KANNUR UNIVERSITY

(Abstract)

M.Sc Biotechnology Programme at Dept.of Biotechnology & Microbiology, Dr Janaki Ammal Campus, Palayad - Revised Scheme & Syllabus - Approved- Implemented w.e f 2023 admission- Orders Issued

ACADEMIC C SECTION

ACAD C/ACAD C3/25198/2023 Dated: 10.01.2024

Read:-1. UO No ACAD C/ ACAD C3/22373/2019 dated 12/09/2023
2. Circular No dated ACAD C/ ACAD C3/22373/2019 dated 12/09/2023
3. Email dated 22/11/2023 from the Head, Dept.of Biotechnology & Microbiology, Dr Janaki Ammal Campus, Palayad
4. Minutes of the meeting of the Department Council dated 20/11/2023
5. Email dated 19/12/2023 from the Head, Dept.of Biotechnology & Microbiology, Dr Janaki Ammal Campus, Palayad

ORDER

1.The revised Regulations for Post Graduate Programmes under Choice Based Credit and Semester System in the University Teaching Departments/ Schools were implemented w.e.f 2023 admissions vide paper read 1 above

2. As per paper read 2 above, Heads of all Teaching Departments were requested to submit the revised Syllabus in accordance with the approved Regulations along with a copy of the Department Council Minutes.

3. As per paper read 3 above, the Head, Dept. of Biotechnology & Microbiology, Dr Janaki Ammal Campus, Palayad submitted the Scheme and Syllabus of M.Sc Biotechnology Programme to be implemented in the University Teaching Department w.e.f 2023 admissions.

4. Department Council vide the paper read 4 above approved the aforementioned scheme and syllabus of M.Sc Biotechnology Programme to be implemented in the Dept.of Biotechnology & Microbiology, Dr Janaki Ammal Campus, Palayad of the University w.e.f.2023 admission.

5. As per paper read 5 above, Head , Dept of Biotechnology & Microbiology has certified that Prof (Dr) Ranjedra Pilankatta , Dept of Biochemistry and Molecular Biology , Central University of Kerala, Periye, Kasaragod , an external academician had reviewed the Syllabus of M.Sc Biotechnology and his comments had been incorporated into the syllabus and updated

6. The Vice Chancellor, after considering the matter in detail and in exercise of the powers of the Academic Council conferred under section 11(1), Chapter lll of Kannur University Act 1996, ***approved the revised Scheme & Syllabus of M.Sc Biotechnology Programme and accorded sanction to implement the same in the Dept. of Biotechnology & Microbiology, Dr Janaki Ammal Campus, Palayad, with effect from 2023 admission, subject to reporting to the Academic Council.***

7.The revised Scheme and Syllabus of M.Sc Biotechnology Programme under CBCSS implemented in the Dept.of Biotechnology & Microbiology, Dr Janaki Ammal Campus, Palayad with effect from 2023 admission, is appended and uploaded in the University website (www.kannuruniversity.ac.in)

8. Orders are issued accordingly.

Sd/-
Narayanadas K
DEPUTY REGISTRAR (ACAD)
For REGISTRAR

To: 1. Head, Dept.of Biotechnology & Microbiology, Dr Janaki Ammal Campus, Palayad
2. Convenor, Curriculum Committee

Copy To: 1.PS to VC/ PA to PVC/ PA to R
2. To Examination Branch (through PA to CE)
3. EP IV/ EXC I
4. Computer Programmer
5. Webmanager (to publish in the website)
6. SF/DF/FC

Forwarded / By Order
SECTION OFFICER

SCHEME AND SYLLABUS

M Sc BIOTECHNOLOGY

2023 ADMISSION ONWARDS

DEPARTMENT OF BIOTECHNOLOGY AND MICROBIOLOGY

KANNUR UNIVERSITY

Scheme and Syllabus of M Sc Biotechnology Programme Under the Choice Based Credit Semester System with effect from 2023 Admission

About the Department

The Department of Biotechnology and Microbiology of Kannur University established in the year 2000 at Dr.Janaki Ammal Campus, Palayad, Thalassery offers M.Sc., Ph.D. and Post-doctoral programs in Biotechnology, Microbiology and Computational Biology. The Department is a Centre of Excellence in Biosciences, receiving research funds from state, national and international agencies. Our vision is to improve quality of life through research and molding future scientists and individuals who will be a workforce to make a better tomorrow.

M.Sc. Programmes

M.Sc. Biotechnology - 13 Seats
M.Sc. Microbiology - 13 Seats
M.Sc. Computational Biology - 12 Seats

Duration of the programmes: 2 years

The whole program is divided into four semesters

Eligibility for Admission to M.Sc. Biotechnology programme

Bachelor's degree in any of the subjects such as Biotechnology/ Microbiology/ Biochemistry/ Chemistry/ Zoology/ Botany/ Plant Science/ Life Science or any other subject with Microbiology/ Biotechnology as one of the subjects of study at degree level with not less than 50% marks in aggregate (excluding languages). Those who are awaiting final year B.Sc. results also can apply but will have to fulfill the eligibility criteria before the admission. Eligible relaxation in the percentage of marks will be given to candidates belonging to SC and ST. Reservation policies of the University/State are followed for admission.

Admission Procedure

Admissions are notified in national newspapers inviting applications for the M.Sc programmes of the Department.

All the eligible applicants must appear for a written entrance test. Questions will be of undergraduate level. A rank list will be prepared based on the entrance test. The admission will be as per the rank in the list and reservation policy.

The subjects and their weightages in the Entrance Test for Biotechnology programme shall be as given

below.

Physics	10%
Chemistry	15%
Botany and Zoology	25%
Biotechnology, Microbiology, Biophysics, Biochemistry, Molecular biology etc	50%

MSc Curriculum

Curriculum of the M.Sc. Biotechnology Programmes in the department follow the level and extent as conceived by the National Curricula Development Centers of UGC/ DBT. The Choice Based Credit System (CBCS) provides an opportunity for the students to choose courses from the prescribed courses comprising core and elective courses. The evaluation of the courses will be through Continuous Evaluation and End Semester Examination. Grading system is followed to show the performances of the students in each course and Cumulative Grade Point Average (CGPA) to indicate the overall performance in the programme.

Courses and Credits

There are core courses and elective courses. 'Core Courses' are the courses that a student must successfully complete compulsorily to receive the degree. All the students admitted to a particular programme should study the same set of core courses and any of these courses cannot be substituted by any elective course. 'Elective Courses' are courses that a student can opt from a list of such courses offered by the department. Students should opt elective courses, for 8 credits, from other departments in second and third semester. In addition to the core and elective courses, the students should also successfully complete one Value Added Course offered by the department or one MOOC course from online sources (Swayam Platform or similar platforms). The MOOC course opted by a student should be relevant to the programme and approved by the department council.

Minimum 82 credits are needed for the successful completion of the programme. The detailed course / credit distribution among the semesters are given in the following pages

Project Work

Students have to take up a research project of 5 months duration in the fourth semester for which they are encouraged to go to national research institutes. The students may also get opportunity to undergo 1-2 weeks training in industrial / research institutions in the field of applied biology.

Evaluation

There shall be continuous evaluation (CE) and end semester evaluation (ESE) for each course. The weightages for CE and ESE shall be in the ratio 40:60.

Continuous Evaluation:

Weightages for each component under Continuous Evaluation (CE) of theory courses shall be as given below.

Assignment	Test papers	Seminar	Total
8	16	16	40

The components and their weightages for CE of practical courses shall be as given below

Performance in the lab/ Midsemester tests /viva	Record	Total
30	10	40

End Semester Evaluation:

End Semester Examinations shall be conducted by the Controller of Examinations. Duration of the End Semester Examination shall be 3 hours.

Evaluation of the project work

The continuous evaluation of the project work shall be done by the research supervisor based on the performance of the student in the lab. There shall be a board of examiners consisting of two experts (including one external) for the ESE of the project work. Each candidate has to submit a copy of the Project Report approved by the project supervisor before the last date fixed by the department. The candidate has to present the project before the board of examiners which will be followed by a viva voce. The evaluation shall be based on the dissertation (weightage 20), its presentation (weightage 20) and viva voce (weightage 20).

Attendance:

The minimum attendance required for each course in a semester shall be 60% of the total number of classes conducted for the course. Only those who secure the minimum attendance in the semester will be allowed to register for the End Semester Examination.

Tenure:

A student must complete the entire program within four years from the date of registration

Program Specific Outcomes (PSOs):

On successful completion of the M.Sc. Biotechnology program the students will be able to

PSO1: Explain the organization, structure and functions of living cells and cell organelles.

PSO2: Explain the function of genes, heredity and flow of genetic information, genetic modification.

PSO3: Explain the biosynthesis, structure, function of biological macromolecules, metabolism and flow of energy in living system.

PSO4: Explain the structure, physiology, classification and application of microbes.

PSO5: Apply various biophysical techniques and statistical methods to study the biological system.

PSO6: Apply the principles of bioprocess technology for the large scale production of useful products.

PSO7: Explain the principles and mechanisms of the immune system, immune responses, and how it provides protection from infection.

PSO8: Apply plant and animal cell culture methods and tissue culture methods to improve quality and quantity of crops and other useful products.

Scheme of the programme

SEMESTER I

Credits:- DSC: 16, IDC: 6, Total: 22

Sl. No	Course Code	Title of the course	Contact hours / Week			Weightage			Credits
			L	T/S	P	ESE	CE	Total	
	Discipline Specific Core								
1	MSBTC01DSC01	Biochemistry	3	2		60	40	100	3
2	MSBTC01DSC02	General Microbiology	3	2		60	40	100	3
3	MSBTC01DSC03	Cell Biology	3	2		60	40	100	3
4	MSBTC01DSC04	Genetics	3	2		60	40	100	3
5	MSBTC01DSC05	Biochemistry Practical			2	60	40	100	1
6	MSBTC01DSC06	General Microbiology Practical			2	60	40	100	1
7	MSBTC01DSC07	Cell Biology Practical			2	60	40	100	1
8	MSBTC01DSC08	Genetics Practical			2	60	40	100	1
	Inter Disciplinary Courses (Any 2 can be chosen from the following 3)								
9	MSBTC01IDC01	Biostatistics	3	2		60	40	100	3
10	MSBTC01IDC02	Biophysical techniques	3	2		60	40	100	3
11	MSBTC01IDC03	Mathematics for Biology	3	2		60	40	100	3

SEMESTER II

Credits:- DSC: 8, DSE: 9, AEC: 4, Total: 21

Sl. No.	Course Code	Title of the course	Contact hours/week			Weightage			Credits
			L	T/S	P	ESE	CE	Total	
Discipline Specific Core									
12	MSBTC02DSC09	Intermediary Metabolism	3	2		60	40	100	3
13	MSBTC02DSC10	Molecular Biology	3	2		60	40	100	3
14	MSBTC02DSC11	Intermediary Metabolism Practical			2	60	40	100	1
15	MSBTC02DSC12	Molecular Biology Practical			2	60	40	100	1
Discipline Specific Electives (Any 3 can be chosen from the following 5)									
16	MSBTC02DSE01	Biophysics	3	2		60	40	100	3
17	MSBTC02DSE02	Immunology	3	2		60	40	100	3
18	MSBTC02DSE03	Microbial Diversity and Ecology	3	2		60	40	100	3
19	MSBTC02DSE04	Food Microbiology	3	2		60	40	100	3
20	MSBTC02DSE05	Ethics, Patency and Intellectual Property Rights	3	2		60	40	100	3
Ability Enhancement Course (For students from other departments)									
21	MSBTC02AEC01	Introduction to Biological databases	2	2		60	40	100	2
22	MSBTC02AEC02	Bioethics and Biosafety	2	2		60	40	100	2
		Course offered by other departments	2			60	40	100	2
		Course offered by other departments	2			60	40	100	2
	Value Addition Course (an approved **MOOC** course may be opted instead of Value Addition Course)								
23	MSBTC02VAC01	Science Writing and	2	2		60	40	100	2

		Communication							

The credits earned from the Value Addition Course or MOOC course will not be taken for the computation of CGPA. But, successful completion of the course is necessary for getting the degree.

SEMESTER III

Credits:- DSC: 16, DSE: 3, MDC: 4, Total: 23

Sl. No.	Course Code	Title of the course	Contact hours/week			Weightage			Credits
			L	T/S	P	ESE	CE	Total	
Discipline Specific Core									
24	MSBTC03DSC13	Microbial Technology	3	2		60	40	100	3
25	MSBTC03DSC14	Enzymology	3	2		60	40	100	3
26	MSBTC03DSC15	Cell and Tissue Manipulation	3	2		60	40	100	3
27	MSBTC03DSC16	Recombinant DNA Technology	3	2		60	40	100	3
28	MSBTC03DSC17	Microbial Technology Practical			2	60	40	100	1
29	MSBTC03DSC18	Enzymology Practical			2	60	40	100	1
30	MSBTC03DSC19	Cell and Tissue Manipulation Practical			2	60	40	100	1
31	MSBTC03DSC20	Recombinant DNA technology Practical			2	60	40	100	1
Discipline Specific Electives (Any 1 can be chosen from the following 4)									
32	MSBTC03DSE06	Bioinformatics	3	2		60	40	100	3
33	MSBTC03DSE07	Biotechnology in Medicine, Health, Agriculture and Environment	3	2		60	40	100	3
34	MSBTC03DSE08	Virology, Mycology and Parasitology	3	2		60	40	100	3
35	MSBTC03DSE09	Environmental Microbiology	3	2		60	40	100	3
Multi-Disciplinary Course (For students from other departments)									

36	MSBTC03MDC01	Basics of Biotechnology	4	2		60	40	100	4
		Course offered by other departments	4			60	40	100	4

SEMESTER IV

Credits- 16

Sl. No.	**Course Code**	**Title of the course**	**Contact hours/week**			**Weightage**			**Credits**
			L	T/S	P	ESE	CE	Total	
Discipline Specific Core									
37	MSBTC04DSC21	Research Project		5	25	60	40	100	16

Detailed syllabus of the courses

Semester	Type of Course	Course Code	Name of the Course
I	Core Course	MSBTC01DSC01	BIOCHEMISTRY

Credits			Teaching Hours			Assessment weightage		
L/T	P/I	Total	L/T	P/I	Total	CE	ESE	Total
3	-	3	45	-	45	40	60	100

L/T = Lecture/Tutorials, P/I = Practical/Internship, CE = Continuous Evaluation, ESE = End Semester Evaluation

Course Description

Biochemistry, involves the study of the chemical reactions and composition of living cells, the organization of biomolecules within the cell, and the structure and function of these biological molecules. The biological macromolecules which this course focuses on are proteins, polysaccharides, and nucleic acids and other biologically important molecules. The overall goal of this course is for the student to get a basic idea of biochemical concepts and techniques which will be essential for the future scientific endeavors.

Course Objectives:

- To understand structure and function of biological macromolecules.
- To understand chemical changes taking place in the living cells.
- To understand transport across biological membranes.
- To understand the role of small molecules in the biological system.

