LEARNING OUTCOMES

FOR

INTEGRATED M.Sc. BIOTECHNOLOGY

CENTRE FOR BIOTECHNOLOGY
SIKSHA O ANUSANDHAN
(DEEMED TO BE UNIVERSITY)
BHUBANESWAR

FACULTY OF PHARMACEUTICAL SCIENCES SPS, SIKSHA 'O' ANUSANDHAN

(DEEMED TO BE UNIVERSITY)

Program Educational Objectives (PEOs) of Int. M.Sc. Biotechnology Programme

1. To prepare graduates to pursue respectable careers in the industry, agriculture, and applied research where biological system is increasingly employed.
2. Graduates will address the increasing need for skilled scientific manpower, contributing to application, advancement, and impartment of knowledge in interdisciplinary areas of biotechnology.
3. To prepare students to assume leadership to address the challenging issues of research, industry and health care system in a multi-cultural and multidimensional environment.
4. Graduates will demonstrate right mixes of innovative ability, equipped with entrepreneurship skills, contributing to self and national development.
5. To understand the regulatory environment and respond to the global developments in biotech/pharmaceutical/health care industry.
6. To learn from every environment and become responsible, ethical and productive citizens.

Program Outcomes (POs) of Int. M.Sc. Biotechnology Programme

A. Provide education that helps to understand the fundamental and advanced concepts in the relevant field and prepare the students to communicate it effectively.

B. Enable students to think independently and critically.

C. Prompt the students to work individually and synergistically.

D. Initiate confidence to develop hypothesis, design experiments and interpret the results.

E. The program provides the graduates a theoretical understanding of innovative areas in Biotechnology and equips them with the necessary subject knowledge and laboratory skills to kick start a career in Academia, Research and Industry related to biotechnology.

F. Hands on technical as well as experimental skills to complement their theoretical knowledge in the curriculum.

G. Demonstrate the ideas and research approach for their higher studies in molecular biotechnology and develop their scientific endeavour.

H. Students will hold research skills to make them competent as a candidate for various opportunities in India and across the world.

Mapping of Program Educational Objectives (PEOs) Vs. Program Outcomes (POs)

	PO_A	PO_B	PO_C	PO_D	PO_E	PO_F	PO_G	PO_H
PEO1	√		√	√	√		√	√
PEO2	√	√	√	√	√	√	√	
PEO3	√	√		√	√		√	√
PEO4			√	√	√	√	√	√
PEO5	√				√		√	v
PO6		√	√					

INTEGRATED M.Sc. BIOTECHNOLOGY
CHOICE BASED CREDIT SYSTEM
(TOTAL CREDITS 232)

SEMESTER I		**SEMESTER II**	
IMB 1.1	**Biochemistry& Metabolism**	**IMB 2.1**	**Mammalian Physiology**
IMB 1.2	**Cell biology**	**IMB 2.2**	**Plant Physiology**
IMB 1.3	**Environmental studies**	**IMB 2.3**	**English Communication**
IMB 1.4	**Biotechnology & Human welfare**	**IMB 2.4**	**Bioethics and Biosafety**
IMB 1.5	**Practicals**	**IMB 2.5**	**Practicals**

SEMESTER III		**SEMESTER IV**	
IMB 3.1	**Genetics**	**IMB 4.1**	**Molecular Biology**
IMB 3.2	**General microbiology**	**IMB 4.2**	**Immunology**
IMB 3.3	**Chemistry-1**	**IMB 4.3**	**Chemistry-2**
IMB 3.4	**Molecular Diagnostic**	**IMB 4.4**	**Industrial fermentation**
IMB 3.5	**Developmental Biology**	**IMB 4.5**	**Entrepreneurship Development**
IMB 3.6	**Practicals**	**IMB 4.6**	**Practicals**

SEMESTER V		**SEMESTER VI**	
IMB 5.1	**Bio Analytical tools**	**IMB 6.1**	**Bioprocess Technology**
IMB 5.2	**Recombinant DNA Technology**	**IMB 6.2**	**Genomics and Proteomics**
IMB 5.3	**Plant Biotechnology**	**IMB 6.3**	**Biostastitics**
IMB 5.4	**Animal Biotechnology**	**IMB 6.4**	**Project**
IMB 5.5	**Practicals**	**IMB 6.5**	**Practicals**

SEMESTER VII		**SEMESTER VIII**	
IMB 7.1	**Biomolecules & Enzymology**	**IMB 8.1**	**Bioinformatics**
IMB 7.2	**Microbial Genomics**	**IMB 8.2**	**Cancer Biology**
IMB 7.3	**Metabolomics**	**IMB 8.3**	**Nanotechnology**
IMB 7.4	**Pharmaceutical Biotechnology**	**IMB 8.4**	**Environmental Biotechnology**
IMB 7.5	**Practicals**	**IMB 8.5**	**Practicals**

SEMESTER IX		SEMESTER X	
IMB 9.1	**Infectious Diesease Biology**	**IMB 10.1**	**Seminar**
IMB 9.2	**Biodiversity & Conservation**	**IMB 10.2**	**Projects**
IMB 9.3	**Natural products & Medicinal Chemistry**		
IMB 9.4	**Intellectual & Property Rights**		
IMB 9.5	**Practicals**		

Credit System & Marks Distribution

SEMESTER I **Total Credit: 20**
Total Mark: 450

Subject code	Subject	Lectures	Credit point	Mark
IMB 1.1	Biochemistry & Metabolism	40	4	100
IMB 1.2	Cell Biology	40	4	100
IMB 1.3	EVS (Environmental Studies)	20	2	50
IMB 1.4	Biotechnology and Human Welfare	40	4	100
IMB 1.5	Practicals	50	6	100
	Total		20	450

SEMESTER II **Total Credit : 20**
Total Mark :450

Subject code	Subject	Lectures	Credit point	Mark
IMB 2.1	Mammalian Physiology	40	4	100
IMB 2.2	Plant Physiology	40	4	100
IMB 2.3	English communication	20	2	50
IMB 2.4	Bioethics and Biosafety	40	4	100
IMB 2.5	Practicals	50	6	100
	Total		20	450

SEMESTER III **Total Credit: 26**
Total Mark: 550

Subject code	Subject	Lectures	Credit point	Mark
IMB 3.1	Genetics	40	4	100
IMB 3.2	General Microbiology	40	4	100
IMB 3.3	Chemistry-1	40	4	100

IMB 3.4	Molecular Diagnostics	20	2	50
IMB 3.5	Developmental Biology	40	4	100
IMB 3.6	Practicals	50	8	100
	Total		26	550

SEMESTER IV **Total Credit : 26**
Total Mark :550

Subject code	Subject	Lectures	Credit point	Mark
IMB 4.1	Molecular Biology	40	4	100
IMB 4.2	Immunology	40	4	100
IMB 4.3	Chemistry-2	40	4	100
IMB 4.4	Industrial Fermentation	20	2	50
IMB 4.5	Entrepreneurship Development	40	4	100
IMB 4.6	Practicals	50	8	100
	Total		26	550

SEMESTER V **Total Credit: 24**
Total Mark: 500

Subject code	Subject	Lectures	Credit point	Mark
IMB 5.1	Bio Analytical tool	40	4	100
IMB 5.2	Recombinant DNA Technology	40	4	100
IMB 5.3	Plant Biotechnology	40	4	100
IMB 5.4	Animal Biotechnology	40	4	100
IMB 5.5	Practicals	50	8	100
	Total		24	500

SEMESTER VI **Total Credit : 24**
Total Mark :500

Subject code	Subject	Lectures	Credit point	Mark
IMB 6.1	Bioprocess Technology	40	4	100
IMB 6.2	Genomics and Proteomics	40	4	100
IMB 6.3	Biostatistics	40	4	100

IMB 6.4	Projects	40	4	100
IMB 6.5	Practicals	50	8	100
	Total		24	500

SEMESTER VII **Total Credit : 24**
Total Mark : 500

Subject code	Subject	Lectures	Credit point	Mark
IMB 7.1	Biomolecules & Enzymology	40	4	100
IMB 7.2	Microbial Genomics	40	4	100
IMB 7.3	Metabolomics	40	4	100
IMB 7.4	Pharamaceutical Biotechnology	40	4	100
IMB 7.5	Practicals	50	8	100
	Total		24	500

SEMESTER VIII **Total Credit : 24**
Total Mark : 500

Subject code	Subject	Lectures	Credit point	Mark
IMB 8.1	Bioinformatics	40	4	100
IMB 8.2	Cancer Biology	40	4	100
IMB 8.3	Nanotechnology	40	4	100
IMB 8.4	Environmental Biotechnology	40	4	100
IMB 8.5	Practicals	50	8	100
	Total		24	500

