroline S. Harwood
5. Bioenergy: Sustainable Perspectives by Ted Weyland
6. Gupta, R. B., Hydrogen Fuel: Production, Transport and Storage, CRC Press, Taylor & Francis Group, 2009.
7. Global Hydrogen Review 2021, IEA (2021), Paris, <https://www.iea.org/reports/global-hydrogen-review-2021>
8. Agata Godula-Jopek, Hydrogen Production by Electrolysis, Wiley-VCH, Germany, 2015
9. Tzimas, E., Filiou, C., Peteves, S.D., & Veyret, J.B. "Hydrogen storage: state-of-the-art and future perspective. Netherlands": European Communities, 2003.
10. Michael Hirscher, "Handbook of Hydrogen Storage", Wiley-VCH, 2010.

• Additional references will be supplied during the course work

M.Sc. Biotechnology

Semester II

BIOT/UD/MJ/554 C P

**Biofuels
(DSE ELECTIVE Course)**

Credits Assigned--2

Marks---50

Contact Hours--60

Practicals

1. **Selection of Hydrogen-Producing Microorganisms:**
2. **Culturing of Hydrogen-Producing Microorganisms:**
3. **Fermentation:** fermentation processes to convert biomass (e.g., organic waste, sugarcane bagasse, or lignocellulosic materials) into hydrogen gas through the metabolic activities of the microorganisms
4. **pH and Temperature Optimization** for biohydrogen production
5. **Substrate Selection:** Identify and optimize the most suitable substrates (e.g., glucose, xylose, cellulose) for hydrogen production by the microorganisms
6. **Bioreactor Design and Operation:**
7. **Dark Fermentation:** Conduct hydrogen production in the absence of light (for photosynthetic microorganisms) to increase the efficiency of biohydrogen production
8. **Hydrogen Detection and Analysis**
Bioethanol production
9. selection of microorganism,
10. optimization of parameters
11. reactor designing
12. downstream processing of ethanol
13. set up and operation of a laboratory/pilot biogas plant

M.Sc. Biotechnology

Semester II

DSE ELECTIVE Course

BIOT/ UD/DSE/ 504 D

An Online certification course from NPTEL /SWAYM /MOOC of equivalent credits { with biology basis }(DSE ELECTIVE Course)

Credits Assigned--4

Marks---100

Contact Hours--60

In case a student opts online course as **BIOT/UD/DSE/504 D** the curriculum, rules, regulations, and scheme of assessment etc of the course conducting agency will be binding of the student. The student should submit the course completion certificate to the department and deposit his earned credits in ABC.

DEPARTMENT OF BIOTECHNICAL ENGINEERING

M.Sc. Biotechnology

Semester II

BIOT/UD/OJT/599
Course)

On the job training/ field project (Research Methodology

Credits Assigned--4

Marks---100

Contact Hours--60

Every student has to complete at least **120 hrs** of **ON THE JOB TRAINING/ IN PLANT TRAINING** at a unit identified / specified by university or department during summer vacation. In case due to some unavoidable circumstances if a student is not able to go for on the job training/ in plant training, then he/she will have complete a **field project** related to core or discipline specific course in consultation of departmental committee