Course Outcomes:

At the end of the Course, the Student will be able to -

CO1	Explain the chemical components of living system
CO2	Demonstrate structure of the basic building blocks of life
CO3	Explain the function and dispersal of the basic building blocks of life
CO4	Elucidate the role of small molecules in the biological system

**Course outcomes based on revised Bloom's taxonomy*

Course Contents:

Module	Description	Teaching Hours
Module 1	1.1 Introduction to Biochemistry: Molecular logic of living system, biological macromolecules. 1.2 Membranes: Structure and functions of different membranes and their composition. 1.3 Membrane proteins & transport: Passive transport, co-transport, anti-port, active transport, secondary active transport, pumps and channels and their significance. 1.4 Importance of Biochemistry in contemporary medicine and its perspectives.	**11 hrs**
Module 2	2.1 Carbohydrates: Definition and classification, Structure, conformation and functions of monosaccharides, disaccharides, polysaccharides. Starch, glycogen, dextrin, cellulose. 2.2 Glycoconjugates: Amino sugars, Glycoproteins, Glycolipids, Mucopolysaccharides. 2.3 Lipids: Definition and classification, structure, function, physical and chemical properties – Fatty acids, Fats, Waxes, Phospholipids, Sphingolipids, Cerebrosides, Gangliosides. 2.4 Lipid derivatives: Sterols, lipoproteins. Eicosanoids - Formation of prostaglandins; prostacyclin and thromboxane, Saponification number, acid number and iodine number of fats.	**12 hrs**
Module 3	3.1 Proteins: Properties of peptides and proteins, amino acids, their properties, and different classification. Essential and non-essential amino acids, 3.2 Structure of peptides and proteins: Primary structure, structures of higher order and their meaning for the function of peptides and proteins. Protein - protein interaction. 3.3 Nucleic acids: Definition and classification, bases, nucleosides, nucleotides 3.4 Nucleic acid's structure: Structure of DNA, RN, function, physical and chemical properties, different types of base pairing.	**11 hrs**
Module 4	4.1 Vitamins: chemistry, source, and functions of water soluble and fat-soluble vitamins. Role of vitamins as cofactors. 4.2 Minerals: Source and functions of macro elements and trace elements 4.3 Hormones: Chemistry, synthesis, and functions of various plant & animal hormones 4.4 Molecules of Biological Importance: Pigments (Plant & Animal), pheromones and neurotransmitters	**11 hrs**

Reading Lists:

1. Lehninger's Principle of Biochemistry. Nelson L D and M M Cox.
2. Biochemistry. Jeremy M. Berg John and Tymoczko Lubert Stryer.
3. Biochemistry with Clinical Correlation. Thomas M Devlin. Wiley- Liss
4. Biochemistry. Donald Voet, Judith G Voet, Charlottew pratt. John Wiley
5. Biochemistry. Jeoffrery Zubay. Wm C Brown Pub.
6. Biochemistry. Mathews CK and KE.van Holde. Benjamin Cumming Pub.
7. Biochemistry. Vol 1&2 David Metzler

Teaching Learning Strategies

ICT enabled classes, Assignments and Seminar presentations

Assessment Rubrics

	Weightage
End Semester Evaluation	60%
Continuous Evaluation	40%

Sample questions to test outcomes

1. Explain biological macromolecules and their functions
2. Identify the applications of biochemistry in contemporary medicine and agriculture
3. Classify biological membrane lipids and explain its structure
4. Evaluate clinical relevance of eicosanoids in biological system
5. Discuss the molecular logic of life

Semester	Type of Course	Course Code	Name of the Course
I	Core Course	MSBTC01DSC02	GENERAL MICROBIOLOGY

Credit			Teaching Hours			Assessment weightage		
L/T	P/I	Total	L/T	P/I	Total	CE	ESE	Total
3		3	45		45	40	60	100

Lecture/Tutorials, P/I=Practical/Internship, CE =Continuous Evaluation, ESE = End Semester Evaluation

Course Description

General microbiology is an introductory course that provides comprehensive understanding of the fundamental principle and concepts in microbiology. The course covers various aspects of microorganisms, including their structure, physiology, classification and role in environment. It explores the fascinating world of bacteria, viruses, fungi, parasites and other microorganisms. Highlighting their impact on human health, the environment, and biotechnology

Course Objectives:

- To give an understanding of the fundamental principles of microbiology, including the characteristics of microorganisms, their structure, and function.
- To understand the methods and techniques used to study microorganisms, including microscopy, culturing, and molecular biology techniques.
- To provide an understanding of the roles of microorganisms in human disease, including the pathogenesis of infectious diseases, the basic principles of antimicrobial therapy, and the use of microorganisms in biotechnology.

Course Outcomes:

At the end of the Course, the Student will be able to -

CO1	Explain the characteristics of microorganisms, their structure, and function
CO2	Explain basic operations in a microbiology laboratory and foundational understanding of the principles and applications of microbiology techniques used to study microorganisms
CO3	Assess the role of microorganisms in human health and disease, including the pathogenesis of infectious diseases and the principles of antimicrobial therapy.
CO4	Evaluate the roles of microorganisms in various fields like biotechnology, environmental science and medicine

**Course outcomes based on revised Bloom's taxonomy*

Course Contents:

Module	Description	Teaching Hours
Module 1	1.1 Introduction, scientific development of microbiology, important contribution of scientists. Milestones in the history of Microbiology. 1.2 Introduction to Bacterial, fungal and viral classifications. Bergey's Manual of determinative bacteriology. Laboratory procedures for identification of bacteria. Molecular phylogeny.	**10 hrs**
Module 2	2.1 Microscopy: Bright field, dark field, fluorescent, phase contrast, interference, polarization and electron microscopies. 2.2 Specimen preparation and staining: common stains used in Microbiology, smear preparation, different staining methods. 2.3 Microbial morphology, bacterial anatomy: different bacterial appendages and its structure, function and demonstration 2.4 Bacterial Growth: cell division, generation time, bacterial count, growth curve, nutrition and metabolism of bacteria. Difference between bacterial and fungal cells: Different staining procedures and study of bacterial and fungal morphology. Fungal Reproduction.	**10 hrs**
Module 3	3.1 Sterilization and Disinfection; definitions, methods of sterilization, Physical methods – heats, filtration, radiation etc. Sterilization control. Chemical Methods: definition, principle action of different chemical agents used for disinfection. Testing of disinfectants 3.2 Cultivation of bacteria: Culture media – different types of culture media used for the cultivation of bacteria, its preparation, uses and application in different fields of microbiology. Culture methods; different culture methods and techniques used for the isolation, cultivation of microorganism, aerobic, anaerobic methods. 3.3 Identification of bacteria: conventional methods- morphology of microbial colony, staining, biochemical tests, motility, typing methods. Automated methods in culture and identification of microorganisms, molecular methods microbial typing. 3.4 Storage and transport of microbes: short term preservation methods, long term preservation methods. Methods of transport of microorganisms	**10 hrs**
	4.1 Microbial nutrition and metabolism of bacteria: factors influencing bacterial growth, Photo autotrophy and bacterial photosynthesis.	

Module 4	4.2 Aerobic and anaerobic respiration (fermentation). Genetically Modified Microorganisms 4.3 Methods of testing antimicrobial substances, Drug resistance of microbes. 4.4 Microbial Pathogenicity: types of infection, mode of infection, source of infection, Mechanism of microbial Pathogenicity.	**15 hrs**

Reading Lists:

1. Microbiology: An Introduction" by Gerard J. Tortora, Berdell R. Funke, and Christine L. Case.
2. "Prescott's Microbiology" by Joanne Willey, Linda Sherwood, and Christopher J. Woolverton
3. Brock Biology of Microorganisms" by Michael T. Madigan, Kelly S. Bender, Daniel H. Buckley, W. Matthew Sattley, and David A. Stahl.
4. Microbiology: Principles and Explorations" by Jacquelyn G. Black and Laura J. Black.
5. Principles of Microbiology – Ronald M Atlas
6. Antimicrobial Drug Resistance, Bryan, L E (eds.) Academic Press
7. Microbiology- Bernad D Davis et al, Harper International edition.
8. Microbiology Concepts and Applications Pelzar Jr. Chan. Kreic. McGraw- Hill, Inc. Microbiology.
9. Zinsser Microbiology Prentice- Hall International Inc. Manual of Methods for General Bacteriology. Gerhaldt P et al (eds.) American Society for Microbiology
10. Textbook of Microbiology 9th Edition, Ananthanarayan, Paniker, Universities Press
11. Essentials of Medical Microbiology, Apurba Sankar Sastry. Jaypee Publications.
12. Textbook of Microbiology Prof C P Bhaveja, Arya publications

Teaching Learning Strategies

ICT enabled classes, Assignments and Seminar presentations

Assessment Rubrics

	Weightage
End Semester Evaluation	60%
Continuous Evaluation	40%

Sample questions to test outcomes

1. Define sterilization? (3 marks)
2 Explain bacterial growth curve (5 marks)
3 What is drug resistance? Explain different types of drug resistance mechanisms bacteria? (10 marks)

****

Semester	Type of Course	Course Code	Name of the Course
I	Core Course	MSBTC01DSC03	CELL BIOLOGY

Credit			Teaching Hours			Assessment weightage		
L/T	P/I	Total	L/T	P/I	Total	CE	ESE	Total
3		3	45		45	40	60	100

Lecture/Tutorials, P/I=Practical/Internship, CE =Continuous Evaluation, ESE = End Semester Evaluation

Course Description

The course aims to explore cell biology from a molecular perspective. It will focus on the study of cell's endomembrane systems, organelles, cytoskeletons, cell growth and division, communication and the mechanisms underlying cellular events

Course Objectives:

- Compare prokaryotic and eukaryotic cell types. Explain the components and function of the extra cellular matrix and study the structural and classify cell junctions
- Outline cell communication mechanisms
- Identify different protein sorting and trafficking mechanisms
- Understand DNA replication and repair mechanisms
- Interpret the molecular mechanism in cell cycle

Course Outcomes:

At the end of the Course, the Student will be able to -

CO1	Describe the molecular nature and functioning of the cell components and how they interact with the external environment
CO2	Outline the response of a cell to an external signal and the mechanisms involved.
CO3	Explain the molecular nature of replication of the cell and the consequences arising out of error in replication
CO4	Outline the molecular events and their control in different phases of cell cycle
CO5	Interpret experimental methodology used in for discovery of key concepts in cell biology

**Course outcomes based on revised Bloom's taxonomy*

Course Contents:

Module	Description	Teaching Hours
Module 1	1.1 General organization of prokaryotic and eukaryotic cells. Techniques in cell biology 1.2 Constituents of the Extra-cellular matrix 1.3 Cell junctions: tight junctions, desmosomes and gap junctions, cell coat. Cell- cell adhesion 1.4 Cytoskeleton: microtubules, microfilaments, and intermediate filaments	**8 hrs**
Module 2	2.1 Cell communication: general principles, signaling pathways. 2.2 Cell compartmentalization, Endo¬membrane systems ¬ Endoplasmic Reticulum, Golgi complex, lysosomes, peroxisomes, plant vacuoles 2.3 Processing and trafficking of biomolecules: Vesicular transport, endocytosis, Exocytosis, posttranslational modification of proteins in endoplasmic reticulum and Golgi. 2.4 Sorting, of proteins into mitochondria, chloroplast, lysosomes	**15 hrs**
Module 3	3.1 Nucleus: Nuclear envelope, nuclear matrix, nuclear transport 3.2 Organization of chromatin: nucleosomes, higher order folding of chromatin. Structure of centrioles, structure of mitotic spindle. Nucleolus in ribosome synthesis. 3.3 Replication of prokaryotic, eukaryotic DNA. Enzymes and proteins of replication. 3.4 DNA repair	**15 hrs**
Module 4	4.1 Cell cycle: Phases of cell cycle. Cascade of phosphorylation and dephosphorylation associated with cell cycle progress. 4.2 Kinases, cyclins and related proteins and their role in cell cycle regulation 4.3 Apoptosis intrinsic, extrinsic pathways regulation of apoptosis by Bcl2 and IAP family 4.4 Introduction to Cancer biology	**7 hrs**

Reading Lists:

1. Molecular Cell Biology Gerald Karp ,Janet Iwasa, Wallace Marshall 9th Edition Wiley 2020
2. Molecular Biology of the Cell Alberts 7th Edition 2022 W W Norton
3. Cell Biology Thomas Pollard, William C. Earnshaw, Jennifer Lippincott, Schwartz, Graham Johnson. 3rd Edition 2017 Elsevier.
4. Lewin's Genes XII Jocelyn E Krebs, Elliott S Goldstein Stephen T Kilpatrick 2018 Jones, and Bartlett Learning

Teaching Learning Strategies and Mode of Transaction

- Interactive lectures using audio visual medium**, s**eminars

- Presentation by individual student

Assessment Rubrics

	Weightage
End Semester Evaluation	60%
Continuous Evaluation	40%

Sample Questions to test Outcomes.

1. A major survival pathway inhibits programmed cell death. How will a deviation in this pathway affects the individual? (10 marks x 2 questions)
2. A motor protein moves along a cytoskeletal element. What would be your strategy to trace its movement? (5 marks x 5 questions)
3. What is the function of a cytoplasmic tail in an NPC? (3 Marks x 5 questions)

****

Semester	Type of Course	Course Code	Name of the Course
I	Core Course	MSBTC01DSC04	GENETICS

Credit			Teaching Hours			Assessment weightage		
L/T	P/I	Total	L/T	P/I	Total	CE	ESE	Total
3		3	45		45	40	60	100

Lecture/Tutorials, P/I=Practical/Internship, CE =Continuous Evaluation, ESE = End Semester Evaluation

Course Description

The course "Genetics" was designed to educate the students about the ways in which characters/genes act and how they are inherited; the mechanisms involved in gene expression, sex determination and the ways in which it functions in populations.

Course Objectives:

- Understand the basic principles of genetics and heredity and Mendelian laws of inheritance
- Understand chromosome theory of inheritance, sex determination, linkage and mapping.
- Familiarize with prokaryotic gene transfer methods.
- Understand extra chromosomal inheritance and population genetics

Course Outcomes:

At the end of the Course, the Student will be able to -

CO1	Grasp the concept of inheritance and variation
CO2	Be aware of hereditary carriers, genes and their mode of expression, patterns of expression etc.
CO3	Solve mathematical problems based on the laws of inheritance
CO4	Know the relation between genes and chromosomes and how they are transmitted to offsprings, roles of mitosis and meiosis, the concept of linkage and recombination
CO5	Explain prokaryotic genetics and gene transfer methods
CO6	Interpret extrachromosomal inheritance through cytoplasm and organelles
CO7	Analyze how genes act at population level and factors governing their distribution at the population level.

*Course outcomes based on revised Bloom's taxonomy

Course Content:

Module	Description	Teaching Hours
Module 1	1.1: Mendel and his contribution to Genetics. Monohybrid crosses and principle of segregation. Dihybrid crosses and principle of independent assortment. Rediscovery of Mendel's principles. 1.2: Multiple alleles. Modification of dominance relationships. Gene interactions. Essential and lethal genes. Environmental impact on genes	**11 hrs**
Module 2	2.1: Genetic linkage. Chromosomal exchange. Genetic maps. Tetrad analysis, Mitotic recombination. Chromosomal and gene mutations. Mitosis & Meiosis. 2.2: Chromosome theory of inheritance. Sex determination. Analysis of sex-linked traits in humans. Quantitative Genetics of complex traits, QTL Inheritance of complex traits, polygene hypothesis, mapping QTLs	**11 hrs**
Module 3	3.1: Cellular and genetic basis of differentiation, Gametogenesis and fertilization. Gene expression control - Oncogenes and tumor suppressor genes. 3.2: Conjugation in bacteria. Transformation in bacteria. Transduction in bacteria. Mapping of genes in bacteria. Mapping of genes in bacteriophages.	**11 hrs**
Module 4	4.1: Bacterial transposons. Eukaryotic Transposable elements 4.2: Cytosomic inheritance, Inheritance through mitochondria and chloroplasts and their mapping 4.3: Genetic variation in populations and measuring. Hardy - Weinberg Equilibrium, in-breeding depression & mating systems; population bottlenecks, migrations, adaptive landscape, spatial variation & genetic fitness, neutral evolution; mutation selection, balancing selection, Fishers theorem, linkage disequilibrium. Genetic Drift. Gene flow. Natural selection. Molecular evolution.	**12 hrs**

Reading Lists:

1. Hartl, D. L., & Jones, E. W. (1998). Genetics: Principles and Analysis. Sudbury, MA: Jones and Bartlett. 2. Pierce, B. A. (2005). Genetics: a Conceptual Approach. New York: W.H. Freeman.

3. Tamarin, R. H., & Leavitt, R. W. (1991). Principles of Genetics. Dubuque, IA: Wm. C. Brown. • Smith, J. M. (1998). Evolutionary Genetics. Oxford: Oxford University Press

4. Snustad PD, Simmons MJ. 2015. Principles of Genetics, 7th edition. Wiley.

5. Klug WS, Cummings MR, Spencer CA, Palladino MA, Darrell Killian. 2018. Concepts of Genetics, 12th edition. Pearson.

6. Griffiths AJF, Wessler SR, Carroll SB, Doebley J. 2015. Introduction to Genetic Analysis, 11th edition. W.H. Freeman & Worth Publishers.

7. Pierce BA. 2016. Genetics: A Conceptual Approach 6th edition. W. H. Freeman. 5. Hartwell L, Goldberg ML, Fischer J, Hood L. 2017. Genetics: From Genes to Genomes 6th edition. McGraw-Hill Education.

8. Hartl DL and Jones EW. 2011. Genetics: Analysis of Genes and Genomes, 7th edition. USA: Jones and Barlett Publishers.

9. Strickberger MW. 2015. Genetics, 3rd edition. Pearson.

10. Samuels ML, Witmer JA, Schaffner A. 2015. Statistics for the Life Sciences, 5th edition. Pearson.

11. Brooker R. 2017. Genetics: Analysis and Principles, 5th edition. McGraw-Hill Higher Education

12. Tamarin R, 7th edition. 2017. Principles of Genetics. McGraw Hill Education.

13. Elrod S, Stansfield W. 2010. Schaum's Outline of Genetics, 5th edition. McGraw-Hill Education.10

14.. Hartl DL, Clark AG. 2006. Principles of Population Genetics 4th edition. Sinauer The associate is an imprint of Oxford University Press.

15. Crow JF, Kimura M. 2009. An Introduction to Population Genetics Theory. The Blackburn Press.

16. Hedrick PW. 2010. Genetics of Populations, 4th edition. Jones & Bartlett Learnin Sambamurthy A. V. S. S. Genetics. Narosa Publishing House.

Teaching Learning Strategies and Mode of Transaction

- Interactive lectures using audio visual medium**, s**eminars
- Presentation by individual student

Assessment Rubrics

	Weightage
End Semester Evaluation	60
Continuous Evaluation	40

Sample Questions to test Outcomes.

1. Explain Co- dominance (3 marks)
2. What is scale of dominance (3 marks)
3. Define sex linked and sex limited traits (3 marks)
4. Suppose A Father Of Blood Type B And A Mother Of Blood Type O Have A Child Of Type O. What Are The Chances That Their Next Child Will Be Blood Type O?