SEMESTER IX **Total Credit : 24**
Total Mark : 500

Subject code	Subject	Lectures	Credit point	Mark
IMB 9.1	Infectious Diesease Biology	40	4	100
IMB 9.2	Biodiversity and Conservation	40	4	100
IMB 9.3	Natural Products and Medicinal Chemistry	40	4	100
IMB 9.4	Intellectual property Rights	40	4	100
IMB 9.5	Practicals	50	8	100
	Total		24	500

SEMESTER X **Total Credit : 24**
Total Mark : 500

Subject code	Subject	Lectures	Credit point	Mark
IMB 10.1	Seminar Presentation		4	100
IMB 10.2	Project		16	100
	Total		20	200

SEMESTER I
(Total Credit: 20; Total Mark: 450)
IMB 1.1: BIOCHEMISTRY AND METABOLISM (Credit: 4)

COURSE	CO	Course Outcome's	PO/ PSO	BTL
IMB1.1 Biochemistry And Metabolism	CO1	Students will be gaining knowledge about the elements present in biological system, important functional groups, concept of pH, pKa, buffers, non-covalent interactions.	E,F,H	1,4
	CO2	Students will be gaining in-depth knowledge about the structure and properties of various biomolecules including carbohydrates, amino acids, proteins, lipids and nucleic acids.	E,F,H	1
	CO3	Students will be exploring the different aspects of biochemical reactions including Bioenergetics, coupling of reactions, different kinds of biochemical reactions, various classes of enzymes, regulatory steps, enzyme regulation etc.	E,F,H	1,4
	CO4	Students will be able to understand major metabolic pathways of biomolecules, their energetic and regulatory aspects and associated metabolic disorders.	E,F,H	1

Learning Objectives: To deal with the structure and functions of the various biomolecules present in the cell. It also covers the metabolic aspects of various biomolecules and their regulatory aspects.

Course Outcome:
1.Students will be gaining knowledge about the elements present in biological system, important functional groups, concept of pH, pKa, buffers, non-covalent interactions
2.Students will be gaining in-depth knowledge about the structure and properties of various biomolecules including carbohydrates, amino acids, proteins, lipids and nucleic acids
3.Students will be exploring the different aspects of biochemical reactions includingBioenergetics, coupling of reactions, different kinds of biochemical reactions, various classes of enzymes, regulatory steps, enzyme regulation etc.
4.Will be able to understand major metabolic pathways of biomolecules, their energetic and regulatory aspects and associated metabolic disorders.

IMB 1.2: CELL BIOLOGY (Credit: 4)

COURSE	CO	Course Outcome's	PO/ PSO	BTL
IMB 1.2 Cell Biology	CO1	Students will be able to understand the function and the composition of the plasma membrane.	E,F,H	1
	CO2	Students will be able to learn the principles of the cell theory.	E,F,H	1,2
	CO3	Students will be able to differentiate between prokaryotes and eukaryotes.	E,F,H	1,2
	CO4	Students will be able to understand the importance of the nucleus and its components.	E,F,H	1,2
	CO5	Students will be able to understand how the endoplasmic reticulum and Golgi apparatus interact with one another and know with which other organelles they are associated.	E,F,H	1,2
	CO6	Students will be able to identify the three primary components of the cell's cytoskeleton and how they affect cell shape, function, and movement.	E,F,H	1,2

Learning Objectives: To understand the structures and purposes of basic components of prokaryotic and eukaryotic cells, especially macromolecules, membranes, and organelles. This covers the knowledge about how these cellular components are used to generate and utilize energy in cells as well as the cellular components underlying mitotic cell division. The topic also includes an understanding of responses to environmental or physiological changes, or alterations of cell function brought about by mutation and the process of cell division in both somatic and germ cell.

Course Outcomes

1. Students will be able to understand the function and the composition of the plasma membrane.
2. Students will be able to learn the principles of the cell theory.
3. Students will be able to differentiate between prokaryotes and eukaryotes.
4. Students will be able to understand the importance of the nucleus and its components.
5. Students will be able to understand how the endoplasmic reticulum and Golgi apparatus interact with one another and know with which other organelles they are associated.
6. Students will be able to identify the three primary components of the cell's cytoskeleton and how they affect cell shape, function, and movement.

IMB 1.3: ENVIRONMENTAL STUDIES (Credit: 2)

COURSE	CO	Course Outcome's	PO/ PSO	BTL
IMB1.3 Environmental Studies	CO1	An Environmental Studies major will be able to recognize the physical, chemical and biological components of the earth's systems and show how they function.	E,F,H	1,3,5
	CO2	An Environmental Studies major will be able to apply lessons from various courses through field experiences.	E,F,H	1,3
	CO3	An Environmental Studies major will be able to do independent research on human interactions with the environment.	E,F,H	1,3
	CO4	An Environmental Studies major will be able to critically examine all sides of environmental issues and create informed opinions about how to interact with the environment on both a personal and social level.	E,F,H	1,3,5

Learning Objectives: To understand concepts and methods from ecological and physical sciences and their application in environmental problem solving. It also covers ethical, cross-cultural, and historical context of environmental issues and understanding the links between human and natural systems.

Course Outcomes

1. An Environmental Studies major will be able to recognize the physical, chemical and biological components of the earth's systems and show how they function.
2. An Environmental Studies major will be able to apply lessons from various courses through field experiences.
3. An Environmental Studies major will be able to do independent research on human interactions with the environment.
4. An Environmental Studies major will be able to critically examine all sides of environmental issues and create informed opinions about how to interact with the environment on both a personal and social level.

IMB 1.4: BIOTECHNOLOGY AND HUMAN WELFARE (Credit: 4)

COURSE	CO	Course Outcome's	PO/ PSO	BTL
IMB 1.4 Biotechnology And Human Welfare	CO1	Comprehend role of industrial biotechnology in improving microbial cells as factories	A,E,H	1,2,3
	CO2	Acquire the knowledge about the transfer of genes, plant microbe interactions	A,E,H	1,3
	CO3	A good understanding of various recombinant DNA techniques and DNA finger printing	A,E,H	1,3,4
	CO4	Develop transgenics resistant to biotic & abiotic stresses and quality characteristics and their role in crop improvement	A,E,H	3,4,6

Learning Objectives: To understand the use of living cells such as bacteria, yeast, algae or component of cells like enzymes, plants and animals to generate industrial products and processes. It includes the techniques for genetic improvement of micro-organisms to improve yield of bioproducts. The Students will learn the fundamentals of transfer of pest resistance genes to plants, interaction between plants and microbes, qualitative improvement of livestock. The Students will acquire knowledge on various recombinant DNA techniques to develop of non-toxic therapeutic agents, recombinant live vaccines, genetherapy, diagnostics and monoclonal technique, project on human genomeand techniques of DNA finger printing

Course outcomes

1. Comprehend role of industrial biotechnology in improving microbial cells as factories
2. Acquire the knowledge about the transfer of genes, plant microbe interactions
3. A good understanding of various recombinant DNA techniques and DNA finger printing
4. Develop transgenics resistant to biotic & abiotic stresses and quality characteristics and their role in crop improvement

IMB 1.5: PRACTICALS (Credit: 6)

COURSE	CO	Course Outcome's	PO/ PSO	BTL
IMB1.5 Practicals	CO1	Basic knowledge about some protein estimation,qualitative tests for Carbohydrates, lipids and proteinsandpreparation and analysis of nuclear, mitochondrial and cytoplasmic fractions,stock solution for bacterial genomic DNA isolationand DNA from minimal available biological samples	A,C,D ,F,H	1,3
	CO2	Basic knowledge on effect of temperature and organic solvents on semi permeable membrane,plasmolysis and de-plasmolysis and structure of Prokaryotic and Eukaryotic	A,C,D ,F,H	1,3

	CO3	Knowledge on squashing technique of mitosis in onion root tip and meiosis in onion anther	A,C,D ,F,H	1,3
	CO4	Basic knowledge on some some analytical tools and experiments.	A,C,D ,F,H	1,3

Learning Objectives

To provides a detailed knowledge about the basic as well as advanced research tools in biotechnology. The main objectives for students will be meticulously explained on how a basic research problem solved. The course includes tools/ instrumentation/methods like buffer precipitation, pH measurement,Beers and Lamberts lawValidation,absorption maxima of given chemicals,determination of pK,estimation of protein. Hands on training will be given for most of the above elements. Another aspect of the course includesqualitative tests for Carbohydrates, lipids and proteins and study ofeffect of temperature and organic solvents on semi permeable membrane,plasmolysis and de-plasmolysis. Students will be given training on structure of Prokaryotic and Eukaryotic andsquashing technique of mitosis in onion root tip and meiosis in onion anther. Students will be given hands-on training on preparation and analysis of nuclear, mitochondrial and cytoplasmic fractions,stock solution for bacterial genomic DNA isolationand DNA from minimal available biological samples.