Type B? Type A? Type Ab? (5 marks)

5. Increasing ploidy results in larger fruit size. Comment (5 marks)
6. Tetraploids are more fertile than triploids. Why? (5 marks)
7. Explain gene interaction and how it modifies Mendelian ratios. (10 marks)
8. Describe with examples how lethal genes modify the laws of inheritance. (10 marks)
9. Explain the gene expression control mechanisms in prokaryotes (10 marks)

****

Semester	Type of Course	Course Code	Name of the Course
I	**Core Course**	**MSBTC01DSC05**	**BIOCHEMISTRY PRACTICAL**

Credits			Teaching Hours			Assessment weightage		
L/T	P/I	Total	L/T	P/I	Total	CE	ESE	Total
	1	1		30	30	40	60	100

L/T = Lecture/Tutorials, P/I=Practical/Internship, CE =Continuous Evaluation, ESE = End Semester Evaluation

Course Description

This course is designed to achieve practical knowledge about different biomolecules through biochemical techniques and methods.

Course Objectives:

- To understand the method of testing biomolecules from biological samples
- To understand the process of purification of biomolecules from biological samples
- To understand the preparation of biochemical reagents
- To understand the determination of biomolecules from biological samples

Course Outcomes:

At the end of the Course, the Student will be able to -

CO1	Analyze and visualize the qualitative properties of biomolecules
CO2	Explain the chemical properties of biomolecules
CO3	Determine the quantity of biomolecules in a biological sample
CO4	Perform the purification techniques for biomolecules

*****Course outcomes based on revised Bloom's taxonomy

Course Contents:

Module	Description	Teaching Hours
Module	1. Qualitative analysis of carbohydrates. 2. Qualitative analysis of proteins. 3. Qualitative analysis of lipids. 4. Estimation of protein.	**30 hrs**

	5. Estimation of lipids (cholesterol, phospholipids, triacylglycerols). 6. Estimation of carbohydrates (glucose, fructose, lactose, starch). 7. Estimation of lycopene from tomato. 8. Estimation of Urea. 9. Estimation of Uric acid. 10. Extraction and estimation of total lipids from seed. 11. Purification of proteins using dialysis. 12. Separation of amino acids using paper chromatography.	

Reading Lists:

1. David Plummer, An Introduction to Practical Biochemistry, McGraw Hill
2. Harold Varley, Practical Clinical Biochemistry, by Gowenlock A. H., CBS.
3. Hans Bisswanger, Practical Enzymology. Wiley VCH.
4. Robert Eisenthal, Enzyme Assays: A Practical Approach, Oxford University Press
5. Sadasivam & Manickam, Biochemical Methods, New Age International
6. DM Vasudevan & Subir Kumar Das, Practical Textbook of Biochemistry, Jaypee Brothers
7. SK. Sawhney, Randhir Singh, Introductory Practical Biochemistry. Alpha Science International

Teaching Learning Strategies

- Practical session, Internal examinations/Unit tests, Seminar presentations

Mode of Transaction

- Off-line mode, Laboratory work, PowerPoint presentation

Assessment Rubrics

	Weightage
End Semester Evaluation	60%
Continuous Evaluation	40%

Semester	Type of Course	Course Code	Name of the Course
I	Core Course	MSBTC01DSC06	GENERAL MICROBIOLOGY PRACTICAL

Credit			Teaching Hours			Assessment weightage		
L/T	P/I	Total	L/T	P/I	Total	CE	ESE	Total
	1	1		30	30	40	60	100

Lecture/Tutorials, P/I=Practical/Internship, CE =Continuous Evaluation, ESE = End Semester Evaluation

Course Description

This Course is designed to provide students with hands-on experience in the fundamental techniques and procedures used in microbiology. This course complements the theoretical knowledge gained in the Introduction to Microbiology course by offering practical applications of microbiological concepts and principles. The course emphasizes the development of basic laboratory skills, including aseptic techniques, microscopy, culturing and isolation of microorganisms, and the use of various biochemical tests for identification and characterization of microorganisms. Students will also learn about safety precautions and ethical considerations in the laboratory.

Course Objectives:

•To understand the fundamental principles of microbiology, including isolation and identification of microorganisms.

•To understand the methods and techniques used to study microorganisms, including microscopy, culturing, and molecular biology techniques.

•To provide a practical knowledge about the roles of microorganisms in human disease, including the pathogenesis of infectious diseases, the basic principles of antimicrobial therapy, and the use of microorganisms in biotechnology

Course Outcomes:

At the end of the Course, the Student will be able to -

CO1	Cultivation and isolation of microorganisms
CO2	Basic operations in a Microbiology Laboratory and foundational understanding of the Principles and applications of microbiology techniques used to identification of microorganisms, including microscopy, culturing, and molecular biology techniques etc
CO3	Perform antimicrobial sensitivity tests
CO4	Application of microorganisms in various fields like biotechnology, environmental science and medicine

*Course outcomes based on revised Bloom's taxonomy

Course Contents:

Module	Description	Teaching Hours
Module	1. Microscopy- structure and organization of compound microscope 2. Sterilization Techniques 3. Staining: simple, negative, Gram's, capsular, spore, metachromatic Granule, Fungal staining 4. Preparation of media & inoculation, Isolation of organisms from various Environments. 5. Growth curve using breeds count, turbidimetry and CFU 6. Effect of pH, temp, oxygen and salinity on bacterial growth in liquid Media. 7. Anaerobic culturing by liquid paraffin overlay and pyrogallol. 8. Starvation induced sporulation of bacteria. 9. Efficiency testing of bacteria proof filters and autoclave 10. Antibiotic sensitivity tests, Biochemical Tests for identification of bacteria	**30 hrs**

Reading Lists:

1. Techniques in Microbiology: A Student Handbook 1st Edition by John M. Lammert (Author). ISBN-13: 978-0132240116.
2. Handbook of Techniques in Microbiology: A Laboratory Guide to Microbes Paperback – 1 December 2007. by A.S. Karawa (Author), M. K. Rai (Author), H.B.T. Singh (Autho) Scientific Publishers
3. Basic Practical Microbiology- A Manual. Society for General Microbiology (SGM). ISBN 0 95368 383 4. www.microbiologyonline.org.uk
4. Bailey and Scott's Diagnostic Microbiology, Mosby Publications

Teaching Learning Strategies

- Practical session, Internal examinations/Unit tests, Seminar presentations

Mode of Transaction

- Off-line mode, Laboratory work, PowerPoint presentation

Assessment Rubrics

	Weightage
End Semester Evaluation	60%
Continuous Evaluation	40%

****

Semester	Type of Course	Course Code	Name of the Course

I	Core Course	MSBTC01DSC07	CELL BIOLOGY PRACTICAL

Credit			Teaching Hours			Assessment weightage		
L/T	P/I	Total	L/T	P/I	Total	CE	ESE	Total
	1	1		30	30	40	60	100

Lecture/Tutorials, P/I=Practical/Internship, CE =Continuous Evaluation, ESE = End Semester Evaluation

Course Description

Cell Biology practical exercises try to combine theoretical knowledge gained and provide hands on experiments to understand the basic nature of the cell and explore various techniques used to study cellular contents.

Course Objectives:

- To explore mechanisms of cellular biology using techniques and model systems
- Gain experience in data collection and analysis
- Interpretation of results, and experimental design
- Develop scientific writing and representation of data.

Course Outcomes:

At the end of the Course, the Student will be able to -

CO1	Isolate Mitochondria and Chloroplast from cells
CO2	Quantify nucleic acids
CO3	Identify chromosomal aberrations using Karyotyping
CO4	Design histological methodology for differentiating cellular proteins, carbohydrates, and nucleic acids

*Course outcomes based on revised Bloom's taxonomy

Course Contents:

Module	Description	Teaching Hours
Module	1. Cell Fractionation: chloroplast: differential centrifugation. 2. Cell Fractionation: mitochondria: differential centrifugation 3. Estimation of nucleic acid by spectrophotometric method. 4. Estimation of RNA by Orcinol test. 5. Estimation of DNA by Diphenylamine test 6. Determination of melting temperature of DNA 7. Study of Barr Body (Buccal smear).	**30 hrs**

	8. Karyotyping. 9. Study of Cellular Carbohydrates (Periodic Acid- Schiff) 10. Study of Cellular Nucleic Acid (Methyl Green Pyronin) 11. Study of Chromosomal DNA (Feulgen Reaction) 12. Study of Cellular Nucleic Acids and Proteins (Hematoxylin Eosin)	

Reading Lists:

1. Current protocols in Cell biology- March 2019- Wiley
2. Biology I: Introduction to Cell and Molecular Biology Lab Guidebook Alexander N Urquhart and Emily K Meredith Simple Book Publishing (pressbooks.pub) 2022
3. Laboratory investigations in Cell and Molecular Biology (4th Ed) Allyn A Bregman 2002 Wiley
4. Cell Biology A Laboratory Handbook 3rd Edition Elsevier Inc 2006
5. Cell and Molecular Biology Lab Manual David A Thompson 2009

Teaching Learning Strategies

- Laboratory Experiments

Assessment Rubrics

	Weightage
End Semester Evaluation	60
Continuous Evaluation	40

****

Semester	**Type of Course**	**Course Code**	**Name of the Course**

I	**Core Course**	**MSBTC01DSC08**	**GENETICS PRACTICAL**

Credit			**Teaching Hours**			**Assessment weightage**		
L/T	P/I	Total	L/T	P/I	Total	CE	ESE	Total
	1	1		30	30	40	60	100

Lecture/Tutorials, P/I=Practical/Internship, CE =Continuous Evaluation, ESE = End Semester Evaluation

Course Objectives:

- To provide hands on training/ wet lab in basic techniques of genetics

Course Outcomes:

At the end of the Course, the student will be able to -

CO1	Conduct Conjugation, transformation and transduction in bacteria
CO2	Identify cell divisional stages and make squash preparations in Mitosis and Meiosis
CO3	DNA fingerprinting by RFLP
CO4	Isolate plasmid DNA
CO4	Solve mathematical problems based on genetic crosses and progeny data

*Course outcomes based on revised Bloom's taxonomy

Course Contents:

(The laboratory work will consist of any 8 experiments from the following list)

Module	**Description**	**Teaching Hours**
Module	1. Study of mutations by Ames test. 2. Assay of antibiotics and demonstration of antibiotic resistance. 3. Bacterial transformation. 4. Transduction. 5. Conjugation 6. Isolation of plasmids. 7. Mitosis -Cell division stages 8. Meiosis - Cell division stages 9. DNA fingerprinting (RFLP)	**30 hrs**

Reading Lists:

1.Cell and Molecular Biology Lab Manual- David A Thompson 2009.
2. Molecular Cloning- A Laboratory Manual- Sambrook, J., Fritsch, E. F. and Maniatis, T. 1989. Second Edition. Cold Spring Harbor Laboratory Press.
3.Zinsser Microbiology Prentice- Hall International Inc. Manual of Methods for General Bacteriology. Gerhaldt P et al (eds.) American Society for Microbiology.
4.Hayes, W., 1994. Genetics of Bacteria and their viruses. 2nd Edn, CBS Publishers and Distributors, New Delhi
5.Methods in Molecular Biology Vol. 28. Protocols for Nucleic acid analysis by non - radioactive probes. Edited by Issac P. G. Human Press.

Teaching Learning Strategies

- Laboratory Experiments

Assessment Rubrics

	Weightage
End Semester Evaluation	60
Continuous Evaluation	40

****

Semester	**Type of Course**	**Course Code**	**Name of the Course**

I	**Elective Course**	**MSBTC01IDC01**	**BIOSTATISTICS**

Credits			**Teaching Hours**			**Assessment weightage**		
L/T	P/I	Total	L/T	P/I	Total	CE	ESE	Total
3	-	3	45	-	45	40	60	100

L/T = Lecture/Tutorials, P/I = Practical/Internship, CE = Continuous Evaluation, ESE = End Semester Evaluation

Course Description

The course 'Biostatistics' provides an introduction to the fundamental concepts and methods of statistical analysis in biology, which are essential for analyzing and interpreting data in the field of life sciences. Students will gain a solid foundation in statistical techniques used to design studies, collect data, and draw meaningful conclusions in various life science research settings. The course will also emphasis on applying biostatistical methods to real-world biological problems and critically evaluating scientific literature. By the end of this course, students will have a strong understanding of the key concepts and tools in biostatistics, enabling them to analyze and interpret data in life science research, and make evidence-based decisions in healthcare and public health settings.

Course Objectives:

- To understand data collection, data types and data presentations.
- To understand the concepts of averages and dispersion of measurement values.
- To understand the concept of probability and probability distributions.
- To understand the method of testing statistical hypotheses.

Course Outcomes:

At the end of the Course, the Student will be able to -

CO1	Differentiate between different sampling techniques
CO2	Make graphical/diagrammatic representation of given statistical data.
CO3	Calculate measures of central tendencies and measures of dispersion of a given data
CO4	Interpret the data by conducting correlation and regression and correlation analysis
CO5	Explain different probability distributions
CO6	Test hypothesis using normal, student's t, chi square and F distributions.

*Course outcomes based on revised Bloom's taxonomy

Course Contents:

Module	Description	Teaching Hours
Module 1	1.1 Collection, classification and diagrammatic representation of statistical data: Variables and constants, Different types of numerical data. 1.2 Collection of data, sampling techniques: Random sampling, Stratified random sampling. 1.3 Classification and tabulation of data, frequency distribution. 1.4 Graphical/diagrammatic representation of data: line charts, Bar charts, Pie-chart, Histograms, frequency polygons, ogives.	**11 hrs**
Module 2	2.1 Measures of central tendency: Arithmetic mean, Median, Mode, Geometric and Harmonic mean. 2.2 Measures of dispersion: Range, Inter-quartile range, Variance and Standard Deviation, coefficient of variation. 2.3 Correlation and Regression: Relation between two variables, scatter diagram, definition of correlations, Pearson's correlation coefficient, Spearman Rank correlation coefficient. 2.4 Definition of regression: regression lines. Fitting lines using the method of least squares.	**13 hrs**
Module 3	3.1 Probability: Permutation and combination, types of events, Definition of probability, addition and multiplication theorems of probability. 3.2 Probability distributions: Binomial, Poisson and Normal distributions. 3.3 Skewness and Kurtosis: Definitions, Karl Pearson's coefficients of Skewness and Kurtosis, moments.	**10 hrs**
Module 4	4.1 Normal distribution and statistical inference: Central Limit Theorem, Concept of confidence interval: Estimation, confidence limit, level of significance, standard error. 4.2 Statistical hypotheses: Tests of significance of means, difference between two means and proportion. Student's t-distribution and testing of hypothesis for small samples. 4.3 Chi-square distribution, Chi-squared tests for independence and for goodness of fit, F-distribution and Analysis of variance.	**11 hrs**

Reading Lists:

1. Principles of Biostatistics -Pagano M. & Kimberlee G. Duxbury Press
2. Probability and Statistical Inference-Hogg R. V. Tanis E. A., Prentice Hall, New Jersey

3. Experimental Design Data Analysis for Biologists-Quinn G. P. & Keough M. J. Cambridge University7 Press
4. Statistical Methods in Biology -3rdedition, Bailey N.T.J., Cambridge University Press
5. Biostatistical analysis -4th edition, Zar, J.H. Pearson Education.
6. Fundamentals of Biostatistics –P. Hanmanth Rao and K. Janardhan, I.K. International Publishing House, New Delhi.
7. Introduction to Biostatistics and Research Methods-P.S.S. Sundar Rao and J. Richard, PHI learning Pvt Ltd, New Delhi.

Teaching Learning Strategies

- ICT enabled classes, Assignments and Seminar presentations

Mode of Transaction

- Off-line mode, Black Board and Chalk

Assessment Rubrics

	Weightage
End Semester Evaluation	60%
Continuous Evaluation	40%

****

Semester	Type of Course	Course Code	Name of the Course
I	**Elective Course**	**MSBTC01IDC02**	**BIOPHYSICAL TECHNIQUES**

Credit			Teaching Hours			Assessment weightage		
L/T	P/I	Total	L/T	P/I	Total	CE	ESE	Total
3		3	45		45	40	60	100

Lecture/Tutorials, P/I=Practical/Internship, CE =Continuous Evaluation, ESE = End Semester Evaluation

Course Description

The course "Biophysical Techniques" was designed to deliver the basic principles and applications of some of the essential laboratory techniques used in the field of Biology. It will give the students a foundation for learning other courses in the programme.

Course Objectives:

- Understand basic principles of biomolecular separation techniques.
- Understand basic principles of spectroscopic and crystallographic techniques for characterization of biological molecules.
- Understand basic principles and applications of histochemical and immunotechniques.
- Understand basic principles and applications of radioactivity based analytical techniques.
- Understand basic principles some analytical techniques to study the intermolecular interactions

Course Outcomes:

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

CO1	Explain working principles and applications of biomolecular separation techniques such as chromatography, electrophoresis.
CO2	Explain the working principle and applications of centrifugation and density gradient sedimentation.
CO3	Explain the principles of UV, visible, IR, ORD, CD, NMR, Mass spectroscopy
CO4	Explain the principle and applications of x-ray crystallography
CO5	Explain histochemical and immunotechniques such as ELISA
CO6	Explain fluorescent techniques such as FRET and FISH
CO7	Explain the principle and applications of techniques such as autoradiography, RIA, SPR, ITC and DSC

*****Course outcomes based on revised Bloom's taxonomy

Course Contents:

Module	Description	Teaching Hours
Module 1	1.1: Chromatography: Partition coefficient, relative mobility, retention time. Basic principles and applications of chromatographic techniques such as paper, TLC, size exclusion, ion exchange, affinity, GLC, HPLC and HPTLC. Types of columns. 1.2: Electrophoresis: Basic principles and application. types of electrophoresis, PAGE, SDS-PAGE, Isoelectric focusing, 2D Gel Electrophoresis, Capillary electrophoresis, PFGE 1.3: Basic principles and applications of centrifugation and density gradient sedimentation: RCF, sedimentation coefficient.	**11 hrs**
Module 2	2.1: Colorimetry and spectrophotometry: Absorption and emission spectrum, Beer-Lambert law. 2.2: ORD, CD, UV/visible, IR, Raman and NMR spectroscopies. 2.3: Mass spectrometry and its applications: different methods of ionization and its detection. 2.4: Single crystal X-ray crystallography: basic principles, crystallization techniques, data collection and structure solution.	**13 hrs**
Module 3	3.1: Histochemical and immune techniques: Antibody generation, detection of molecules using ELISA, western blot, immunoprecipitation. Patch clamp techniques. 3.2: Fluorescence and fluorometry, FRET, BRET, Immunofluorescence microscopy, in situ localization by techniques such as FISH and GISH. Flow cytometry.	**10 hrs**
Module 4	4.1: Radioactive decay, radioisotopes normally used in biology. 4.2: Basic principle of Geiger-Muller and scintillation counters. 4.3: Radiotracer techniques, Radioimmunoassay. Autoradiography. 4.4: Surface Plasmon Resonance spectroscopy. 4.5: Isothermal Titration Calorimetry. 4.6: Differential Scanning Calorimetry.	**11 hrs**

Reading Lists:

1. Physical Biochemistry: Principles and Applications, 2nd Edition- David Sheehan, 2013, Wiley
2. Principles and Techniques of Biophysics, N. Arumugam and V. Kumaresan, Saras Publication
3. Practical Techniques in Molecular Biotechnology, Bal Ram Singh and Raj Kumar, (2022), Cambridge University Press
4. Fundamentals Of Molecular Spectroscopy, P.S. Sindhu, (2011) New Age International Publishers
5. Spectroscopy for the Biological Sciences, Gordon G. Hammes (2005), Wiley

Teaching Learning Strategies

- ICT enabled classes, Assignments and Seminar presentations

Assessment Rubrics

	Weightage
End Semester Evaluation	60%
Continuous Evaluation	40%

Sample Questions:

1. Compare applications of paper chromatography with TLC. (3 marks)
2. What physical properties of molecules determine the speed and direction of their movement in gel electrophoresis? (3 marks)
3. What are the factors that affect the separation of molecules during centrifugation? (3 marks)
4. Explain the differences observed in EI and CI mass spectra. (5 marks)
5. You have been given a mixture of two proteins with the same molecular weight but different pI values. Propose a chromatographic method to separate the proteins and explain the principle. (5 marks)
6. UV-Visible spectra of solutions tend to consist of a few broad peaks while the IR spectra of the same solutions give sharp peaks. Explain. (5 marks)
7. Discuss the applications fluorescence spectroscopy in the study of protein folding? (10 marks)
8. Explain the technique of radioimmunoassay. List its advantages and disadvantages when compared to ELISA. (10 marks)
9. Discuss on the applications of chromatography in qualitative and quantitative analysis. (10 marks)

Semester	**Type of Course**	**Course Code**	**Name of the Course**

I	**Elective Course**	**MSBTC01IDC03**	**MATHEMATICS FOR BIOLOGY**

Credit			**Teaching Hours**			**Assessment weightage**		
L/T	P/I	Total	L/T	P/I	Total	CE	ESE	Total
3		3	45		45	40	60	100

Lecture/Tutorials, P/I=Practical/Internship, CE =Continuous Evaluation, ESE = End Semester Evaluation

Course Description

The course "Mathematics for Biology" is designed to provide students with a solid foundation in mathematical concepts relevant to the field of biology. The course aims to enable students to apply mathematical reasoning and problem-solving skills to biological phenomena and systems. The course will equip the students with basics mathematical concepts that help them to critically analyze biological problems through mathematics and develop mathematical models to describe biological phenomena.

Course Objectives:

- To understand the basics concepts in mathematics
- To introduce basic algebra and calculus
- To understand the concept of vector algebra
- To introduce integral transforms and numerical analysis in applied mathematics

Course Outcomes:

At the end of the course, the student will be able to

CO1	Explain coordinate systems, set theory, functions, limits, continuity and derivatives
CO2	Explain and demonstrate the application of derivatives, integrals and differential equations
CO3	Explain and demonstrate the use of scalars, vectors and matrices
CO4	Explain different numerical methods and integral transforms

**Course outcomes based on revised Bloom's taxonomy*

Course Contents:

Module	**Description**	**Teaching Hours**
Module 1	1.1 Cartesian and polar coordinate systems: Equations of standard objects in plane and space – line, circle, plane, sphere; equations of rays and circles in polar forms.	**10 hrs**

	1.2 Basics of Set theory, combinatorics and Functions: Set theory - sets, elements, operations between sets, finite and countable sets. 1.3 Combinatorics- factorials, permutations and combinations, binomial coefficients. 1.4 Functions- domain and range of functions, plotting of functions; types of functions – linear, polynomial, exponential, logarithmic, trigonometric functions; basic properties and operations on functions, inverse of a function. 1.5 Calculus - concept of limit and continuity, evaluation of limits of polynomials and rational functions, continuous functions, the intermediate value theorem.	
Module 2	2.1 Derivatives of functions: basic concept of derivatives- definition and examples of derivatives, derivatives of standard functions; applications of derivatives - derivative as rate of change of quantities - the velocity, graphical treatment of derivative - the slope of a curve, local/global maxima and minima of functions, mean value theorem for derivatives. 2.2 Integrals of functions**:** definite and indefinite integrals– definition, graphical treatment of integrals – area under a curve, integration of standard functions, rules of integration including integration by parts. 2.3 Differential equations: first order differential equations- solution of differential equations, variable separable method, linear differential equations, applications of differential equations in biology; second order linear differential equations linear, homogeneous differential equations with constant coefficients, their solution using auxiliary equations.	**11 hrs**
Module 3	3.1 Vector Algebra: introduction to scalars and vectors – scalars and vectors, vector addition and scalar multiplication, magnitude and direction of a vector, unit vector, vector representation in cartesian coordinates; product of vectors and vector valued functions - dot product and cross product of vectors, vector and scalar triple products, scalar valued and vector valued functions. 3.2 Matrix algebra: basic concepts of matrices - definition of matrices, types of matrices, matrix operations - matrix addition, subtraction, scalar multiplications, matrix multiplication, transpose and inverse (an overview); matrices as linear transformations - system of simultaneous linear equations, matrix representations of linear systems, solution of homogeneous and non-homogeneous systems of linear equations, eigenvalues and eigenvectors of a matrix and their properties.	**12 hrs**
	4.1 Numerical methods: solution of nonlinear equations- Newton’s method for solving equations of the form f(x)=0; numerical differentiation and integration-numerical differentiation, numerical integration– Trapezoidal and	

Module 4	Simpson's rules; numerical solution of Ordinary Differential Equations- Euler method for solving first order ordinary differential equations, Runge Kutta method (second order only) 4.2 Laplace and Fourier Transforms: Laplace transforms–definition, Laplace transforms of elementary functions, properties of Laplace transforms, existence of Laplace transform- sufficient conditions, convolution of Laplace transforms, inverse Laplace transforms of simple functions (basic functions only); Fourier series- Fourier Series representation of functions at continuous points.	**12 hrs**

Reading Lists:

1. Advanced Engineering Mathematics: Erwin Kreyszig 10 edn. Wiley
2. Higher Engineering Mathematics: 42 Edn, B. S. Grewal, Khanna Publishers
3. A Textbook of Engineering Mathematics Paperback – 10th edition by N.P. Bali Thomas' Calculus, 14th Edition, Pearson by George B. Thomas and Joel Hass

Teaching Learning Strategies

- ICT enabled classes, Quizzes, Assignments and Seminar presentations

Assessment Rubrics

	Weightage
End Semester Evaluation	60%
Continuous Evaluation	40%

Sample questions to test outcomes:

1. Solve the simultaneous linear equations:$2x+ 3y= 8$, $3x+ 2y= 7$ (3 Marks)
2. Find the global minima of the function $f(x)=x^2- 4x$ in the interval [0,5] (3 Marks)
3. Use the rules of differentiation to find the derivative of each of the following:

   (i)$y=3x^5$ (ii) $y=14x^2$ (iii) $f(x)=60$ (5 Marks)

4. A square has vertices (1,1), (-1,1), (-1,-1), (1,-1). Find the linear transformation,
   a. which shift the square to 3 points to left and 2 points above.
   b. which rotate the square anticlockwise into an angle of 90 degrees. (5 Marks)
5. Solve the following integral

$$\int_1^5 \frac{1}{x-7} dx$$

using Simpson's rule with 10 subintervals. (10 Marks)

****

Semester	Type of Course	Course Code	Name of the Course
II	**Core Course**	**MSBTC02DSC09**	**INTERMEDIARY METABOLISM**

Credits			Teaching Hours			Assessment weightage		
L/T	P/I	Total	L/T	P/I	Total	CE	ESE	Total
3	-	3	45	-	45	40	60	100

L/T = Lecture/Tutorials, P/I = Practical/Internship, CE = Continuous Evaluation, ESE = End Semester Evaluation

Course Description

Upon completion of this course, students will be able to explain and demonstrate how the chemical reactions in the metabolic pathways drive various biological processes in cells and organisms, and how alteration in these pathways lead to biological impairment.

Course Objectives:

- To understand metabolic pathways and energy production in cells
- To understand electron transport chains and energy storage in living system
- To understand metabolisms of different nutrient molecules
- To understand the production of complex macromolecule

Course Outcomes:

At the end of the Course, the Student will be able to -

CO1	Explain the metabolic pathways present in the living organism
CO2	Demonstrate alteration in the metabolic pathways lead to biological impairment
CO3	Explain the function and dispersal of different metabolites in an organism
CO4	Elucidate the role metabolic enzymes in the living system

Course Contents:

Module	Description	Teaching Hours
Module 1	1.1 Bio-energetic principle, activated carriers in metabolism and importance of ATP and phosphorylation 1.2 Digestion and absorption of carbohydrate, breakdown of polysaccharides & oligosaccharides. Glycolysis, glycogenolysis,	**14 hrs**

	entry of other carbohydrates into glycolytic sequences, fermentation, citric acid cycle, glyoxylate cycle, Regulation of catabolic pathways. 1.3 Glycogenesis, gluconeogenesis, disaccharide biosynthesis, pentose phosphate pathway, role of nucleoside biphosphate sugars in carbohydrate biosynthesis and in sugar inter-conversion. Metabolism of storage and structural polysaccharides bacterial and animal coats Regulation of catabolic pathways. 1.4 Mitochondrial and photosynthetic electron transport. Reducing equivalents, High energy molecules	
Module 2	2.1 Digestion and absorption lipids, oxidation of fatty acids and conjugate lipids 2.2 Biosynthesis and elongation of fatty acids 2.3 Biosynthesis and conversion of cholesterol to steroid hormones, Metabolism of ketone bodies. 2.4 Photosynthetic CO2 fixation, Rubisco	**10 hrs**
Module 3	3.1 Digestion and absorption of protein. Protein degradation, role of Ubiquitin, transamination, oxidative deamination, urea cycle 3.2 Biosynthesis of individual amino acids 3.3 Degradation of individual amino acids 3.4 One carbon metabolism: THF, SAM, other one carbon carriers, enzymes, and regulation of amino acid metabolism.	**10 hrs**
Module 4	4.1 Function of nucleotides, sugar nucleotide complexes 4.2 Purine ribonucleotide metabolism; denovo synthesis (purines and pyrimidines) and its regulation, salvage pathway, inter conversion of purine and pyrimidine ribonucleotides, 4.3 Catabolism of purine and pyrimidine nucleotides, deoxy ribonucleotides, regulation deoxy nucleotide metabolism 4.4 Biosynthesis of nucleotide coenzymes. Integration of metabolism	**11 hrs**

Reading Lists:

1. Lehninger's Principle of Biochemistry. Nelson L D and M M Cox.
2. Biochemistry. Jeremy M. Berg John and Tymoczko Lubert Stryer.
3. Biochemistry with Clinical Correlation. Thomas M Devlin. Wiley- Liss
4. Biochemistry. Donald Voet, Judith G Voet, Charlottew pratt. John Wiley
5. Biochemistry. Jeoffrery Zubay. Wm C Brown Pub.
6. Biochemistry. Mathews CK and KE.van Holde. Benjamin Cumming Pub.
7. Biochemistry. Vol 1&2 David Metzler

Teaching Learning Strategies

- ICT enabled classes, Assignments and Seminar presentations

Assessment Rubrics

	Weightage
End Semester Evaluation	60%

Continuous Evaluation	40%

Sample questions to test outcomes

1. Evaluate metabolic fates of cholesterol in animals
2. Illustrate the functioning of SAM in one carbon metabolism
3. Explore mechanism of action of ribonucleotide reductase
4. Estimate the amount of NADH produced during TCA cycle
5. Discuss the role of kinase enzymes in glycolytic pathway

****

Semester	Type of Course	Course Code	Name of the Course
II	Core Course	MSBTC02DSC10	MOLECULAR BIOLOGY

Credit			Teaching Hours			Assessment weightage		
L/T	P/I	Total	L/T	P/I	Total	CE	ESE	Total
3		3	45		45	40	60	100

Lecture/Tutorials, P/I=Practical/Internship, CE =Continuous Evaluation, ESE = End Semester Evaluation

Course Description

The course “Molecular Biology” was designed to educate the students about the mechanisms involved in gene expression of prokaryotes and eukaryotes; roles played by DNA, RNA, ribosomes and polymerases; how gene expression is regulated and how it can be measured.

Course Objectives:

- Understand the organization of the genome.
- Familiarize with cellular processes like transcription and translation
- Study the methods to measure the level of expression of RNA and protein.
- Understand regulation of gene expression

Course Outcomes:

At the end of the Course, the Student will be able to -

CO1	Grasp the concept of gene expression via transcription and translation
CO2	Be aware of roles played by DNA, RNA, Polymerases, promoters, enzymes and organelles in gene expression of prokaryotes and eukaryotes
CO3	Explain differences in the prokaryotic and eukaryotic gene expression processes
CO4	Describe protein synthetic process; genetic code, transcription
CO5	Elaborate on gene regulation processes and controls in prokatyotic and eukaryotic systems
CO6	Analyze gene expression and measure it using different techniques

*Course Outcomes based on revised blooms taxonomy

Course Content:

Module	Description	Teaching Hours
Module 1	1.1: The genome: Content, Mapping (Linkage, Restriction cleavage, Sequencing), Variations, Repetitive and Non-repetitive sequences 1.2: Organalle DNA –Mitochondrial and Chloroplast. 1.3: Genome sequences and Gene numbers 1.4: Transcription in Prokaryotes -Biosynthesis of RNA, Enzymatic machinery, Promoter selection and role of RNA Polymerase and ancillary factors.	**12 hrs**
Module 2	2.1: Transcription in eukaryotes: RNA polymerases, Eukaryotic promoter structure, enhancer elements and transcription factors, transcriptionally active chromatin, biosynthesis of ribosomal, transfer and messenger RNAs. Post transcriptional modifications 2.2: Antibiotic inhibitors of transcription. 2.3: Gene silencing	**12 hrs**
Module 3	3.1: Genetic code and gene protein relationships, nonsense and mis sense mutations and suppressers, 3.2: Ribosome structure (prokaryotic and eukaryotic), mRNA struc ture, polycistronic v/s monocistronic 3.3: Specificity of aminoacyl tRNA synthetases, polypeptide chain elongation and termination, factors of protein synthesis (pro & eukaryotic) and their role. 3.4: Inhibitors of protein synthesis and their mechanism of action, translational regulation 3.5: Post-translational modification, biosynthesis of secretory proteins	**12 hrs**
Module 4	4.1: Regulation of gene expression, bacterial operons (lac, gal, ara, trp, hut, etc 4.2: Viral models (T4 and T7), stringent and relaxed control of gene expression 4.3: Regulation in eukaryotes, chromatin activity and gene regulation 4.4: Isolation methods for eukaryotic mRNA 4.5: Identification of translation products (flurography, western blot ting 4.6: Genome sequencing – chemical 4.7: An overview of next generation sequencing techniques	**12 hrs**

Reading Lists:

1. Benjamin Lewin, Gene IX, 9th Edition, Jones and Barlett Publishers, 2007
2. J.D. Watson, N.H. Hopkins, J.W. Roberts, J.A. Seitz & A.M. Weiner; Molecular Biology of the Gene, 6th Edition, Benjamin Cummings Publishing Company Inc, 2007
3. Alberts et al; Molecular Biology of the Cell, 4th edition, Garland, 2002.
4. David E Bruns, Edward R Ashwood, & Carl A Burtis; Fundamentals of Molecular Diagnostics, Saunders/Elsevier 2007
5. Lela Buckingham and Maribeth Flaws; Molecular Diagnostics: Fundamentals, Methods,

& Clinical Applications; F. A. Davis Company 2009.
6. James D. Watson, Tania A. Baker, Stephen P. Bell & Alexander Gann 2013. Molecular Biology of the Gene. 7th Edition,
7. Benjamin Cummings, San Francisco, California, USA. 8. Burton E. Tropp 2012. Molecular Biology: Genes to Proteins. 4th Edition,
8. Jones & Bartlett, Burlington, USA. 9. Jocelyn E. Krebs, Elliott S. Goldstein & Stephen T. Kilpatrick 2012. 9. Lewin's GENES XI. Jones & Bartlett, Burlington, USA.
9. Robert F. Weaver 2011. Molecular Biology 5th Edition, McGraw-Hill, NY, USA.
10. Michael M. Cox, Jennifer Doudna & Michael O'Donnell 2011.
11. Molecular Biology: Principles and Practice. W. H. Freeman, NY, USA. 12.
12. Nancy Craig, Orna Cohen-Fix, Rachel Green and Carol Greider 2010. Molecular Biology: Principles of Genome Function. Oxford University Press, USA.
13. Lodish, H., Baltimore, D. Berk, A., Zipursky, S. L. Matsudaira, P. and Darnell. J. 1995 molecular Cell Biology, 3rd ed, WH.Freeman & Co.
14. Stent, G. S. and Calender, R. Molecular Genetics 1986. An Introductive Narrative, CBS Publishers and Distributors, New Delhi.