Course outcomes:

1.Basic knowledge about some protein estimation,qualitative tests for Carbohydrates, lipids and proteinsandpreparation and analysis of nuclear, mitochondrial and cytoplasmic fractions,stock solution for bacterial genomic DNA isolationand DNA from minimal available biological samples

2.Basic knowledge on effect of temperature and organic solvents on semi permeable membrane,plasmolysis and de-plasmolysis and structure of Prokaryotic and Eukaryotic

3. Knowledge on squashing technique of mitosis in onion root tip and meiosis in onion anther

4.Basic knowledge on some some analytical tools and experiments.

SEMESTER II
(Total Credit: 20; Total Mark: 450)

IMB 2.1: MAMMALIAN PHYSIOLOGY (Credit: 4)

COURSE	CO	Course Outcome's	PO/ PSO	BT L
IMB 2.1 Mammalian Physiology	CO1	Students are able to understand the physiology at cellular and system levels .	A,E,H	1,2
	CO2	Students are able to Discover the interaction between body systems and the outside environment for the exchange of materials, the release of waste, and the overall maintenance of the internal systems that regulate the exchange.	A,E,H	1,2
	CO3	Students are able to describe the physiology of digestion, respiration, circulation, muscle,Nervous and endocrine system.	A,E,H	1

Learning Objectives: The goal of this course is to explain the main concepts of human anatomy and physiology: • To understand the metabolic activities in mammalian body. • To understand the process of digestion, respiration, circulation, System physiology: Skeletal, Muscular, Nervous, Endocrine system.

Course Outcome:

1. Students are able to understand the physiology at cellular and system levels .
2. Students are able to Discover the interaction between body systems and the outside environment for the exchange of materials, the release of waste, and the overall maintenance of the internal systems that regulate the exchange.
3. Students are able to describe the physiology of digestion, respiration, circulation, muscle,Nervous and endocrine system.

IMB 2.2: PLANT ANATOMY AND PHYSIOLOGY (Credit: 4)

COURSE	CO	Course Outcome's	PO/ PSO	BT L
IMB 2.2 PLANT ANATOMY AND PHYSIOLOGY	CO1	Discuss the structural components of plant cell walls and membranes	A,E,H	1,2
	CO2	Compare and contrast the characteristics of plastid types	A,E,H	1,2
	CO3	List and describe the anatomy and ecological significance of epidermal and secretory structures	A,E,H	1,2
	CO4	Compare, contrast draw and describe the	A,E,H	1,2

		taxonomic and evolutionary variation in xylem and phloem components		
	CO5	Outline and describe the current understanding of the components of shoot, root, and floral development, including gene expression,tissue differentiation and growth	A,E,H	1
	CO6	Outline and describe the process of woody secondary growth in stems	A,E,H	1
	CO7	Identify and describe stelar patterns in stems and roots of vascular plants with and without secondary growth	A,E,H	1,4
	CO8	Take a job in the fields of experimental plant biology and plant science in general be a member of scientific teams in experimental plant biology	A,E,H	3,6

Learning Objectives: This study focuses on the internal structure and function of plant cells, tissue, and organs. This includes the problem of the use of external sources of matter and energy in the processes of metabolism, as well as the growth and development processes and their internal regulation. Plant physiology focuses on explaining the behaviour of plants as a whole (as biological systems).

Course Outcome:
After successfully completion the student will be able to:
1)Discuss the structural components of plant cell walls and membranes
2)Compare and contrast the characteristics of plastid types
3) List and describe the anatomy and ecological significance of epidermal and secretory structures
4)Compare, contrast draw and describe the taxonomic and evolutionary variation in xylem and phloem components
5) Outline and describe the current understanding of the components of shoot, root, and floral development, including gene expression,tissue differentiation and growth
6)Outline and describe the process of woody secondary growth in stems
7) Identify and describe stelar patterns in stems and roots of vascular plants with and without secondary growth
8) Take a job in the fields of experimental plant biology and plant science in general be a member of scientific teams in experimental plant biology

IMB 2.3: ENGLISH COMMUNICATION (Credit: 2)

COURSE	CO	Course Outcome's	PO/ PSO	BTL
IMB 2.3 ENGLISH COMMUNICATION	CO1	Develop their intellectual, personal and professional abilities.	A,B,H	1,2
	CO2	Acquire basic language skills (listening, speaking, reading and writing) in order to communication with speakers of English language.	A,B,H	1,2
	CO3	Acquire the linguistic competence necessarily required in various life situations.	A,B,H	1,2,3
	CO4	Acquire the linguistic competence required in different professions.	A,B,H	1,2,3
	CO5	Develop their awareness of the importance of English as a means of international communication.	A,B,H	3,6
	CO6	Develop positive attitudes towards learning English.	A,B,H	3,6

Learning Objectives:

1. Familiarity with terms, practices and theoretical foundations of the disciplines.
2. Understand and apply the conventions of academic writing in English
3. Development of the reading, analytical, and critical skills of the disciplines.
4. Ability to communicate correctly and effectively within and about the disciplines.

Course Outcome:

1. Develop their intellectual, personal and professional abilities.
2. Acquire basic language skills (listening, speaking, reading and writing) in order to communication with speakers of English language.
3. Acquire the linguistic competence necessarily required in various life situations.
4. Acquire the linguistic competence required in different professions.
5. Develop their awareness of the importance of English as a means of international communication.
6. Develop positive attitudes towards learning English.

IMB 2.4: BIOETHICS AND BIOSAFETY (Credit: 4)

COURSE	CO	Course Outcome's	PO/ PSO	BTL
IMB 2.4 Bioethics And Biosafety	CO1	Interpret basics of biosafety and bioethics and its impact on all the biological sciences and the quality of human life	A,B,E, H	3,5
	CO2	Recognize importance of biosafety practices	A,B,E,	3,4

		and guidelines in research	H	
	CO3	Comprehend the benefits of GM technology and related issues	A,B,E, H	3,4
	CO4	Recognize importance of protection of new knowledge and innovations and its role in business	A,B,E, H	3,5,6

Learning Objectives:

To introduce basic concepts of ethics and safety that are essential for different disciplines of science and procedures involved and protection of intellectual property and related rights. To understand balanced integration of scientific and social knowledge in sustainable development.

Course Outcome:

1.Interpret basics of biosafety and bioethics and its impact on all the biological sciences and the quality of human life
2.Recognize importance of biosafety practices and guidelines in research
3. Comprehend the benefits of GM technology and related issues
4. Recognize importance of protection of new knowledge and innovations and its role in business

IMB 2.5:PRACTICALS (Credit: 6)

COURSE	CO	Course Outcome's	PO/ PSO	BTL
IMB 2.5 PRACTICALS	CO1	Students are able to perform their own blood grouping test along with others.	B,C,D ,E,F,H	1,3,5
	CO2	They are able to perform some more techniques like determination of haemoglobin, TLC and DLC.	B,C,D ,E,F,H	1,3,4
	CO3	Students are able to perform different tests like plasmolysis, guttation, anatomy of monocot and dicot's root,stem& leaf.	B,C,D ,E,F,H	1,3,4
	CO4	Students can interpret basics of biosafety and bioethics and its impact on all the biological sciences and the quality of human life	B,C,D ,E,F,H	1,3,6

Learning Objectives:

To give understanding on determination of blood groups. Performing tests like coagulation time of blood, determination of Haemoglobin, TLC and DLC. It also includes a number of demonstrations of plasmolysis, guttation, anatomy of monocot and dicot's root,stem& leaf. Different case studies on bioethics and biosafety are also included.

Course Outcome:

1. Students are able to perform their own blood grouping test along with others.
2. They are able to perform some more techniques like determination of haemoglobin, TLC and DLC.

3. Students are able to perform different tests like plasmolysis, guttation, anatomy of monocot and dicot's root,stem& leaf.
4. Students can interpret basics of biosafety and bioethics and its impact on all the biological sciences and the quality of human life

SEMESTER III
(Total Credit: 26; Total Mark: 550)

IMB 3.1: GENETICS (Credit: 4)

COURSE	CO	Course Outcome's	PO/ PSO	BTL
IMB 3.1 Genetics	CO1	To understand the elementary perception of Mendelian principles and learn its application in different genetic experiments.	A,E,H	1,2,3
	CO2	To deduce the aberrations from the standard mendelian laws in the form of incomplete and codominace.	A,E,H	1
	CO3	To learn the fundamental genetic mechanisms that controlsex linakge and sex determination	A,E,H	1
	CO4	Understand how Hardy-Weinberg principle unfold the consistency of allelic and genotype frequencies in absence of evolutionary influencesin generation to generation.	A,E,H	1,4

Learning Objectives:

Genetics is the study of heredity and genes. The aim of this course is to strengthen the Mendelian principles along with topics like theory of inheritance, non-allelic interaction, chromosome bandning, mutations, recombination, genetic disease and linkage. This course will help students to venture into the different areas of molecular aspects of genetics.