Teaching Learning Strategies

- Assignments, Internal examinations/Unit tests, Seminar presentations

Mode of Transaction

- Off-line mode, Black Board and Chalk, PowerPoint presentation

Assessment Rubrics

	Weightage
End Semester Evaluation	60%
Continuous Evaluation	40%

****

Semester	Type of Course	Course Code	Name of the Course
II	**Core Course**	**MSBTC02DSC11**	**INTEREMEDIARY METABOLISM PRACTICAL**

Credits			Teaching Hours			Assessment weightage		
L/T	P/I	Total	L/T	P/I	Total	CE	ESE	Total
	1	1		30	30	40	60	100

L/T = Lecture/Tutorials, P/I=Practical/Internship, CE =Continuous Evaluation, ESE = End Semester Evaluation

Course Description

This course is designed to achieve practical knowledge in metabolic pathways and enzymatic reactions taking place in different metabolic pathways and its output.

Course Objectives:

- To understand the method of testing metabolic intermediates from biological samples
- To understand the process of biochemical reactions taking place in metabolic pathways
- To understand the preparation of enzymes and substates for biochemical reactions
- To understand the determination of activity of biomolecules in biological samples

Course Outcomes:

At the end of the Course, the Student will be able to -

CO1	Analyze and visualize the qualitative properties of metabolic intermediates
CO2	Explain the chemical properties of metabolic intermediates
CO3	Determine the quantity of a metabolic intermediates in a biological sample
CO4	Explain activity of metabolic intermediates in a biological sample

Course Contents:

Module	Description	Teaching Hours
Module	1. Estimation of SGOT and SGPT 2. Estimation of ALP & ACP 3. Estimation of creatinine 4. Estimation of GGT 5. Estimation of glutathione peroxidase 6. Estimation of Bilirubin 7. Quantitative analysis of Amino acids	**30 hrs**

	8. Determination of SOD & Catalase activity 9. Isolation and estimation of protein 10. C and N terminal analysis of peptide 11. Enzymatic estimation of glucose in blood 12. Quantitative estimation of Sodium, Potassium and Calcium 13. Estimation of ascorbic acid in lemon juice.	

Reading Lists:

1. David Plummer, An Introduction to Practical Biochemistry, McGraw Hill
2. Harold Varley, Practical Clinical Biochemistry, by Gowenlock A. H., CBS.
3. Hans Bisswanger, Practical Enzymology. Wiley VCH.
4. Robert Eisenthal, Enzyme Assays: A Practical Approach, Oxford University Press
5. Sadasivam & Manickam, Biochemical Methods, New Age International
6. DM Vasudevan & Subir Kumar Das, Practical Textbook of Biochemistry, Jaypee Brothers
7. SK. Sawhney, Randhir Singh, Introductory Practical Biochemistry. Alpha Science International

Teaching Learning Strategies

- Practical session, Internal examinations/Unit tests, Seminar presentations

Mode of Transaction

- Off-line mode, Laboratory work, PowerPoint presentation

Assessment Rubrics

	Weightage
End Semester Evaluation	60%
Continuous Evaluation	40%

****

Semester	Type of Course	Course Code	Name of the Course
II	Core Course	MSBTC02DSC12	MOLECULAR BIOLOGY PRACTICAL

Credit			Teaching Hours			Assessment weightage		
L/T	P/I	Total	L/T	P/I	Total	CE	ESE	Total
	1	1		30	30	40	60	100

L/T=Lecture/Tutorials, P/I=Practical/Internship, CE =Continuous Evaluation, ESE = End Semester Evaluation

Course Description

The laboratory-based course in "Molecular Biology" combines the theoretical knowledge gained to provide hands-on training in the subject

Course Objectives:

- To provide hands-on training / wet lab in molecular biology.

Course Outcomes:

At the end of the Course, the student will be able to -

CO1	Isolate DNA from plant, animal and prokaryotic organisms
CO2	Quantify nucleic acids by agarose electrophoresis
CO3	Determine the concentration of nucleic acids using a biophotometer
CO4	Isolate RNA from different sources and quantify it
CO5	Quantify gene expression using Real – Time PCR
CO6	Familiarize with RFLP and AFLP techniques for DNA fingerprinting
CO7	Protein electrophoresis and visualisation

Course Contents:

(The laboratory work will consist of any 8 -10 experiments from the following list)

Module	Description	Teaching

		Hours
Module 1	1. Genomic DNA isolation by CTAB method from plant tissues 2. Isolation of bacterial genomic DNA. 3. Molecular weight determination of DNA by Agarose gel electrophoresis 4. Restriction fragment analysis of DNA. 5. Plasmid DNA isolation. 6. Estimation of DNA concentration by Spectrophotometric method. 7. Estimation of RNA concentration by Spectrophotometric method. 8. Lac induction by X-Gal method. 9. RNA isolation 10. Gel electrophoresis to see the isolated RNA. 11. Quantification of DNA/RNA 12. RFLP 13. AFLP 14. Protein electrophoresis (SDS) poly acrylamide electrophoresis and visualization	**30 hrs**

Reading Lists:

1. Molecular Cloning- A Laboratory Manual - Sambrook, J., Fritsch, E. F. and Maniatis, T. 1989, Second Edition. Cold Spring Harbor Laboratory Press
2. Cell and Molecular Biology Lab Manual David A Thompson 2009.
3. Methods in Molecular Biology Vol. 28. Protocols for Nucleic acid analysis by non - radioactive probes. Edited by Issac P. G. Human Press
4. Ausubel, F. M. et al. (2002) Short protocols in Molecular Biology. Vol. 1, 2
5. John Wiley & Sons. Wilson, J. & Hunt, T. (2007) Molecular Biology of the Cell - Problems Book: 5th Edition. Garland Science.
6. Lodish, H. (2007). Students Solutions Manual for Molecular Cell Biology. W. H. Freeman Co. Innis, M. A., Gelfand, D. H. & Sninsky, J. J. (1999). PCR Applications: Protocols for functional Genomics. Academic Press.
7. Mitra, S. (1996) Genetic Engineering. Macmillan India Ltd. Reed, R. et al
8. Old, R. W., Primrose, S. B., & Twyman, R. M. (Latest edition). Principles of Gene Manipulation: an Introduction to Genetic Engineering. Oxford: Blackwell Scientific Publications. •
9. Molecular Cloning: A laboratory manual- Sambrook and Russell. Vol I,II, and III CSHL
10. Green, M. R., & Sambrook, J. (2012). Molecular Cloning: a Laboratory Manual. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.
11. Brown, T. A. (2006). Genomes (3rd ed.). New York: Garland Science Pub.
12. DNA cloning: A practical approach- D.M Glover and B,D, Hames • Molecular biotechnology- Glick and Pasternak

****

Semester	Type of Course	Course Code	Name of the Course

II	**Elective Course**	**MSBTC02DSE01**	**BIOPHYSICS**

Credit			**Teaching Hours**			**Assessment weightage**		
L/T	P/I	Total	L/T	P/I	Total	CE	ESE	Total
3		3	45		45	40	60	100

Lecture/Tutorials, P/I=Practical/Internship, CE =Continuous Evaluation, ESE = End Semester Evaluation

Course Description

Biophysics deals with the application of physics to biological systems. This course provides brief description of biophysical properties, thermodynamics and kinetics relevant to biological system. It also deals with structure and interactions of biological macromolecules like protein and nucleic acids.

Course Objectives:

- Understand important biophysical properties.
- Understand the basic thermodynamics of living systems.
- Understand the structure and conformation of biological macromolecules.
- Understand inter-molecular interactions involving biological molecules.

Course Outcomes:

At the end of the Course, the Student will be able to -

CO1	Explain the principles of biophysical properties like diffusion, osmosis, dialysis, surface tension and adsorption
CO2	Explain the basic principles of thermodynamics and kinetics of the chemical reactions in the living system.
CO3	Explain the structure and conformation of proteins
CO4	Explain the structure and conformation of DNA and t-RNA
CO5	Explain different forces that stabilize molecular structures
CO6	Explain the principle of protein folding
CO7	Explain theories of Receptor-ligand interactions

Course Contents:

Module	**Description**	**Teaching**

		Hours
Module 1	Principles of Biophysical chemistry: 1.1: Diffusion: Fick's law and diffusion, Gibbs-Donnan equilibrium. Diffusion across biological membranes. 1.2: Osmosis: Osmotic pressure, Van't Hoff's laws. 1.3: Dialysis: Diffusion dialysis and electrodialysis, hemodialysis. 1.4: Surface tension: Cohesive and adhesive forces, thermodynamic theories of surface tension, surfactant. 1.5: Adsorption: types of adsorption, adsorption isotherms, adsorbents.	**11 hrs**
Module 2	2.1: Thermodynamics of biological system: open, closed and isolated systems, Laws of thermodynamics, Enthalpy, Entropy and Free energy, exothermic and endothermic reactions, Equilibrium and non-equilibrium thermodynamics 2.2: Overview of light dependent reactions (Z-scheme), production of ATP, high energy phosphate compounds, coupled reactions. 2.3: Rate, order and molecularity of a reaction,activation energy and role of enzymes in a reaction.	**11 hrs**
Module 3	3.1: Structure of globular proteins: primary, secondary, tertiary and quaternary structure, preferred main chain torsion angles and Ramachandran plot. 3.2: Motifs and domains in proteins: H-L-H, Zn-finger and Leucine zipper motifs. Different protein folds (each with one example): All alpha helix, all β sheet, α / β and α+β folds. 3.3: Structure of membrane proteins. 3.4: Nucleic acid structure: DNA double helix, forces stabilizing DNA structure, preferred sugar conformations. Non-conventional DNA structures: Holliday junction, Triple helices and quadruplexes. DNA supercoiling. 3.5: t-RNA structure.	**12 hrs**
Module 4	4.1: Forces stabilizing macromolecular structures: Dipole-dipole, ion-dipole interactions, ionic bonds, Hydrogen bonds, Van der Waals, Hydrophobic and hydrophilic interactions. 4.2: Protein folding: Anfinsen's experiments, Levinthal paradox	**11 hrs**

	and free energy funnel, folding intermediates, molten globular structures, folding accessory proteins. Thermodynamics of protein folding, driving forces. 4.3: Receptor-ligand interactions: theories of receptor activation, agonists and antagonists, affinity and efficacy, dose-response relationship	

Reading Lists:

1. Biophysical chemistry (9th Ed) - Gurtu, 2015, Pragati Prakasan
2. Biological thermodynamics (2nd Ed)- Donald T. Haynie, 2013, Cambridge University Press,Cambridge.
3. Biophysics (2nd Ed) - Vasantha Pattabhi and N. Gautham, 2009, Alpha Science International Ltd.
4. Essentials of Biophysics - P. Narayanan, 2005, New Age International publishers
5. Introduction to Protein Structure - C. Branden and I. Tooz. , 2012, Garland Science
6. Principles of Protein Structure - G.E.Schulz & R.H.Schirmer, Springer
7. Principles of Nucleic Acid Structure - W. Saenger, Springer
8. Protein Folding (2nd Ed) - B. Noelting, 2005, Springer
9. Structure and Mechanism in Protein Science - Alan Fersht, 2017, World Scientific

Teaching Learning Strategies

- ICT enabled classes, Assignments and Seminar presentations

Assessment Rubrics

	Weightage
End Semester Evaluation	60%
Continuous Evaluation	40%

Sample Questions:

1. Prove that the value of state variables depends only on the current state of the system and not the path of the system.
2. Compare reversible and irreversible processes.
3. Explain Gibbs free energy and spontaneity of a process.
4. Discuss the importance of high energy phosphate compounds.
5. Establish that the entropy of the universe always increases.
6. Explain the role of a catalyst in a chemical reaction.
7. Compare osmosis and dialysis.
8. How was the double helical structure of DNA established experimentally?
9. What are anticodons? mark the anticodon in the cloverleaf model of t-RNA.
10. Why is the peptide bond planar?
11. Compare parallel and antiparallel beta sheets.
12. Detergents are used to isolate membrane proteins. Why?

13. Explain the significance of periodic repetition of a leucine residue at every 7th position in leucine zipper motif.

****

Semester	Type of Course	Course Code	Name of the Course
II	**Elective Course**	**MSBTC02DSE02**	**IMMUNOLOGY**

Credit			Teaching Hours			Assessment weightage		
L/T	P/I	Total	L/T	P/I	Total	CE	ESE	Total
3		3	45		45	40	60	100

Lecture/Tutorials, P/I=Practical/Internship, CE =Continuous Evaluation, ESE = End Semester Evaluation

Course Description

This course will give an advanced understanding of the principles and mechanisms of the immune system, immune responses, and how it provides protection from infection. It will also outline the detrimental effects of the immune system. Additionally, the various methodology employed in immunology will be looked upon.

Course Objectives:

- Identify the characteristics of the cell types and organs of the immune system
- Highlight the fundamental characteristics of antigens and antibodies, types of antibodies and how antibodies are formed.
- Learn about the types and function of the immune system
- Describe the concepts of hypersensitivity, auto immunity and transplantation.
- Explain immune deficiencies and other clinical conditions
- Familiarize the application of different immunological techniques

Course Outcomes:

At the end of the Course, the Student will be able to -

CO1	Classify different types of cells, organs of the immune system
CO2	Classify types of antigens, antibodies, and explain how different types of antibodies are produced.
CO3	Outline the key mechanisms involved in innate and adaptive immunity.
CO4	Explain the origin of undesirable immunological reactions and their complications.

CO5	Interpret experimental methodology used in for discovery of key concepts in Immunology
CO6	Apply the theoretical know-how gained for the interpretation of the origin of clinical conditions in immune deficiencies and infectious diseases

*Course Outcomes based on revised blooms taxonomy

Course Contents:

Module	Description	Teaching Hours
Module 1	1.1 History of the Immune system, Cells of the Immune system. 1.2 Innate immune mechanisms, PRR, PAMP, Phagocytosis, inflammatory response 1.3 Pathways of complement activation, regulation, and functions of complement. 1.4 Adaptive immunity: Properties of immunogens and antigens. Pathways of antigen processing and presentation	**10 hrs**
Module 2	2.1 Primary and secondary lymphoid organs, structure, and cellular organization. 2.2 Structure of immunoglobulins. Antigen binding site of antibody. Receptors, co-receptors on B cells and T cells 2.3 Generation of receptor diversity in B and T cells. 2.4 B cell development, activation, differentiation, Types of B cells, Function of B cells, memory B cells	**13 hrs**
Module 3	3.1 T cell development, activation, differentiation types of T cells, their functions, memory T cells. 3.2 Signal transduction in B&T cell. Role of cytokines. Humoral and cytotoxic response, MHC complex and MHC restriction 3.3 Introduction to Immunology of infectious diseases, Hypersensitivity, and immunology of transplantation, 3.4 Primary immune-deficiencies, autoimmunity, immune suppression, tolerance. Tumor immunology. Role of NK cells in tumor and viral infections	**13 hrs**
Module 4	4.1 Factors governing immunogenicity, haptens and its applications, epitopes, adjuvants. 4.2 Principle and applications of Antigen - antibody interactions. Agglutination, immunodiffusion, immunoelectrophoresis, immunofluorescence, RIA and ELISA and assays for cell mediated immunity 4.3 Monoclonal Antibodies, Vaccines 4.4 Assays for Apoptosis	**9 hrs**

Reading Lists:

1. Immunology Kuby 2019 Eighth Edition| Jenni Punt; Sharon Stanford; Patricia Jones; Judy Owen Macmillan Learning
2. Immunobiology Janeway 2022 10th Edition W.W.Norton & Co Inc

3. Essential Immunology. Roitt 2017 13th Edition. Wiley Blackwell
4. Cellular and Molecular Immunology Abbas et al., 10th Edition 2021 Elsevier

Teaching Learning Strategies

- Interactive lectures using audio visual medium
- Seminars
- Presentation by individual student

Assessment Rubrics

	Weightage
End Semester Evaluation	60%
Continuous Evaluation	40%

Sample Questions to test Outcomes.

1. Describe the process involved in the removal of an antigen (10 Marks x 2 questions)
2. How does an NK cell differentiate between a normal cell and a tumor or infected cell (5 marks x 5 questions)
3. Differentiate between Affinity and avidity (3 Marks x 5 questions)

****

Semester	Type of Course	Course Code	Name of the Course
II	**Elective Course**	**MSBTC02DSE03**	**MICROBIAL DIVERSITY AND ECOLOGY**

Credits			Teaching Hours			Assessment weightage		
L/T	P/I	Total	L/T	P/I	Total	CE	ESE	Total
3	-	3	45	-	45	40	60	100

Course Description

Microbial diversity and Ecology program deals with the study of microorganisms, including bacteria, archaea, fungi, viruses, and other microscopic organisms, found in a particular environment. These microorganisms are present in nearly every habitat on Earth, including soil, water, air, and even within the bodies of plants, animals, and humans. Microbial diversity is incredibly vast, with estimates suggesting that the majority of Earth's biodiversity is composed of microorganisms. The program also deals with the study of the interactions between microorganisms and their environment, as well as the relationships they have with other organisms. It explores how microorganisms' function, adapt, and respond to their surroundings and how they influence the overall ecosystem.

Course Objectives:

- To study the concepts of microbial diversity and ecology
- To study the diversity of microorganisms in various environments.
- To learn the interactions of microbial communities in the environment.
- To learn about natural and engineered microbial communities

Course Outcomes:

At the end of the Course, the Student will be able to -

CO1	Explain and demonstrate the concept of microbial diversity and ecoogy
CO2	Evaluate the techniques used to identify and enumerate microbial communities
CO3	To evaluate the interactions of microbial communities within the environment
CO4	To learn the natural and engineered microbial communities and their interactions.

Course Content:

Module	Description	Teaching Hours

Module 1	1.1 Microbial Ecology, Diversity, and Evolution The evolution of life on Earth and the role of microorganisms and bioenergetics. 1.2 Ecology of macro- and microorganisms: definitions, terminology, concepts 1.3 Individuals and populations: productivity, growth, distribution, activity 1.4 Communities: colonization, succession, diversity, structure Microbial functions in ecosystems	**10hrs**
Module 2	2.1 Habitat characterization 2.2 Characterization of microbial communities: culture-based methods, biomarkers, cell stains 2.3 Characterization of microbial communities using different techniques. 2.4 PCR, real-time PCR, molecular fingerprints FISH, sequencing, pyrosequencing	**10hrs**
Module 3	3.1 Interactions of microorganisms with their physical and chemical environment 3.2 Microbial guilds and biogeochemical cycles, Interactions with the biotic environment: symbiosis, competition, parasitism, predation Interactions within microbial communities: quorum sensing, syntrophy, antibiotics 3.3 Interactions of microorganisms with algae and plants 3.4 Interactions of microorganisms with animals and humans, human microbiome.	**13hrs**
Module 4	4.1 Terrestrial ecosystems: rocks and soil, prairie, forest, tundra 4.2 Extreme environments: deserts, hot springs, glaciers, deep subsurface, mine drainage 4.3 Landfills, wastewater treatment reactors, bioremediation. Culture collections, agricultural systems, aquaculture 4.4 Synthetic communities and applied microbial ecology	**12hrs**

Reading Lists:

1. Microbial Diversity: Form and Function in Prokaryotes: Oladele Ogunseitan, October 2004, Blackwell Science Ltd
2. Microbial Diversity and Ecology in Hotspots: Aparna Gunjal, Sonali Shinde, November 25, 2021, Academic Press
3. Microbial Diversity: Current Perspectives and Potential:T. Satyanarayana & B.N. Johri, 2005 IK International Pvt Ltd.
4. Microbial Ecology: Larry L. Barton, Diana E. Northup, September 2011 Wiley-Blackwell.
5. Microbial Ecology: An Evolutionary Approach, J McArthur 2006 Academic Press

Teaching Learning Strategies

- Assignments, Internal examinations/Unit tests, Seminar presentations

Mode of Transaction

- Off-line mode, Black Board and Chalk, PowerPoint presentation

Assessment Rubrics

	Weightage
End Semester Evaluation	60%
Continuous Evaluation	40%

****

Semester	Type of Course	Course Code	Name of the Course
II	Elective Course	MSBTC02DSE04	FOOD MICROBIOLOGY

Credits			Teaching Hours			Assessment weightage		
L/T	P/I	Total	L/T	P/I	Total	CE	ESE	Total
3	-	3	45	-	45	40	60	100

L/T = Lecture/Tutorials, P/I=Practical/Internship, CE =Continuous Evaluation, ESE = End Semester Evaluation

Course Description

The aim of the course is to provide a comprehensive overview of the field of food microbiology, which includes issues related to food safety, preservation and food production. In particular, the course provides an overview of microbial ecophysiology, identification and control of food microorganisms, and the spread of spoilage and pathogenic microorganisms of plant and animal foods. Finally, the course provides an overview of the most important fermented foods.

Course Objectives:

- To give a general knowledge on various factors affecting microbial spoilage of food.
- To give detailed information on various strategies that can be adopted for preservation of food.
- To give detailed knowledge on various microbial derived food products.
- To give detailed information on regulatory mechanisms in maintaining quality of food.

Course Outcomes:

At the end of the Course, the Student will be able to -

CO1	Acquire knowledge in the type and analysis of microbial communities and loads in food beverages.
CO2	Analyze types of food poisoning microorganisms that are present in the food and beverages.
CO3	Formulate strategies for preservation of food and beverages.
CO4	Identify the concepts of quality checking in food industry.

Course Contents:

Module	Description	Teaching Hours
	1.1 Factors which influence microbial growth, survival and death in foods, spores and their significance 1.2 Indicator microorganisms and microbiological criteria.	

Module 1	1.3 Microbial spoilage of foods 1.4 Factors affecting food spoilage at different levels– intrinsic and extrinsic factors	**13hrs**
Module 2	2.1 Spoilage of meat, poultry and sea foods, milk and dairy products, fruits, vegetables and grains. 2.2 Preservation methods and preservatives: 2.3 Physical methods of preservation, chemical preservatives and natural antimicrobial compounds, biologically based preservation system. 2.4 Problems associated with preservatives.	**10hrs**
Module 3	3.1 Food fermentations: fermented dairy products, 3.2 Fermented vegetables, fermented meat, poultry and fish products, 3.3 Traditional fermented foods, cocoa and coffee, beer and wine. 3.4 Probiotics and prebiotics	**12hrs**
Module 4	4.1 Food borne pathogens: Food poisoning, intoxications like botulism and aflatoxins. 4.2 Food hygiene and control. Single Cell Protein. 4.3 HACCP. Molecular techniques in food microbiology. 4.4 Food security, food safety and GM foods	**10hrs**

Reading Lists:

1. Food microbiology–Adams MR and Moss MO
2. Food Microbiology–Frazier WC and Westhoff
3. Food Microbiology (2nd Ed)–Doyle et al.
4. Basic food microbiology –Banwart GJ
5. Dairy Microbiology–RobinsonRK
6. Valorization of Food Processing By- Products, Fermented Foods and Beverages Series, (Ed)M Chandrasekaran CRC Press

Teaching Learning Strategies

- Assignments, Internal examinations/Unit tests, Seminar presentations

Mode of Transaction

- Off-line mode, Black Board and Chalk, PowerPoint presentation

Assessment Rubrics

	Weightage
End Semester Evaluation	60%
Continuous Evaluation	40%

****

Semester	Type of Course	Course Code	Name of the Course
II	**Elective Course**	**MSBTC02DSE05**	**ETHICS, PATENCY AND INTELLECTUAL PROPERTY RIGHTS**

Credit			Teaching Hours			Assessment weightage		
L/T	P/I	Total	L/T	P/I	Total	CE	ESE	Total
3		3	45		45	40	60	100

Lecture/Tutorials, P/I=Practical/Internship, CE =Continuous Evaluation, ESE = End Semester Evaluation

Course Description

The course Ethics, Patency and Intellectual Property Rights was designed to offer the students, to explain the importance of life forms, problems associated with the genetic alteration of life forms, the various types of intellectual property rights, importance of biosafety and the different levels of biosafety.

Course Objectives:

- To explicate how precious each life form is and the risks associated with altering the genetic makeup of an organism.
- To explain the ethical issues in biological research.
- To figure out India's IPR policy and the patent system in India.
- To interpret the importance of maintaining the biosafety measures

Course Outcomes:

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

CO1	To explicate the importance of individual life forms.
CO2	To point out the ethical issues associated with biological research.
CO3	To illustrate the patents and patent procedures in India.
CO4	To figure out the biosafety levels.

Course Contents:

Module	Description	Teaching Hours

Module 1	1.1: Introduction to Bioethics 1.2: Ethical aspects of interfering in the natural process, Ethical issues associated with ART, Prenatal diagnosis, Bioethics in animal cloning, Ethical issues associated with stem cell research, Ethical issues with the use of animal models. 1.3: Ethics in human research- The Nuremberg code, The declaration of Helsinki, The Belmont report. 1.4: Ethical issues of transgenesis, Ethical issues related to GMOs.	**8 hrs**
Module 2	2.1: Patent, Types of patents, product patent and process patent. 2.2: General requirement of Patent law, Patent offices, Procedure to get a patent in India. claims, types of claims. 2.3: Harmonization of Patent laws, international treaties on IPR, GATT, TRIPS, Strasbourg convention, UPOV convention. 2.4: Transfer of Technology. 2.5: Biopiracy, Bioterrorism	**14 hrs**
Module 3	3.1: Patentability of microorganism, characterization and repeatability, Deposition of Culture collection, Budapest treaty, IDAs, 3.2: Diamond V. Chakrabarty case, Dimminaco A.G.V. Controller of Patents and Designs case 3.3: Patentability of transgenic animals, Onco mouse, Harvard college V. Canada (Commissioner of Patents) case.	**14 hrs**
Module 4	4.1: Biosafety, Definition, Objectives, Biological Containment (BC) and Physical Containment (PC) 4.2: Biosafety levels, Biosafety level Ⅰ, Biosafety level Ⅱ, Biosafety level Ⅲ, Biosafety level Ⅳ. The containment laboratory design and facilities. 4.3: Institutional biosafety committee (IBSC). Guidelines for rDNA research.	**9 hrs**

Reading Lists:

1. Bioethics for Scientist by John Bryant, Linda Baggott La Velle and John Searle, John Wiley & Sons Ltd, 2002.
2. Contemporary Issues in Bioethics by Tom L. Beauchamp & LeRoy Walters, 5th Edition.
3. Bioscience Ethics by Irina Pollard published in USA by Cambridge University Press, New York. (2009).
4. Intellectual Property Rights under Globalization by Talwar Sabanna, Serials publications, New Delhi.
5. Intellectual property law by tina hart, linda fazzani & simon clark. (4th Edition), palgrave macmillan.
6. Agriculture and Intellectual Property Rights by V Santaniello, R E Evenson, D Zilberman and G A Carlson. University Press.
7. Intellectual Property by W R Cornish. (3rd Edition). Universal press.
8. Intellectual Property Law by Lionel Bently and Brad Sherman. Oxford, University press.
9. Intellectual Property Rights in Agricultural Biotechnology by F H Erbisch, K M Maredia. University press.

Teaching Learning Strategies

- Assignments, Internal examinations/Unit tests, Seminar presentations

Mode of Transaction

- Off-line mode, Black Board and Chalk, PowerPoint presentation

Assessment Rubrics

	Weightage
End Semester Evaluation	60%
Continuous Evaluation	40%

Sample Questions:

1. Biosafety cabinets? (3 marks)
2. Genetic make-up? (3 marks)
3. What is t-PA? (3 marks)
4. Write a short note on Process patent? (5 marks)
5. Describe the ethical issues behind stem cell biology? (5 marks)
6. Describe the term risk assessment? (5 marks)
7. Patentability of microorganism. Discuss? (10 marks)
8. Write a note on international treaties on IPR? (10 marks)
9. Explain about the guidelines for r DNA research? (10 marks)

****

Semester	Type of Course	Course Code	Name of the Course
III	**Core Course**	**MSBTC03DSC13**	**MICROBIAL TECHNOLOGY**

Credit			Teaching Hours			Assessment weightage		
L/T	P/I	Total	L/T	P/I	Total	CE	ESE	Total
3		3	45		45	40	60	100

Lecture/Tutorials, P/I=Practical/Internship, CE =Continuous Evaluation, ESE = End Semester Evaluation

Course Description

The course Microbial Technology was designed to offer the students, to explain the importance of microbial bioprocess for the commercial production of metabolites and biomass.

Course Objectives:

- To impart knowledge on the importance of microbial bioprocess for the commercial production of metabolites and biomass.
- To explain the operation of different types of bioreactors.
- To explicate upstream and downstream processing.
- To illustrate the various applications of microbial technology.

Course Outcomes:
At the end of the Course, the Student will be able to -

CO1	To explicate the relevance of strain improvements of commercially important microorganisms.
CO2	To illustrate the production of fermented food items.
CO3	To formulate the bioprocess media for the commercial production of microbial metabolites.
CO4	To explain Bioremediation.

Course Contents:

Module	Description	Teaching Hours
Module 1	1.1: Introduction to fermentation process 1.2: Isolation, screening and preservation of industrially important microbes.	**7 hrs**

	1.3: The improvement of industrially important microorganisms with special reference to primary and secondary metabolites production.	
Module 2	2.1: Bioreactors – Design, Types. 2.2: Bioprocess control instrumentations, Devices for monitoring variables such as temperature, aeration, agitation, pressure and pH. 2.3: Biosensors in bioprocess monitoring. 2.4: Bioprocess media, formulation and sterilization of media, Agro- Industry byproducts as bioprocess media. 2.5: Upstream and Downstream processing.	**15 hrs**
Module 3	3.1: Kinetics of fermentation process, Mass transfer and Heat transfer. 3.2: Scale up of bioprocess. 3.3: Solid state fermentation and its applications.	**15 hrs**
Module 4	4.1: Microbial production of Amino acids, Polysaccharides, Antibiotics, Vaccines and Enzymes. 4.2: Biopesticides, Biofertilizers. 4.3: Bioremediation, Industrial wastewater treatment, aerobic and anaerobic systems.	**8 hrs**

Reading Lists:

1. Principles of Fermentation Technology by Peter F Stanbury, A. Whittaker, S.J. Hall.
2. Fermentation Microbiology and Biotechnology by E.M.T. El-Mansi, C.F.A Bryce, A.L. Demain, A.R. Allman (2nd Edition).
3. Bioprocess engineering Principles Pauline M Doran.
4. Biotechnology – The Science and the Business by V. Moses & R.E. Capes.
5. Comprehensive Biotechnology by Murray Mono Young.
6. Biological fundamentals- Biotechnology by H.J. Rehm and G. Reed.
7. Fundamentals of Biotechnology by Paul Prave etal.
8. Industrial Microbiology by Prescott and Dunns.

Teaching Learning Strategies

- Assignments, Internal examinations/Unit tests, Seminar presentations

Mode of Transaction

- Off-line mode, Black Board and Chalk, PowerPoint presentation

Assessment Rubrics

	Weightage
End Semester Evaluation	60%
Continuous Evaluation	40%

Sample Questions:

1. Biosensor? (3 marks)
2. Impellers? (3 marks)
3. Fermentation? (3 marks)
4. Write a short note on Heat transfer? (5 marks)
5.Write a note on Downstream processing? (5 marks)
6. What are the important parts of a fermenter? (5 marks)
7.Explain about the different methods for strain improvement? (10 marks)
8. Write a note on Solid state fermentation? (10 marks)
9.Write an essay on Industrial waste water management? (10 marks)

****

Semester	Type of Course	Course Code	Name of the Course
III	**Core Course**	**MSBTC03DSC14**	**ENZYMOLOGY**

Credit			Teaching Hours			Assessment weightage		
L/T	P/I	Total	L/T	P/I	Total	CE	ESE	Total
3		3	45		45	40	60	100

Lecture/Tutorials, P/I=Practical/Internship, CE =Continuous Evaluation, ESE = End Semester Evaluation

Course Description

At the end of this course, students will gain knowledge about structure/activity relationships and its implications in enzyme mechanisms. They will also be capable of isolating and characterizing enzymes, know, and apply enzyme kinetics concepts, and know how to construct enzyme inhibitors. Students will also acquire skills to initiate a research or industrial career in food, pharmaceutics, or biotechnology.