Course Outcome:

1. To understand the elementaryperception of Mendelian principles and learn its application in different genetic experiments.
2. To deduce the aberrations from the standard mendelian laws in the form of incomplete and codominace.
3. To learn the fundamental genetic mechanisms that controlsex linakge and sex determination
4. Understand how Hardy-Weinberg principle unfold the consistency of allelic and genotype frequencies in absence of evolutionary influencesin generation to generation.

IMB 3.2: GENERAL MICROBIOLOGY (Credit: 4)

COURSE	CO	Course Outcome's	PO/ PSO	BTL
IMB 3.2 General Microbiology	CO1	This course comprises basic knowledge about microorganisms, their structure, composition and physiology of growth.	A,E,H	1,2
	CO2	Students would be aware about the taxonomical classifications and nutritional grouping of microbes based on their habitat.	A,E,H	1,2
	CO3	Moreover, inclusions of wider applications of microbial nutrition and transport and microbial genetics.	A,E,H	1,3

Learning Objectives:

To offer an understanding of microbial diversity, classification, nomenclature and microbial genetics.

Course outcome:

1. This course comprises basic knowledge about microorganisms, their structure, composition and physiology of growth.
2. Students would be aware about the taxonomical classifications and nutritional grouping of microbes based on their habitat.
3. Moreover, inclusions of wider applications of microbial nutrition and transport and microbial genetics.

IMB 3.3: CHEMISTRY- 1 (Credit: 4)

COURSE	CO	Course Outcome's	PO/ PSO	BTL
IMB 3.3 Chemistry- 1	CO1	Demonstrate an understanding of the fundamental principles of atomic structure and quantum numbers	A,H	1
	CO2	Students will gain knowledge in resonance,hyperconjugation,nucleophiles, electrophiles and Strength of organic acids and bases.	A,H	1
	CO3	Will be able to understand the principles of stereochemistry and application of aliphatic hydrocarbons.	A,H	1,3

Learning Objectives:
The course being offered as an elective intends to apply the knowledge in chemistry to understand the various concepts of atomic structure, molecular bonding, basic principles of stereochemistry and aliphatic hydrocarbons.

Course Outcome:
1. Demonstrate an understanding of the fundamental principles of atomic structure and quantum numbers
2. Students will gain knowledge in resonance,hyperconjugation,nucleophiles, electrophiles and Strength of organic acids and bases.
3. Will be able to understand the principles of stereochemistry and application of aliphatic hydrocarbons.

IMB 3.4: MOLECULAR DIAGNOSTICS (Credit: 2)

COURSE	CO	Course Outcome's	PO/ PSO	BTL
IMB 3.4 Molecular Diagnostics	CO1	Familiarization of basic concept of various enzyme immuneassays.	A,E,G, H	1,3
	CO2	Gaining knowledge on molecular methods in clinical microbiology.	A,E,H	1,3
	CO3	Able to apply the advanced knowledge acquired to interpret HPLC, GLC and electron mircoscopy data	A,E,H	1,3,4

Learning Objectives: The main aim of this course is to provide in-depth knowledge of concepts and techniques of molecular biology.

Course Outcome:
1. Familiarization of basic concept of various enzyme immuneassays.
2. Gaining knowledge on molecular methods in clinical microbiology.
3. Able to apply the advanced knowledge acquired to interpret HPLC, GLC and electron mircoscopy data

IMB 3.5: DEVELOPMENTAL BIOLOGY (Credit: 4)

COURSE	CO	Course Outcome's	PO/ PSO	BT L
IMB 3.5 Developmental Biology	CO1	Students learn about the embryonic development, organogenesis and importance of germ layers in developmental process of vertebrate organs.	A,H	1,2

Learning Objectives:

1. To provide an understanding about the basic principles of development of higher vertebrates with special reference to gametogenesis and fertilization.
2. To provide an understanding of the early embryonic development.
3. To understand the embryonic differentiation, cell commitment and determination.
4. To highlight the importance of organogenesis and fate of germ layers

Course Outcome:

Students learn about the embryonic development, organogenesis and importance of germ layers in developmental process of vertebrate organs.

IMB 3.6:PRACTICALS (Credit: 8)

COURSE	CO	Course Outcome's	PO/ PSO	BTL
IMB 3.6 Practicals	CO1	Understand the principles and techniques of genetics	A,B,C, D,E,F, H	1,3
	CO2	Learn to make pedigree chart to understand the pattern of various genetic diseases like colour blindness	A,B,C, D,E,F, H	1,3,4
	CO3	Learn to isolate bacterial population from different sources.	A,B,C, D,E,F, H	1,3,4
	CO4	Undesrand the developmental stages of animals.	A,B,C, D,E,F, H	1
	CO5	Understand the principle chemical reaction and procedure for estimation of ions by titration and iodometry	A,B,C, D,E,F, H	1,3

Learning Objectives:

1. To provide fundamental insights of the principles, practice and key concepts relevant to genetics.
2. To understand the benefits of pedigree chart and karyotyping.
3. To give a deep understanding to pure culture concepts and cultural characteristics.

4. To perform staining procedures including differential and structural staining for bateria.
5. To perform micrometry and viable counts of microorganisms.
6. To determine the antibiotic sensitivity analysis.
7. To identify developmental stages of chick embryo, frog embryo, Anopheles and Drosophila using permanent slides.
8. To determine the presence of specific compound in a mixture of solution.
9. Estimation of ions by standard titration method using internal indicator.

Course outcomes:

1. Understand the principles and techniques of genetics
2. Learn to make pedigree chart to understand the pattern of various genetic diseases like colour blindness
3. Learn to isolate bacterial population from different sources.
4. Undesrand the developmental stages of animals.
5. Understand the principle chemical reaction and procedure for estimation of ions by titration and iodometry

SEMESTER IV
(Total Credit: 26; Total Mark: 550)

IMB 4.1: MOLECULAR BIOLOGY (Credit: 4)

COURSE	CO	Course Outcome's	PO/ PSO	BTL
IMB 4.1 Molecular Biology	CO1	Knowledge on mechanism of replication and DNA repair	A,E,G ,H	1
	CO2	Understanding on mechanism of transcription and splicing	A,E,G ,H	1
	CO3	Students will gain knowledge on translation process	A,E,G ,H	1
	CO4	Students will gain knowledge on gene regulation mechanism (operon concept)	A,E,G ,H	1

Learning Objectives: Students will gain knowledge on structure of DNA, RNA and fundamental molecular processes like replication, transcription, translation and gene regulations.

Course Outcome:

1. Knowledge on mechanism of replication and DNA repair
2. Understanding on mechanism of transcription and splicing
3. Students will gain knowledge on translation process
4. Students will gain knowledge on gene regulation mechanism (operon concept)

IMB 4.2: IMMUNOLOGY (Credit: 4)

COURSE	CO	Course Outcome's	PO/ PSO	BTL
IMB 4.2 Immunology	CO1	Student will gain knowledge about our body defense mechanism	A,E, H	1
	CO2	Develops understanding on antibody production and its work against various antigens	A,E, H	1
	CO3	Gain knowledge on vaccine and vaccination.	A,E, H	1,3
	CO4	Skill development on different immune-techniques like RIA and ELISA	A,E, H	1,3,4

Learning Objectives: This is an advance immunology course and it emphasises on details of B cell and T cells. Mechanism of antigen processing and presentation by MHC molecules is included. Vaccination and varieties of vaccines are also focused in this course. Knowledge about immune-techniques (RIA / ELISA) are added.

Course Outcome:

1. Student will gain knowledge about our body defense mechanism
2. Develops understanding on antibody production and its work against various antigens
3. Gain knowledge on vaccine and vaccination.
4. Skill development on different immune-techniques like RIA and ELISA

IMB 4.3: CHEMISTRY- II (Credit: 4)

COURSE	CO	Course Outcome's	PO/ PSO	BTL
IMB 4.3 Chemistry-II	CO1	Students will gain knowledge on chemical energies, entropy and related concepts.	A,H	1
	CO2	Understandings on chemical equilibrium	A,H	1
	CO3	Students will gain detail idea about preparation and applications of both aliphatic and aromatic organic compounds.	A,H	1
	CO4	This is very much helpful in drug structure designing and understanding of structure of various biomoleclules.	A,H	1,3

Learning Objectives: Basic or fundamental laws of chemistry are included. The concept of chemical energetic, chemical equilibrium are also added. This course contains details about both aliphatic and aromatic compounds.