Course Objectives:

- To understand the nomenclature, methods of isolation and purification, activity, and uses of enzymes.
- To understand the structure and function of enzymes.
- To understand enzyme kinetics and kinetic parameters
- To understand the mechanism of enzyme inhibition

Course Outcomes:

At the end of the Course, the student will be able to -

CO1	Explain the methods of isolation and purification, measurement of activity and uses of enzymes.
CO2	Explain the structure and function of enzymes.
CO3	Explain the kinetics of enzyme-substrate interactions.
CO4	Explain the mechanism of enzyme inhibition

Course Contents:

Module	Module contents	Teaching Hours
Module 1	1.1 Basic definitions and nomenclature (EC recommended and classical) 1.2 Enzyme isolation and purification, measurement of enzyme activity, specific activity, molar activity (turnover number),	**08 hrs**

	criteria for purity 1.3 Coenzymes. Synthetic enzymes, abzymes, isoenzymes and ribozymes. 1.4 Use of enzymes in medicine and industry. Immobilized enzymes.	
Module 2	2.1 Enzyme structure and function: folding of the polypeptide chain, active site and its location, binding site. 2.2 Allosteric enzymes: Subunit Interactions, regulation of enzyme activity, Jacob, and Monod model of allosteric enzymes, Koshland model 2.3 Detailed discussion using haemoglobin, ATPase (Effects of ATP and CTP) as examples 2.4 K class and V class allosteric enzymes. Structure and their function in metabolism	**11 hrs**
Module 3	3.1 Enzyme kinetics: Single substrate – single intermediate, Michaelis – Menten and Briggs – Haldane kinetics 3.2 Graphical analysis of kinetic data, progress curves, linear plots 3.3 Determination of Vmax and Km – experimental aspects 3.4 Importance of Km and Vmax	**13 hrs**
Module 4	1.1 Enzyme inhibition: Mechanisms and rate studies, degree of inhibition, competitive, non-competitive, and uncompetitive inhibition, activation 1.2 Graphical analysis (primary and secondary kinetic plots), 1.3 Two substrate reactions, sequential and Ping–Pong mechanisms, nature of rate equations, examples. Irreversible inhibition 1.4 Alteration of Km and Vmax in various types of inhibition. Feedback inhibition	**13 hrs**

Reading Lists:

1. Enzymes: Biochemistry, Biotechnology, Clinical Chemistry, Trevor Palmer, Philip L.R. Bonner, 2008
2. Fundamentals of Enzymology: The Cell and Molecular Biology of Catalytic Proteins, Nicholas C. Price and Lewis Stevens, 1999
3. Essentials of Enzymology, Colby Smith, 2020
4. Fundamentals of Enzymology, Jo Phillips, **Ed:** 1st, 2020
5. Essentials of Enzymology, Rufus O. Okotore, 2015
6. Enzyme Kinetics- Bowden and Wharton
7. Immobilised Enzymes- Trevan
8. Handbook of Enzyme Technology- Alan Weisman- 3 rd ed Prentice- Hall
9. Enzyme Technology- Chapline and Bucke – Cambridge University Press
10. Biochemistry – Donald Voet & Judith Voet 1995. John Wiley and Sons, In

Teaching Learning Strategies

- ICT enabled classes, Assignments and Seminar presentations

Assessment Rubrics

	Weightage

End Semester Evaluation	60%
Continuous Evaluation	40%

Sample questions to test outcomes

1. Describe the equations of enzyme kinetics
2. Discuss the methods used in enzyme kinetics
3. Evaluate kinetics of enzyme-substrate interactions
4. Illustrate different types of enzyme inhibition
5. Explore the mechanism of action of ribonucleotide reductase
6. Discuss the methods of isolation and purification

****

Semester	Type of Course	Course Code	Name of the Course
III	**Core Course**	**MSBTC03DSC15**	**CELL AND TISSUE MANIPULATION**

Credit			Teaching Hours			Assessment weightage		
L/T	P/I	Total	L/T	P/I	Total	CE	ESE	Total
3		3	45		45	40	60	100

Lecture/Tutorials, P/I=Practical/Internship, CE =Continuous Evaluation, ESE = End Semester Evaluation

Course Description

The course "Cell and tissue Manipulation" was designed to expose the students about the concepts and practices in culturing of plant and animal cells, tissues and organs, the different culture conditions, pathways of regeneration and applications involved.

Course Objectives:

- Understand the principles and familiarize the practices and methodology of plant tissue culture
- Familiarize with protoplast culture methods.
- Understand the principles and practices in plant genetic transformation.
- Learn the principles and methods of animal tissue culture.

Course Outcomes:

At the end of the Course, the Student will be able to -

CO1	Learn the principle and methods of plant tissue culture: Media preparation, aseptic practices and maintenance.
CO2	Familiarize with the different pathways of regeneration, explants used and conditions of tissue culture
CO3	Learn the concept and technique of protoplast culture and plant genetic transformation
CO4	Learn the principle and methods of animal tissue culture: Viability conditions, aseptic practices, growth factors and methods of scale up.
CO5	Learn the techniques of animal embryo culture manipulation and cloning

*Course Outcomes based on revised blooms taxonomy

Course Content:

Module	Description	Teaching Hours
Module 1	1.1: Plant tissue culture: Laboratory requirements and general techniques. Tissue culture media, growth regulators and	**12 hrs**

	control of growth and differentiation of plant cells in culture 1.2: Hormone habituation and growth of cells in suspension 1.3: Pathways of plant regeneration, factors controlling regeneration 1.4: Organogenesis, root - shoot transformation in vitro 1.5: Induction, development and maturation of somatic embryogenesis 1.6: Haploid production from plant tissues 1.7: Triploid production 1.8: Embryo culture and embryo rescue	
Module 2	2.1: Principles and commercial practices of plant micro propagation, in vitro phenomena in mass propagation like genetic instability, vitrification, browning and contamination 2.2: Germplasm conservation: Slow growth, syn seeds and cryopreservation, and DNA banks, genetic stability assessment, disease indexing and eradication	**12 hrs**
Module 3	3.1: Isolation, purification and viability factors affecting protoplasts. Protoplast culture, culture conditions, culture media. Introduction to protoplast fusion. Techniques of protoplast fusion. Enzymes involved in cell wall digestion. 3.2: Factors affecting protoplast fusion and fate of products of protoplast fusion. Symmetric and asymmetric hybrids, cybrids 3.3: Plant genetic transformation: Concepts, gene constructs, selection systems, transformation methods – agrobacterium mediated, biolistics	**12 hrs**
Module 4	4.1: Animal cell culture: Conditions of viability of animal cells in culture. Growth factors of animal cells in culture 4.2: Production of hybridomas and monoclonal antibodies. Cloning of hybrid cells. 4.3: Biology and characterization of cultured cells, Parameters of growth, Scaling up of animal cell culture, animal cell transformation 4.4: Cell culture- applications -vaccines. 4.5: Organ and histotypic cultures, 3-D culture 4.6: Apoptosis, measurement of cell death 4.6: In vitro fertilization and culture of animal embryos; cryopreservation of embryos; embryo transfer technology 4.7: Transgenic manipulation of animal embryos 4.8: Animal cloning - basic concept, cloning for conservation of endangered species	**12 hrs**

Reading Lists:

1. Razdan, M. K. (2003). Introduction to Plant Tissue Culture. Enfield, NH: Science.

2. Bhojwani, S. S. and Razdan, M. K. 2004. Plant Tissue culture: Theory and Practice.

Elsevier.
3. Ian Freshney 2010 Culture of Animal Cells- A manuel of basic techniques and specialized applications; Wiley Inc.
4. Pörtner, R. (2007). Animal Cell Biotechnology: Methods and Protocols. Totowa, NJ: Humana Press
5. Doods, J.H. and Roberts, L.W. 1985. Experiments in Plant Tissue culture, Cambridge University Press.
6. George, E.F. 1993-96. Plant propagation by Tissue culture-2 vols. Exegetics Ltd.
7. Narayanaswamy, S. 1994. Plant cell and Tissue culture. Tata McGraw Hill Ltd.
8. Bhojwani, S.S. (1990.), Plant Tissue Culture: Application and Limitations. Amsterdam, Elsevier,
9. Butler M (2003) Animal Cell Culture Technology
10. John M Davis (2011) Animal Cell Culture : Essential Methods

Teaching Learning Strategies

- Assignments, Internal examinations/Unit tests, Seminar presentations

Mode of Transaction

- Off-line mode, Black Board and Chalk, PowerPoint presentation

Assessment Rubrics

	Weightage
End Semester Evaluation	60%
Continuous Evaluation	40%

****

Semester	Type of Course	Course Code	Name of the Course
III	Core Course	MSBTC03DSC16	RECOMBINANT DNA TECHNOLOGY

Credit			Teaching Hours			Assessment weightage		
L/T	P/I	Total	L/T	P/I	Total	CE	ESE	Total
3		3	45		45	40	60	100

Lecture/Tutorials, P/I=Practical/Internship, CE =Continuous Evaluation, ESE = End Semester Evaluation

Course Description

The course Recombinant DNA technology was designed to equip the students with the basic techniques of genetic engineering, to explicate the tools required for genetic engineering, to figure out transgenic technology, and to demonstrate the advanced techniques of genetic engineering.

Course Objectives:

- To explain the genetic engineering techniques.
- To explicate the important steps in genetic engineering.
- To demonstrate the applications of genetic engineering.
- To expound the technology behind transgenic animals.
- To unriddle Knock-out and Knock -in technology.

Course Outcomes:

At the end of the Course, the Student will be able to -

CO1	Explain basic techniques of Recombinant DNA technology.
CO2	Apply essential tools required for genetic engineering
CO3	Expound the applications of genetic engineering
CO4	Explicate the applications of transgenic animals.

Course Contents:

Module	Description	Teaching Hours
Module 1	1.1: Historical events that led to the methods of recombinant DNA technology	**8 hrs**

	1.2: Gene cloning, Steps of gene cloning. 1.3: Enzymes involved in recombinant DNA technology- Polymerases, Klenow fragment, Nucleases, Restriction endonucleases, Ligases, Poly nucleotide kinases, Terminal deoxynucleotidyl transferases, Alkaline phosphatases.	
Module 2	2.1: Vectors used in Recombinant DNA technology, Plasmids, Cosmids, Phagemids, Artificial chromosomes, Shuttle vectors, Viral vectors, Expression vectors. 2.2: Linkers, Adapters, Homopolymer tailing. 2.3: Transformation, Transfection, Transient transfection.	**14 hrs**
Module 3	3.1: Gene libraries, Types of gene libraries 3.2: Preparation of Gene libraries, cDNA libraries, Expression libraries, 3.3: Storage of libraries, Screening of libraries, Screening by DNA hybridization, Screening by Immunological Assay, Screening by protein activity, Screening by Genetic complementation 3.4: Hybrid arrest translational systems, Hybrid release translations	**13 hrs**
Module 4	4.1: PCR, Various types of PCR and its applications 4.2: Fluorescent in-situ hybridization, Chromosome microdissection and micro cloning 4.3: Genetic engineering of animals and generation of transgenic animals. 4.4: Knock out Technology and Knock-in technology, Applications. 4.5: Antisense RNA technology and its application. 4.6: CRISPR-Cas9 Genome editing technology	**10 hrs**

Reading Lists:

1. Introduction to Biotechnology (4th Edition) by William J. Thieman, Michael A. Palladino. Global Edition. Pearson Education Limited,2020.
2. Gene Cloning an introduction (3rd Edition) T.A. Brown. Stanley Thornes (Publishers) Ltd, 1995.
3. DNA and Biotechnology (3rd Edition) by Molly Fitzgerald- Hayes and Frieda

Reichsman. Academic press, 2010
4. Biotechnology. Applying the Genetic Revolution. By David P. Clark and Nanette J. Pazdernik. Elsevier Academic Press, 2009.
5. Molecular Biology. Structure and Dynamics of Genomes and Proteomes. By Jordanka Zlatannova and Kensal E. van Holde, Garland Science. Taylor & Francis Group, 2016.
6. Gene cloning an Introduction (3rd Edition) by T.A. Brown, Stanley Thornes Pub Ltd.
7. From Genes to Clones. Introduction to Gene Technology by Ernst Winnacker. Translated by Horst Ibelgaufts. Panima Publishing Corporation. New Delhi.
8. Molecular Biotechnology Principles and Applications of Recombinant DNA (3rd Edition) by Bernard R. Glick and Jack J. Pasternak. ASM Press.
9. Introduction to Biotechnology (4th Edition) by William J. Thieman, Michael A. Palladino. Pearson Education Limited 2020.

Teaching Learning Strategies

- Assignments, Internal examinations/Unit tests, Seminar presentations

Mode of Transaction

- Off-line mode, Black Board and Chalk, PowerPoint presentation

Assessment Rubrics

	Weightage
End Semester Evaluation	60%
Continuous Evaluation	40%

Sample Questions:

1.What are vectors? (3 marks)
2. Molecular pharming? (3 marks)
3. Adapters? (3 marks)
4.Write note on selectable marker gene? (5 marks)
5. M13 phage is a good cloning vector. Explain? (5 marks)
6. How to engineer an embryonic stem cell? (5 marks)
7. Write note on Cre-loxP recombination system? (10 marks)
8. Transgenic animal models? (10 marks)
9. Write an essay on restriction endonucleases? (10 marks)

****

Semester	Type of Course	Course Code	Name of the Course
III	Core Course	MSBTC03DSC17	MICROBIAL TECHNOLOGY PRACTICAL

Credit			Teaching Hours			Assessment weightage		
L/T	P/I	Total	L/T	P/I	Total	CE	ESE	Total
	1	1		30	30	40	60	100

Lecture/Tutorials, P/I=Practical/Internship, CE =Continuous Evaluation, ESE = End Semester Evaluation

Course Description

The course Microbial technology practical was designed to provide hands on training in fermentation technology.

Course Objectives:

- To explore Fermentation techniques
- To explain different parts of a Fermenter.
- To explain production of wine
- To explain production of enzymes

Course Outcomes:

At the end of the Course, the Student will be able to -

CO1	Explain the parts of a fermenter
CO2	Explain the production of wine
CO3	Explicit the technique of Mushroom production.

*Course Outcomes based on revised blooms taxonomy

Course Contents:

Module	Description	Teaching Hours
Module	1. The Fermenter -its parts, Types 2. Strain development 3. Preparation of fermentation media. 4. Sterilization of the media, and the fermenter. 5. Production of wine 6. Production of enzymes. 7. Production of Mushrooms. 8. Determination of Dissolved oxygen 9. Determination of Biological oxygen demand. 10. Determination of alcohol content in Wine.	**30 hrs**

Reading Lists:

1. Microbial Biotechnology- A Laboratory Manual for Bacterial Systems by Das, Surajit, Dash, Hirak Ranjan. Springer.
2. Laboratory Bioprocess Technology Paperback- 1 January 2013. By A.N. Shukla, Arjun publishing house.
3. Practical Fermentation Technology, Brian Mc Neil and Linda M Harvey. John Wiley and Sons Inc.

Teaching Learning Strategies

- Laboratory Experiments

Assessment Rubrics

	Weightage
End Semester Evaluation	60%
Continuous Evaluation	40%

Semester	Type of Course	Course Code	Name of the Course
III	**Core Course**	**MSBTC03DSC18**	**ENZYMOLOGY PRACTICAL**

Credit			Teaching Hours			Assessment weightage		
L/T	P/I	Total	L/T	P/I	Total	CE	ESE	Total
	1	1		30	30	40	60	100

Lecture/Tutorials, P/I=Practical/Internship, CE =Continuous Evaluation, ESE = End Semester Evaluation

Course Description

This course is designed to achieve practical knowledge in the properties of enzymes and to acquire a detail knowledge of mechanism of enzyme action and regulation of enzyme activity.

Course Objectives:

- To understand the properties of enzymes and substates in enzymatic reactions
- To understand the activity of different enzymes in biochemical reactions
- To understand the mechanical and kinetics properties of enzyme including various models of kinetics and various types of inhibition
- To understand the method of testing clinically relevant enzymes in biological samples

Course Outcomes:
At the end of the Course, the Student will be able to -

CO1	Explain the properties of enzymes and substrates in enzymatic reactions
CO2	Explain the activity of different enzymes in the biochemical reactions
CO3	Determine the quantity of enzymes in biological samples
CO4	Explain the mechanical and kinetic properties of enzymes

Course Contents:

Module	Description	Teaching Hours
Module	1. Detection of enzymes in various biological samples 2. Effect of concentration on enzyme activity 3. Effect of pH enzyme activity 4. Effect of temperature on enzyme activity 5. Effect of inhibitors on enzyme activity	**30 hrs**

	6. Assay of salivary amylase activity 7. Estimation of lipase activity 8. Estimation of LDH activity 9. Determination of specific activity of peroxidase in radish extract 10. Determination of Km and Vmax using Lineweaver – Burk graph	

Reading Lists:

1. David Plummer, An Introduction to Practical Biochemistry, McGraw Hill
2. Harold Varley, Practical Clinical Biochemistry, by Gowenlock A. H., CBS.
3. Hans Bisswanger, Practical Enzymology. Wiley VCH.
4. Robert Eisenthal, Enzyme Assays: A Practical Approach, Oxford University Press
5. Sadasivam & Manickam, Biochemical Methods, New Age International
6. DM Vasudevan & Subir Kumar Das, Practical Textbook of Biochemistry, Jaypee Brothers
7. SK. Sawhney, Randhir Singh, Introductory Practical Biochemistry. Alpha Science International

Teaching Learning Strategies

- Practical session, Internal examinations/Unit tests, Seminar presentations

Mode of Transaction

- Off-line mode, Laboratory work, PowerPoint presentation

Assessment Rubrics

	Weightage
End Semester Evaluation	60%
Continuous Evaluation	40%

****

Semester	Type of Course	Course Code	Name of the Course
III	**Core Course**	**MSBTC03DSC 19**	**CELL AND TISSUE MANIPULATION PRACTICAL**

Credit			Teaching Hours			Assessment weightage		
L/T	P/I	Total	L/T	P/I	Total	CE	ESE	Total
	1	1		30	30	40	60	100

Lecture/Tutorials, P/I=Practical/Internship, CE =Continuous Evaluation, ESE = End Semester Evaluation

Course Description

The laboratory-based course in "Cell and Tissue Manipulation" combines the theoretical knowledge gained to provide hands-on training in the subject

Course Objectives:

- To provide hands-on training / wet lab in plant and animal tissue culture.