Course Outcome:

1. Students will gain knowledge on chemical energies, entropy and related concepts.
2. Understandings on chemical equilibrium
3. Students will gain detail idea about preparation and applications of both aliphatic and aromatic organic compounds.
4. This is very much helpful in drug structure designing and understanding of structure of various biomoleclules.

IMB 4.4: INDUSTRIAL FERMENTATIONS (Credit: 2)

COURSE	CO	Course Outcome's	PO/ PSO	BTL
IMB 4.4 Industrial Fermentations	CO1	Students will gain knowledge on fermentation process and many types of bioreactors	A,E, H	1,3,4
	CO2	Understanding on production of various microbial secondary products	A,E, H	1,2
	CO3	Develops idea on enzyme immobilization techniques	A,E, H	1,3
	CO4	Creates employability and entrepreneurships	A,E, H	1,3,6

Learning Objectives:

This course deals with fermentation process and various types of bioreactors. It provides knowledge on large scale production of various microbial products. Details on both upstream and downstream processes are included.

Course Outcome:

1. Students will gain knowledge on fermentation process and many types of bioreactors
2. Understanding on production of various microbial secondary products
3. Develops idea on enzyme immobilization techniques
4. Creates employability and entrepreneurships

IMB 4.5: ENTERPRENEURSHIP DEVELOPMENT (Credit: 4)

COURSE	CO	Course Outcome's	PO/ PSO	BTL
IMB 4.5 Enterpreneurship Development	CO1	Students gain knowledge of entrepreneurship and its importance	A,C,H	1,5,6
	CO2	Students get idea on establishment of enterprise	A,C,H	1,3,6
	CO3	Understanding on marketing management and development of international business	A,C,H	1,3,6

Learning Objectives:

This course includes need of entrepreneurship, establishment of enterprise and financing. It also covers the marketing management and development of international business.

Course Outcome:

1. Students gain knowledge of entrepreneurship and its importance
2. Students get idea on establishment of enterprise
3. Understanding on marketing management and development of international business

IMB 4.6:PRACTICALS (Credit: 8)

COURSE	CO	Course Outcome's	PO/ PSO	BTL
IMB 4.6 Practicals	CO1	Knowledge of DNA isolation and immune-techniques will enable the students to secure jobs in clinical/Pharmaceutical and Quality assurance industries.	A,B,C ,D,E, H	1,3,6
	CO2	All these chemical practical helps the students on understanding enthalpy, neutralization and mechanism of formation of many aromatic compounds	A,B,C ,D,E, H	1,3,6

Learning Objectives:

To give understanding on isolate and quantify plant DNA. Performing immune-techniques like ELISA, Immunodiffusion. . Perform immuno diagnostic test (Typhoid, Malaria, Dengue). It also includes a number of chemical tests like determination of enthalpy, neutralization of acid and bases. Preparation and quantification of different aromatic amines.

Course Outcome:

1. Knowledge of DNA isolation and immune-techniques will enable the students to secure jobs in clinical/Pharmaceutical and Quality assurance industries.

2. All these chemical practical helps the students on understanding enthalpy, neutralization and mechanism of formation of many aromatic compounds

SEMESTER V
(Total Credit: 24; Total Mark: 500)

IMB 5.1: BIO-ANALYTICAL TOOLS (Credit: 4)

COURSE	CO	Course Outcome's	PO/ PSO	BT L
IMB 5.1 Bio-Analytical Tools	CO1	Introduce the basic concept and principles of bioanalytical techniques.	A,E, F,H	1,3
	CO2	Learn how to extract and isolate biomolecules from different sources.	A,E, F,H	1,3
	CO3	Learn to apply important chromatographic techniques to purify biomolecules.	A,E, F,H	1,3
	CO4	Familiarize the working principles of electrophoresis and spectroscopic techniques and use of the knowledge to structurally characterize biomolecules	A,E, F,H	1,3

Learning Objective
The key objective of the course is to provide basic knowledge to undergraduate students on several analytical tools to understand structure and functions of biomolecules.

Course Outcomes:
1. Introduce the basic concept and principles of bioanalytical techniques.
2. Learn how to extract and isolate biomolecules from different sources.
3. Learn to apply important chromatographic techniques to purify biomolecules.
4. Familiarize the working principles of electrophoresis and spectroscopic techniques and use of the knowledge to structurally characterize biomolecules

IMB 5.2: RECOMBINANT DNA TECHNOLOGY (Credit: 4)

COURSE	CO	Course Outcome's	PO/ PSO	BTL
IMB 5.2 Recombinant Dna Technology	CO1	Students will have familiarity on the basis of genetic engineering and how to apply advanced molecular biology methods in different sectors of biotechnology.	A,E, H	1,3
	CO2	Students will be acquiring knowledge in following aspects: Transformation methods, Transposon, Gene knockout technologies, restriction digestion of	A,E, H	1,3

		Plasmid and genomic DNA, Genomic and cDNA library preparation, Ligation, insert analysis, Gene therapy, Methods of gene transfer		

Learning Objectives:
To provide fundamental understandings of the principles and key concepts relevant to genetic engineering and its uses in medicine, health, agricultural and environmental biotechnology.

Course Outcomes:

1. Students will have familiarity on the basis of genetic engineering and how to apply advanced molecular biology methods in different sectors of biotechnology.
2. Students will be acquiring knowledge in following aspects: Transformation methods, Transposon, Gene knockout technologies, restriction digestion of Plasmid and genomic DNA, Genomic and cDNA library preparation, Ligation, insert analysis, Gene therapy, Methods of gene transfer

IMB 5.3: PLANT BIOTECHNOLOGY (Credit: 4)

COURSE	CO	Course Outcome's	PO/ PSO	BT L
IMB 5.3 Plant Biotechnology	CO1	Students will know different methods of plant tissue culture, Protoplast Isolation and fusion.	A,E, H	1,3
	CO2	Students will also know methods of in vitro haploid production and Somatic hybridization.	A,E, H	1,3
	CO3	Students will have familiarity on the basics of nitrogen fixation and its enzymes.	A,E, H	1,3

Learning Objectives:
This course will provide knowledge in applications of biotechnology in plant sciences.

Course Outcome:

1. Students will know different methods of plant tissue culture, Protoplast Isolation and fusion.
2. Students will also know methods of in vitro haploid production and Somatic hybridization.
3. Students will have familiarity on the basics of nitrogen fixation and its enzymes.

IMB 5.4: ANIMAL BIOTECHNOLOGY (Credit: 4)

COURSE	CO	Course Outcome's	PO/ PSO	BT L
IMB 5.4 Animal Biotechnology	CO1	Students will understand the various applications of animal cell technology in research, clinics and industry.	A,E, H	1,3
	CO2	Discussed methods of production of transgenic animals/cells and their application in various areas of biotechnology will equip the students fit for biotechnology research and industry.	A,E, H	1,3

Learning Objectives:

This course will provide knowledge in applications of biotechnology in animal sciences.

Course Outcome:

1. Students will understand the various applications of animal cell technology in research, clinics and industry.
2. Discussed methods of production of transgenic animals/cells and their application in various areas of biotechnology will equip the students fit for biotechnology research and industry.

IMB 5.5: PRACTICALS(Credit: 8)

COURSE	CO	Course Outcome's	PO/ PSO	BT L
IMB 5.5 Practicals	CO1	Practical exposure to microscopy, different chromatographic techniques.	A,C, D,E, F,H	1,3, 4
	CO2	Practical exposure to genomic DNA isolation using animal tissues and their quantification.	A,C, D,E, F,H	1,3, 4
	CO3	Understand the method to amplify specific gene, digestion and cloning of the particular gene.	A,C, D,E, F,H	1,3, 4
	CO4	Understand the basis of separation of mixture of compounds using Chromatography.	A,C, D,E, F,H	1,3, 4
	CO5	Practical exposure to different micropropagation techniques.	A,C, D,E, F,H	1,3

Learning Objective

Hands-on experience to research in recombinant DNA technology and plant tissue culture. Focuses on using bio-analytical tools. Practicals also focuses on basic molecular biology techniques including DNA isolation and electrophoresis.

Course Outcomes

1. Practical exposure to microscopy, different chromatographic techniques.
2. Practical exposure to genomic DNA isolation using animal tissues and their quantification.
3. Understand the method to amplify specific gene, digestion and cloning of the particular gene.
4. Understand the basis of separation of mixture of compounds using Chromatography.
5. Practical exposure to different micropropagation techniques.

SEMESTER VI
(Total Credit: 24; Total Mark: 500)

IMB 6.1: BIOPROCESS TECHNOLOGY (Credit: 4)

COURSE	CO	Course Outcome's	PO/ PSO	BTL
IMB 6.1 Bioprocess Technology	CO1	Students will be gaining in depth knowledge on fermentation and design of various types of bioreactors.	A,H	1,3
	CO2	In depth knowledge on bioreactors and large scale production will be helpful in skill development of students.	A,H	1,3
	CO3	Employability skill will be developed in students by studying this course.	A,H	1,3,6
	CO4	Knowledge on large scale production will help in entrepreneurship.	A,H	1,3,6

Learning Objectives:

This course will provide knowledge on application of microbiology. In this course, students will learn about fermentation process and various types of bioreactors. Students will be able to learn about large scale production of various microbial products along with enzyme immobilization technique.

Course Outcome:

1. Students will be gaining in depth knowledge on fermentation and design of various types of bioreactors.
2. In depth knowledge on bioreactors and large scale production will be helpful in skill development of students.
3. Employability skill will be developed in students by studying this course.
4. Knowledge on large scale production will help in entrepreneurship.

IMB 6.2: GENOMICS & PROTEOMICS (Credit: 4)

COURSE	CO	Course Outcome's	PO/ PSO	BT L
IMB 6.2 Genomics & Proteomics	CO1	Student will gain knowledge on structural organization of genome in prokaryotes and eukaryotes.	A,H	1,4
	CO2	Knowledge on different molecular markers in genome analysis will be gained.	A,H	1,4
	CO3	In depth knowledge on protein targeting to different organelles and protein analysis using different techniques like electrophoresis and mass spectroscopy etc will be achieved.	A,H	1,3, 4
	CO4	Employability skill will be developed in students by studying this course.	A,H	1,6

Learning Objectives:

The main objective of this course is to provide in depth knowledge on organisation of genome in prokaryotes and eukaryotes. The course will also provide knowledge on protein targeting to different organelles. Additionally, the students will gain knowledge on protein analysis using different biophysical techniques.

Course Outcome:

1. Student will gain knowledge on structural organization of genome in prokaryotes and eukaryotes.
2. Knowledge on different molecular markers in genome analysis will be gained.
3. In depth knowledge on protein targeting to different organelles and protein analysis using different techniques like electrophoresis and mass spectroscopy etc will be achieved.
4. Employability skill will be developed in students by studying this course.

IMB 6.3:BIOSTATISTICS (Credit: 4)

COURSE	CO	Course Outcome's	PO/ PSO	BTL
IMB 6.3 Biostatistics	CO1	Students will gain knowledge on importance of data collection and interpretation of data effectively.	A,D, H	1,3,4
	CO2	Students will learn how to analyze different biological data effectively using statistical methods.	A,D, H	1,3,4
	CO3	This course will provide employability to the students.	A,D, H	5,6

	CO4	Knowledge on data analysis will help in entrepreneurship.	A,D, H	4,6

Learning Objectives:

In this course, students will learn how to collect and analyse data. The students will also learn the concept of probability in statistical or random experiments. By studying this course students will learn how to analyse statistical results effectively.

Course Outcome:

1. Students will gain knowledge on importance of data collection and interpretation of data effectively.
2. Students will learn how to analyze different biological data effectively using statistical methods.
3. This course will provide employability to the students.
4. Knowledge on data analysis will help in entrepreneurship.

IMB 6.4:PROJECT (Credit: 4)

COURSE	CO	Course Outcome's	PO/ PSO	BTL
IMB 6.4 Project	CO1	To gain experience being involved in a large project and to develop research and problem-solving skills.	A,B,C,D, E,F,G,H	1,3,4
	CO2	By being in a large project, it is expected that various skills like time management and report writing will be further refined.	A,B,C,D, E,F,G,H	1,3,4

Learning Objectives:

- A project objective describes the desired results of a project, which often includes a tangible item.
- An objective is specific and measurable, and must meet time, budget, and quality constraints.

Course Outcomes:

1. To gain experience being involved in a large project and to develop research and problem-solving skills.
2. By being in a large project, it is expected that various skills like time management and report writing will be further refined.

IMB 6.5: Practicals (Credit 8)

COURSE	CO	Course Outcome's	PO/ PSO	BTL
IMB 6.5 Practicals	CO1	Students will gain knowledge on microbial growth kinetics	A,C, F,H	1
	CO2	Students will gain knowledge about production of and analysis of ethanol, lactic acid and antibiotics etc.	A,C, F,H	1,3,4
	CO3	Additionally, students will gain knowledge on cell immobilization.	A,C, F,H	1,3,4
	CO4	Students will gain knowledge on different molecular biology techniques like electrophoresis, southern blotting, western blotting etc.	A,C, F,H	1,3,4

Learning Objectives:

To provide advanced knowledge on different techniques on microbiology and molecular biology.

Course Outcome:

1. Students will gain knowledge on microbial growth kinetics
2. Students will gain knowledge about production of and analysis of ethanol, lactic acid and antibiotics etc.
3. Additionally, students will gain knowledge on cell immobilization.
4. Students will gain knowledge on different molecular biology techniques like electrophoresis, southern blotting, western blotting etc.

SEMESTER VII
(Total Credit: 24; Total Mark: 500)

IMB 7.1: BIOMOLECULES & ENZYMOLOGY (Credit: 4)

COURSE	CO	Course Outcome's	PO/ PSO	BTL
IMB 7.1 BIOMOLECULES & ENZYMOLOGY	CO1	Students will obtaine basic knowledges about the relationship between properties and structure of the enzymes, their mechanism of action and kinetics of enzymatic reactions.	A,F	1
	CO2	They would be able to characterize the enzymes in each enzymatic class, examples of such enzymes and their application in practice.	A,F	1,3

	CO3	They understand the regulatory mechanisms of enzyme activity, enzyme inducers and represors.	A,F,G	1,3

Learning objective

To understand the principles of enzyme kinetics, mechanisms of enzyme catalysisand mechanisms of enzyme regulation.

Course outcomes

1. Students will obtaine basic knowledges about the relationship between properties and structure of the enzymes, their mechanism of action and kinetics of enzymatic reactions.
2. They would be able to characterize the enzymes in each enzymatic class, examples of such enzymes and their application in practice.
3. They understand the regulatory mechanisms of enzyme activity, enzyme inducers and represors.

IMB 7.2: MICROBIAL GENOMICS (Credit: 4)

COURSE	CO	Course Outcome's	PO/ PSO	BT L
IMB 7.2 MICROBIAL GENOMICS	CO1	Understand the molelecular technique for identification and diversity study of microbes	A,G	1,
	CO2	Understand the basic principle of different types of sequencing technique.	D,E	1,3
	CO3	Study of microbes through noncultivable or metagenomic approach.	D,E	3,4

Learning objective

To provide a fundamental knowledge on advance molecular techniques and sequencing methods used tocharcterisation of microbial genome. To identify the uncultivable microbes through metagenomic approach.

Course outcomes

1. Understand the molelecular technique for identification and diversity study of microbes
2. Understand the basic principle of different types of sequencing technique.
3. Study of microbes through noncultivable or metagenomic approach.

IMB 7.3: METABOLOMICS (Credit: 4)

COURSE	CO	Course Outcome's	PO/ PSO	BT L
IMB 7.3 METABOLOMICS	CO1	Understand how metabolomics technology can enhance research in plant sciences.	A	1
	CO2	Be able to evaluate and apply the appropriate experimental design in a given metabolomics research.	F,H	3,4
	CO3	Be able to apply advanced NMR and MS methods in metabolomics experiments.	E,F	3
	CO4	Understand how to manipulate metabolic pathway for enhancing the production of metabolites.	B,C,E	4,5, 6

Learning objective

This course includes extensive study on Metabolism and the interaction of the metabolome with the genome, proteome and the environment. Evaluate advantages and limitations of some analytical techniques used in metabolomics studies. Discuss some of the modern-day applications of metabolomics.

Course outcomes:

1. Understand how metabolomics technology can enhance research in plant sciences.
2. Be able to evaluate and apply the appropriate experimental design in a given metabolomics research.
3. Be able to apply advanced NMR and MS methods in metabolomics experiments.
4. Understand how to manipulate metabolic pathway for enhancing the production of metabolites.

IMB 7.4: PHARMACEUTICAL BIOTECHNOLOGY (Credit: 4)

COURSE	CO	Course Outcome's	PO/ PSO	BT L
IMB 7.4 PHARMACEUTICAL BIOTECHNOLOGY	CO1	Students get familiarized with different immunological responses and the molecules responsible for immunomodulation.	A	1
	CO2	They learned the process of different diagnosis tools using antibody and antigen for different diseases.	B,C	3,4
	CO3	Different disorders and their probable drug molecule and mode of action.	C,D	3
	CO4	Steroids used in different diseases and their microbial production.	E,F	3,4, 6

	CO5	Protein miss-folding and role on diseases.	A	1

Learning Objective: To provide an understanding about the basic concept of immunological response, different disorders and drug discovery & designing, mechanism of action of different drugs, microbial use of steroid transformation and protein engineering for drug development.

Course outcome:

1. Students get familiarized with different immunological responses and the molecules responsible for immunomodulation.
2. They learned the process of different diagnosis tools using antibody and antigen for different diseases.
3. Different disorders and their probable drug molecule and mode of action.
4. Steroids used in different diseases and their microbial production.
5. Protein miss-folding and role on diseases.

IMB 7.5: PRACTICALS (Credit: 8)

COURSE	CO	Course Outcome's	PO/ PSO	BT L
IMB 7.5 PRACTICALS	CO1	Understand the various methods of screening of industrially important enzyme producing microorganisms.	A,F	1
	CO2	Understand the different molecular technique for identification and phylogenetic analysis of bacteria.	B,D,F	3,4
	CO3	Perform metagenomic DNA isolation and quatification.	F	3,4
	CO4	Learn competent cell preparation for transformation experiment	F	3,4
	CO5	Understand the principle and perform GC_MS, HPTLC and HPLC for plant metabolite analysis	E,F	4,6

Learning Objective

To provide fundamental insights of the principle, methods and key concepts relevant to molecular technique for identification and chacterization of bacteria. To provide hands on training of chromatography and mass spectrophotometr for analysis of plant metabolites.

Outcomes

1. Understand the various methods of screening of industrially important enzyme producing microorganisms.
2. Understand the different molecular technique for identification and phylogenetic analysis of bacteria.
3. Perform metagenomic DNA isolation and quatification.
4. Learn competent cell preparation for transformation experiment
5. Understand the principle and perform GC_MS, HPTLC and HPLC for plant metabolite analysis.

SEMESTER VIII
(Total Credit: 24; Total Mark: 500)

IMB 8.1:BIOINFORMATICS (Credit: 4)

COURSE	CO	Course Outcome's	PO/ PSO	BT L
IMB 8.1 BIOINFORMATICS	CO1	Students should be able to apply basic bioinformatic tools for the studies and research in other areas of their biotechnology and microbiology programs, such as finding gene/protein homologs, designing primers, identifying mutations, etc	C,G,H	1,3, 4

Learning Objectives: To introduce to the field of bioinformatics via an array of publicly available tools and resources

Course Outcome:
Students should be able to apply basic bioinformatic tools for the studies and research in other areas of their biotechnology and microbiology programs, such as finding gene/protein homologs, designing primers, identifying mutations, etc

IMB 8.2: CANCER BIOLOGY (Credit: 4)

COURSE	CO	Course Outcome's	PO/ PSO	BT L
IMB 8.2 CANCER BIOLOGY	CO1	Describe the six hallmarks of cancer	A	1
	CO2	Describe different causes of cancer development	A	1
	CO3	Explain the role of mutations in cancer formation	A	1
	CO4	Can give example of proto-oncogene and viral oncogene and its role in cancer development	A, D	1,4
	CO5	Explain cell cycle and its regulation and dysregulation in cancer giving example of tumor suppressor proteins	A,D	1,4
	CO6	Apoptosis and its role in cancer	A	1

Learning Objectives: This course covers in details the molecular mechanism of cancer development with emphasis on tumor viruses, oncogenes, tumor suppressor genes, cell cycle and

its control and other hallmarks of cancer. It also covers the molecular approaches to cancer diagnostics and treatment. More recent advances in cancer epigenetics are also discussed

Course Outcome:
1. Describe the six hallmarks of cancer
2. Describe different causes of cancer development
3. Explain the role of mutations in cancer formation
4. Can give example of proto-oncogene and viral oncogene and its role in cancer development
5. Explain cell cycle and its regulation and dysregulation in cancer giving example of tumor suppressor proteins
6. Apoptosis and its role in cancer
7. Factors that control metastasis in cancer cells
8. Biomarkers in cancer identification and therapy
9. Role of diet and epigenetics in cancer
10. Different aspects of modern cancer therapy

IMB 8.3: NANOTECHNOLOGY (Credit: 4)

COURSE	CO	Course Outcome's	PO/ PSO	BT L
IMB 8.3 NANOTECHNOLOGY	CO1	To enable comprehensive understanding of the structural and functional principles of bio nanomachines.	A,E	1
	CO2	To introduce different mode of action of nanoparticle and their interaction with other biomolecules.	C,D	3,4
	CO3	To introduce the application of nanoparticles in different biological activities like antibiotics, cancer diagnosis and therapy, drug delivery etc.	C,D,E	3,4, 6

Learning Objective: To help the students to appreciate the overarching structural and functional principles of biological systems viz. molecular interactions, energetics, transport, self-assembly, selforganisation and information processing. To educated them how these principles can be employed as a strategy construct bionanomachines that is destined work in non biological contexts.

Course Outcome:
1. To enable comprehensive understanding of the structural and functional principles of bio nanomachines.
2. To introduce different mode of action of nanoparticle and their interaction with other biomolecules.

3. To introduce the application of nanoparticles in different biological activities like antibiotics, cancer diagnosis and therapy, drug delivery etc.

IMB 8.4: ENVIRONMENTAL BIOTECHNOLOGY (Credit: 4)

COURSE	CO	Course Outcome's	PO/ PSO	BT L
IMB 8.4 ENVIRONMENTAL BIOTECHNOLOGY	CO1	To understand the basic environmental issues like pollution and the management to overcome it.	A	1
	CO2	Describe the most commonly applied disinfection methods, and the steps typically involved in drinking water treatment process in water pollution.	A,D	1,3
	CO3	Describe suitable methods for characterizing the activity, function, diversity, and composition of microbial communities.	D,G	3,5
	CO4	Explain the microbial processes and growth requirements undelaying the activated sludge process, nitrification, denitrification, enhanced phosphorus removal, and anaerobic digestion.	A	1
	CO5	Evaluate alternative process schemes for combined biological nutrient removal (BNR)	A	1
	CO6	Evaluate the potential for biodegradation of organic pollutants, taking microbial and physical/chemical environments, as well as the chemical structure of the compound itself.	A,B	1,3
	CO7	Soil pollution and contamination due to pesticides and bio pest control.	B,C	3,4
	CO8	Gross knowledge about global environment problems which are the cause of global warming.	A	1

Learning Objectives: To offer insights in the interaction of human and environment and manipulation of environment by biotechnology in favour of human.

Course Outcomes:

1. To understand the basic environmental issues like pollution and the management to overcome it.

2.Describe the most commonly applied disinfection methods, and the steps typically involved in drinking water treatment process in water pollution.
3. Describe suitable methods for characterizing the activity, function, diversity, and composition of microbial communities.
4. Explain the microbial processes and growth requirements undelaying the activated sludge process, nitrification, denitrification, enhanced phosphorus removal, and anaerobic digestion.
5. Evaluate alternative process schemes for combined biological nutrient removal (BNR)
6. Evaluate the potential for biodegradation of organic pollutants, taking microbial and physical/chemical environments, as well as the chemical structure of the compound itself.
7. Soil pollution and contamination due to pesticides and bio pest control.
8. Gross knowledge about global environment problems which are the cause of global warming.

IMB 8.5: PRACTICALS(Credit 8)

COURSE	**CO**	**Course Outcome's**	**PO/ PSO**	**BT L**
IMB 7.1 BIOMOLECULES & ENZYMOLOGY	CO1	To in hand experience of different bioinformatical tools and softwares and their application in different molecular biology and biotechnology.	E,F,H	3,4, 6
	CO2	In hand experience of nanoparticle formation and its application in bacterial killing.	E,F	3,4
	CO3	In hand experience in different techniques of environment biotechnology to estimate water pollution.	F	3,4
	CO4	In hand experience for identification of (a)cancer types depends on morphology, (b) apoptosis, (c)cancer biomarker (d)UV radiation based cell damage	F	3,4

Learning Objectives: To offer in hand experience and application of differernt bioinformatical tools, cancer biology, nanotechnology and environmental biotechnology.

Course Outcomes:
1. To in hand experience of different bioinformatical tools and softwares and their application in different molecular biology and biotechnology.
2. In hand experience of nanoparticle formation and its application in bacterial killing.
3. In hand experience in different techniques of environment biotechnology to estimate water pollution.
4. In hand experience for identification of (a)cancer types depends on morphology, (b) apoptosis, (c)cancer biomarker (d)UV radiation based cell damage

SEMESTER IX
(Total Credit: 24; Total Mark: 400)

IMB 9.1: INFECTIOUS DISEASE BIOLOGY (Credit: 4)

COURSE	CO	Course Outcome's	PO/ PSO	BT L
IMB 9.1 INFECTIOUS DISEASE BIOLOGY	CO1	Describe and predict the impacts of infectious diseases on human and global health	A	1
	CO2	Describe the basic form, function, behavior, and diversity of infectious agents and their vectors	A	1
	CO3	Understand how hosts defend themselves against infectious agents	A	1
	CO4	Apply the fundamental principles underlying disease dynamics at multiple spatial and temporal scales to predict how new diseases emerge.	D	3,4
	CO5	Learn about vaccines	A	1

Learning Objectives: To provide students with a broad perspective on health and disease, the dynamic nature of host-associated microbes, an in-depth understanding of the origins and dynamics of infectious diseases, and contemporary thought about the nature of health, disease, and disease management.

Course Outcome:

1. Describe and predict the impacts of infectious diseases on human and global health
2. Describe the basic form, function, behavior, and diversity of infectious agents and their vectors
3. Understand how hosts defend themselves against infectious agents
4. Apply the fundamental principles underlying disease dynamics at multiple spatial and temporal scales to predict how new diseases emerge.
5. Learn about vaccines

IMB 9.2: BIODIVERSITY CONSERVATION (Credit :4)

COURSE	CO	Course Outcome's	PO/ PSO	BT L
IMB 9.2 BIODIVERSITY CONSERVATION	CO1	The issues and problems of sustainable resource usage, conservation of endangered biota, long-term preservation of biodiversity, ecosystem services and ecological economics, and management and conservation of ecosystems.	A	1
	CO2	Some major empirical generalizations	A	1

		related to biodiversity, including the species-area effect, the latitudinal gradient in species richness, the relationship between habitat diversity (heterogeneity) and species richness, and the diversity-stability relationship.		
	CO3	Understand that higher biodiversity, per se, is not necessarily better from a conservation perspective.	A	1
	CO4	The processes that generate and maintain biodiversity.	A	1
	CO5	The differences between within-population and among-population genetic diversity.	A	1
	CO6	General knowledge of past mass extinctions and the current extinction crisis.	A	1
	CO7	Some utilitarian and non-utilitarian reasons for conserving biodiversity.	A	1

Learning Objectives: To make students understand the biological diversity (biodiversity) which includes species diversity (richness), genetic diversity, and ecosystem diversity. They will be able to recognize the scale dependence of biodiversity and its measurement (including alpha, beta, and gamma diversity). Students become aware of some major empirical generalizations related to biodiversity, including the species-area effect, the latitudinal gradient in species richness, the relationship between habitat diversity (heterogeneity) and species richness, and the diversity-stability relationship.

Course Outcome:

1. The issues and problems of sustainable resource usage, conservation of endangered biota, long-term preservation of biodiversity, ecosystem services and ecological economics, and management and conservation of ecosystems.
2. Some major empirical generalizations related to biodiversity, including the species-area effect, the latitudinal gradient in species richness, the relationship between habitat diversity (heterogeneity) and species richness, and the diversity-stability relationship.
3. Understand that higher biodiversity, per se, is not necessarily better from a conservation perspective.
4. The processes that generate and maintain biodiversity.
5. The differences between within-population and among-population genetic diversity.
6. General knowledge of past mass extinctions and the current extinction crisis.
7. Some utilitarian and non-utilitarian reasons for conserving biodiversity.

IMB 9.3: NATURAL PRODUCT AND MEDICINAL CHEMISTRY (Credit :4)

COURSE	CO	Course Outcome's	PO/ PSO	BT L
IMB 9.3 NATURAL PRODUCT AND MEDICINAL CHEMISTRY	CO1	Understand the importance of natural products in drug development and to look for various strategies used to have drug leads from various classes of natural products.	A,B	1,4
	CO2	Use synthetic methodology to develop better lead compounds of various classes of natural products.	A,E	1,3
	CO3	Understand of importance of quality control and assurance in the development of herbal medicines.	A,B	1,3

Learning Objectives: To develop an understanding of important concepts of natural products, their role in drug development and structure optimization.

Course Outcome:

1. Understand the importance of natural products in drug development and to look for various strategies used to have drug leads from various classes of natural products.
2. Use synthetic methodology to develop better lead compounds of various classes of natural products.
3. Understand of importance of quality control and assurance in the development of herbal medicines.

IMB 9.4: INTELLECTUAL PROPERTY RIGHTS (Credit: 4)

COURSE	CO	Course Outcome's	PO/ PSO	BT L
IMB 9.4 INTELLECTUAL PROPERTY RIGHTS	CO1	Introduction to IPR. Learn the Importance of IPR. Different types of IP protections. A. Patents: their definition, granting, infringement, searching & filing. B. Copyrights: their definition, granting, infringement, searching & filing. C. Trademarks: role in commerce, importance, protection, registration. D. Design Registration: Industrial Designs and Design Patents, its protection.	A,B,E	1,3
	CO2	Case studies in IPR. Understand the importance of having an IP management strategy to protect innovative products from facing infringements. Famous examples of Patent infringements were discussed.	A,B,E	1,3

Learning Objectives: To make students aware of the rights for protection of their inventions. Innovations/creativity is useful for the society and it's very important to protect these innovations. The course is designed with a view to create IPR consciousness; and familiarize the learners about the documentation and administrative procedures relating to IPR.

Course Outcome:

1. Introduction to IPR. Learn the Importance of IPR. Different types of IP protections. A. Patents: their definition, granting, infringement, searching & filing. B. Copyrights: their definition, granting, infringement, searching & filing. C. Trademarks: role in commerce, importance, protection, registration. D. Design Registration: Industrial Designs and Design Patents, its protection.
2. Case studies in IPR. Understand the importance of having an IP management strategy to protect innovative products from facing infringements. Famous examples of Patent infringements were discussed.

IMB 9.5: Practicals (Credit: 8)

COURSE	CO	Course Outcome's	PO/ PSO	BT L
IMB 9.5 Practicals	CO1	Gain knowledge of phytochemical screening, spectral analysis and separation techniques of natural products, which will enable the students to secure jobs in clinical/Pharmaceutical and Quality assurance industries.	E,F,H	3,4, 6
	CO2	Understand the biodiversity, its importance, the need to conserve it and various other aspects of biodiversity	E,F	3,4

Learning objectives:

To provide an understanding on MMT assay which is a colorimetric assay for assessing cell metabolic activity and Prepare antibody in animal models. It includes various methods and applications for assessment of biodiversity components, preparation techniques for herbarium and museum species. It also covers learning to describe and identification of plant families, population indices, and approaches to understand biodiversity value and biodiversity indicators. Students also gain skill for phytochemical screening, spectral analysis and separation techniques of natural products.

Course Outcome:

1. Gain knowledge of phytochemical screening, spectral analysis and separation techniques of natural products, which will enable the students to secure jobs in clinical/Pharmaceutical and Quality assurance industries.
2. Understand the biodiversity, its importance, the need to conserve it and various other aspects of biodiversity

SEMESTER X
(Total Credit: 20; Total Mark: 200)

IMB 10.1: SEMINAR PRESENTATION (Credit: 4)

COURSE	CO	Course Outcome's	PO/ PSO	BTL
IMB 10.1 SEMINAR PRESENTATION	CO1	Gains inputs to know to present self	A,B,C	1
	CO2	Builds confidence to present in front of audience	A,B,C	3,5,6

Learning Objective

To improve confidence, presentation skills and communication skills of the students

Course Outcomes:

1. Gains inputs to know to present self
2. Builds confidence to present in front of audience

IMB10.2:PROJECT WORK (Credit:16)

COURSE	CO	Course Outcome's	PO/ PSO	BTL
IMB10.2 PROJECT WORK	CO1	Help frame hypothesis.	B	3,6
	CO2	Literature survey.	A,E	1,3
	CO3	Hands-on experience with regard to different instrumentations and techniques.	B,C,F, G,H	1,3, 4,5
	CO4	Data interpretation and statistical analysis.	B,C,E, F,G,H	1,3, 4,5
	CO5	Paper writing.	B,C,G, H	1,4, 5,6

Learning Objective

The project aims to expose the students to a short term research experience. Through the process they learn to frame hypothesis, define objectives, collect relevant literature, design and perform experiments, data analysis and paper writing.

Course Outcomes

1. Help frame hypothesis.
2. Literature survey.
3. Hands-on experience with regard to different instrumentations and techniques.
4. Data interpretation and statistical analysis.
5. Paper writing.