Course Outcomes:
At the end of the Course, the student will be able to -

CO1	Plan the layout of a plant tissue culture laboratory
CO2	Prepare plant tissue culture media from scratch with stock solutions
CO3	Surface sterilize and inoculate different explants
CO4	Design experiments for micropropagation and callus regeneration
CO5	Familiarize with animal cell culture practices

Course Contents:

(The laboratory work will consist of any 8-10 experiments from the following list)

Module	Description	Teaching Hours
Module	1. Preparation of media. 2. Surface sterilization. 3. Organ culture – shoot tip, meristem, node, leaf, embryo, orchid seed 4. Callus induction 5. Organogenesis 6. Protoplast isolation and culture. 7. Anther culture. 8. Preparation of media and membrane filtration (animal cell culture). 9. Preparation of single cell suspension from spleen and thymus. 10. Cell counting and cell viability. 11. Trypsinization of monolayer and subculturing.	**30 hrs**

Reading Lists:

1. Razdan, M. K. (2003). Introduction to Plant Tissue Culture. Enfield, NH: Science.
2. Bhojwani, S. S. and Razdan, M. K. 2004. Plant Tissue culture: Theory and Practice. Elsevier.
3. Ian Freshney 2010 Culture of Animal Cells- A manual of basic techniques and specialized applications; Wiley Inc.
4. Pörtner, R. (2007). Animal Cell Biotechnology: Methods and Protocols. Totowa, NJ: Humana Press

Teaching Learning Strategies

- Laboratory experiments

Assessment Rubrics

	Weightage
End Semester Evaluation	60%
Continuous Evaluation	40%

****

Semester	Type of Course	Course Code	Name of the Course
III	Core Course	MSBTC03DSC20	RECOMBINANT DNA TECHNOLOGY PRACTICAL

Credit			Teaching Hours			Assessment weightage		
L/T	P/I	Total	L/T	P/I	Total	CE	ESE	Total
	1	1		30	30	40	60	100

Lecture/Tutorials, P/I=Practical/Internship, CE =Continuous Evaluation, ESE = End Semester Evaluation

Course Description

The course Recombinant DNA technology practical was designed to provide hands on training in basic and applied genetic engineering

Course Objectives:

- To explore the genetic engineering works
- To explain RAPD
- To explain RFLP
- To explore PCR

Course Outcomes:

At the end of the Course, the Student will be able to -

CO1	Isolate total genomic DNA
CO3	Explain Genetic engineering procedures
CO4	Explore PCR

*Course Outcomes based on revised blooms taxonomy

Course Contents:

Module	Description	Teaching Hours
Module 1	1. Isolation of genomic DNA from Prokaryotes 2. Isolation of genomic DNA from Eukaryotic Plant source 3. Isolation of genomic DNA from Eukaryotic Animal source 4. Isolation of plasmid DNA 5. Agarose gel electrophoresis. 6. Restriction digestion and Restriction mapping of DNA a. Transformation b. Conjugation 7. RFLP 8. RAPD 9. DNA Finger printing. 10. PCR	**30 hrs**

Reading Lists:

1. Short protocols in Molecular Biology by Frederick M. Ausubel etal. Vol 1. Wiley.
2. Basic Techniques in Molecular Biology by S. Surzycki, Springer.
3. Recombinant DNA Laboratory Manual, by Judith Zyskind, Sanford Bernstein, Revised Edition, 1st Edition (1992).
4. Molecular Biology and Recombinant DNA technology by Asok Kumar.
5. Recombinant DNA Technology by Keya Chaudhuri

Teaching Learning Strategies

- Laboratory Experiments

Assessment Rubrics

	Weightage
End Semester Evaluation	60%
Continuous Evaluation	40%

****

Semester	Type of Course	Course Code	Name of the Course
III	Elective Course	MSBTC03DSE06	BIOINFORMATICS

Credit			Teaching Hours			Assessment weightage		
L/T	P/I	Total	L/T	P/I	Total	CE	ESE	Total
3		3	45		45	40	60	100

Lecture/Tutorials, P/I=Practical/Internship, CE =Continuous Evaluation, ESE = End Semester Evaluation

Course Description

This course is designed to give students both a theoretical background and a working knowledge of bioinformatics. It will give emphasis on biological databases, sequence analysis and its applications. In silico molecular modelling and its application in drug designing also has been given importance in the course.

Course Objectives:

- Become familiar with biological databases and sequence alignment methods.
- Understand methods in genomics and proteomics.
- Understand the molecular level interactions and molecular modeling.
- Understand the method of in silico drug design.

Course Outcomes:

At the end of the Course, the Student will be able to -

CO1	Access different biological databases and retrieve data
CO2	Perform sequence alignment using protein and nucleic acid sequences
CO3	Explain different methods for the identification of genes from genome sequences.
CO4	Explain different methods used in proteomics
CO5	Visualize and compare molecular structures using graphics programs such as Swiss PDB viewer and Pymol
CO6	Explain the method of molecular modelling and molecular structure prediction

CO7	Explain the method of in silico drug design.

Course Contents:

Module	Description	Teaching Hours
Module 1	1.1: Biological databases, Nucleic acid databases, Protein databases (sequence, structure, classification), genome databases, specialized databases 1.2: Data format (FASTA, PDB), Data storage and retrieval. 1.3: Pairwise sequence alignment: Global and local alignment: methods, scoring matrices (PAM, BLOSUM). 1.4: Database searching: FASTA and BLAST. 1.5: Multiple sequence alignment: methods, tools and applications. 1.6: Phylogenetic analysis: type of phylogenetic trees, methods of its construction-distance based methods and character-based methods.	**12 hrs**
Module 2	2.1: Genomics, genome projects, identification of sequence patterns, motifs and profiles, gene prediction methods 2.2: Genome mapping, genome sequencing, annotation. 2.3: Comparative genomics, Functional genomics- ESTs, SAGE, DNA microarrays, pharmacogenomics. 2.4: Proteomics: 2D Gel Electrophoresis, MALDI, Tandem mass spectroscopy, peptide mass fingerprinting, Protein microarrays, protein expression analysis, protein-protein interactions.	**12 hrs**
Module 3	3.1: Structural bioinformatics: Structure visualization, structure comparison, RMSD, Use programmes such as SPDBV and Pymol. 3.2: Molecular modelling: Potential energy functions, Energy minimization, local and global minima, Molecular Dynamics and Monte Carlo simulations. 3.3: Protein structure prediction: Secondary and tertiary structure prediction- homology modeling, ab initio prediction.	**10 hrs**
Module 4	4.1: In silico drug design: Drugs and drug targets. Computer aided drug design: structure based and ligand based methods. Ligand	**11 hrs**

	databases. Molecular docking, virtual screening, lead compounds, 4.2: Pharmacophore, QSAR, ADME property prediction. 4.3: An introduction to systems biology and biological networks, its applications in drug development.	

Reading Lists:

1. Bioinformatics: A beginner's guide by Jean-Michel Claverie and Gerdic Notredame, 2003, Wiley

2. Introduction to Bioinformatics by Attwood, Parry-Smith,Phukan, 2007, Pearson Education

3. Fundamental concepts of Bioinformatics by Krane D.E and Raymer M.L., 2003, Pearson Education

4. Bioinformatics: Databases and Algorithms by N. Gautham, 2006, Alpha Science International Ltd.

5. Bioinformatics: Sequence and Genome anlysis by Mount DW, 2004, Cold Spring Harbour Laboratory Press, New York

6. Bioinformatics (4th Ed) - Baxevanis AD, Bader GD Wishart DS (Eds), 2020, Wiley

7. Bioinformatics: Methods and applications (4th ed) by S. C. Rastogi, N. Mendiritta, P. Rastogi, 2013, PHI Learning

8. Essential Bioinformatics by Jin Xiong, 2006, Cambridge University Press

9. Structural Bioinformatics (2nd ed) Gu and Bourne, 2009, Wiley

10. An introduction to Medicinal Chemistry (7th ed) by Patrick G, 2023, Oxford University Press.

11. Pharmacology and Pharmacotherapeutics (25th ed) by– Satoskar, Rege, TRipathi and Bhandarkar, 2017, Popular Prakashan.

12. Foye's Principles of Medicinal chemistry (6th ed) by Lemke, Williams, Roche and Zito, 2008, Wolters Kluwer, Lippincott Williams & Wilkins

Teaching Learning Strategies

- ICT enabled classes, Assignments and Seminar presentations

Mode of Transaction

- Off-line mode, Black Board and Chalk, PowerPoint presentation

Assessment Rubrics

	Weightage
End Semester Evaluation	60%
Continuous Evaluation	40%

Sample questions:

1. Write the differences between structure databases and structure classification databases.
2. Compare primary, secondary and specialized databases.
3. Write a short note on International Nucleotide Sequence Database Collaboration.
4. How do you retrieve data from a database?
5. What is gap penalty in sequence alignment?
6. Differentiate between scaled and unscaled phylogenetic trees?
7. Elaborate the terms ‘homologous’, ‘orthologous’, ‘paralogous’ and ‘analogous’
8. Discuss on multiple sequence alignment and its applications.
9. Compare hierarchical and whole genome shotgun sequencing methods.
10. Explain the statistical approach for gene prediction?
11. Write a note on protein structure comparison using RMSD.
12. Discuss on important steps in structure-based drug design.

****

Semester	**Type of Course**	**Course Code**	**Name of the Course**
III	**Elective Course**	**MSBTC03DSE07**	**BIOTECHNOLOGY IN MEDICINE, HEALTH, AGRICULTURE AND ENVIRONMENT**

Credit			**Teaching Hours**			**Assessment weightage**		
L/T	P/I	Total	L/T	P/I	Total	CE	ESE	Total
3		3	45		45	40	60	100

Lecture/Tutorials, P/I=Practical/Internship, CE =Continuous Evaluation, ESE = End Semester Evaluation

Course Description

The course aims to highlight the applications and advances in Biotechnology in the field of Medicine, Health, Agriculture and Environment.

Course Objectives:

- Apply Biotechnological techniques to the current lacunae in the field of agriculture,

medicine and environment conservation

- Analyze and explain the need of biotechnology in improving day to day life
- Impress upon the application of biotechnological tools

Course Outcomes:

At the end of the Course, the Student will be able to –

CO1	Evaluate the use of Biotechnology tools and products in the field Medicine
CO2	Suggest biotechnological tools for betterment of Health
CO3	Differentiate between the old and new approaches of improving agriculture
CO4	Analyze the use of biotechnology to solve environmental issues
CO5	Suggest biotechnological tools for betterment of aquaculture, forestry, wildlife, and veterinary sciences

Course Contents:

Module	Module contents	Teaching Hours
Module 1	1.1 Developments in gene therapy 1.2 Molecular basis, identification, and cure of genetic disorders: like Immunodeficiencies, Diabetes mellitus, coronary artery disease, Neurogenetic disorders, cancer, Muscular Dystrophy, mitochondrial disease 1.3 Diagnosis based on genomic and cDNA microarray 1.4 Therapies based on RNA and stem cells.	**10 hrs**
Module 2	2.1 Gene edited plants and transgenic plants grown as crops. 2.2 Bioreactors in plant production and scale up. Plants as bioreactors 2.3. Engineering for secondary metabolites, herbicide resistance and improvement of food quality 2.4 Biofertilizers, Biopesticides	**10 hrs**
Module 3	3.1 Biotechnological monitoring of air, water, and soil pollution. 3.2 Biosensors. Biological indicators 3.3 Strategies for waste management and control. 3.4 Biofuels Biofuels: biogas; bioethanol; biodiesel; biohydrogen 3.5 Bioremediation: Fundamentals, methods, and strategies of application (biostimulation, bioaugmentation) – examples	**15 hrs**
Module 4	4.1 Biotechnologically produced clinical products. 4.2 Nanomedicine: Nanodevices medical microbots, nanorobotics, nanomedicine, nanosurgery 4.3 Nanoparticles for biological assays and as drug delivery vehicles 4.4 Applications of Biotechnology in aquaculture, forestry, wildlife, and veterinary sciences.	**10 hrs**

Reading Lists:

1. Singh, B., Mal, G., Gautam, S.K., Mukesh, M. (2019). Biotechnology for Wildlife. In: Advances in Animal Biotechnology. Springer, Cham. https://doi.org/10.1007/978-3-030-21309-1_46
2. An Introduction to Molecular Biotechnology: Fundamentals, Methods and Applications. Michael Wink (Ed) Germany: 2021. Wiley.
3. Gene cloning and DNA analysis: An Introduction 8th Edition T.A. Brown Wiley Blackwell 2020
4. Principles of Nanomedicine Sourav Bhattacharjee (Ed) 1st Edition 2019 Jenny Stanford publishing DOI https://doi.org/10.1201/9780429031236 Taylor and Francis
5. Techniques for Wildlife Investigation and Management, 6th Ed., C. Braun 2005., The Wildlife Society, Bethesda, MD.
6. Forest genomics and biotechnology Pages: 142 – 158 Editors: R. Mellan, M. Kirst 2019 Cabi digital library
7. Agina Onyinyechukwu Ada Animal Research International (2022) 19(3): 4604 – 4616 Application of advanced biotechnology tools in veterinary medicine
8. Agricultural Biotechnology: Latest Research and Trends Dinesh Kumar Srivastava, Ajay Kumar Thakur, Pankaj Kumar (Ed) 2021 Springer
9. Environmental Biotechnology: For Sustainable Future Ranbir Chander Sobti, Naveen Kumar Arora, Richa Kothari (Ed) 2019 Springer
10. Genetic Engineering: Emerging Concepts and Technologies Patrick Faraday 2018 Syrawood Publishing House
11. Handbook of Advanced Approaches towards Pollution Prevention and Control Volume I: Conventional and Innovative Technology and Assessment Techniques for Pollution Prevention and Control Edited by Rehab O Abdel Rahman and Chaudhery Mustansar Hussain 2021 Elsevier Inc.
12. Handbook of Biofuels Sanjay Sahay (Ed) 2021 Elsevier Inc.

Teaching Learning Strategies

- Assignments, Internal examinations/Unit tests, Seminar presentations

Mode of Transaction

- Off-line mode, Black Board and Chalk, PowerPoint presentation

Assessment Rubrics

	Weightage
End Semester Evaluation	60%
Continuous Evaluation	40%

Sample Questions to test Outcomes.

1. How can we improve food quality through genetic engineering? Explain with examples (10 marks 2 questions)
2. Using DNA microarray how would you detect the cause of a particular type of cancer (5 marks 5 questions)
3. How would you make an iPSC (3 marks x 5 questions)

****

Semester	**Type of Course**	**Course Code**	**Name of the Course**
1II	**Elective Course**	**MSBTC03DSE08**	**VIROLOGY, MYCOLOGY & PARASITOLOGY**

Credit			**Teaching Hours**			**Assessment weightage**		
L/T	P/I	Total	L/T	P/I	Total	CE	ESE	Total
3		3	45		45	40	60	100

Lecture/Tutorials, P/I=Practical/Internship, CE =Continuous Evaluation, ESE = End Semester Evaluation

Course Description

Virology, Mycology, and Parasitology is an introductory course that focuses on the study of viruses, fungi, and parasites. The course provides an in-depth understanding of the structure, function, pathogenesis, and interactions of these microorganisms with their hosts. Students will explore the fundamental concepts, techniques, and current advancements in the field of virology, mycology, and parasitology.

Course Objectives:

- To impart detail understanding in viral taxonomy, viral replication and cultivation methods.
- Identify and differentiate the major types of viruses, paratites, funguses and understand their modes of transmission and epidemiology.
- To describe various viral diseases of human importance, it's prevention, laboratory diagnosis and control with special emphasis on vaccines.
- To provide adequate knowledge about pathogenic molds and yeasts causing diseases to humans.
- To enable students to understand the pathogenesis, clinical presentation, laboratory diagnosis, prevention/ control of various protozoan diseases.

Course Outcomes:

At the end of the Course, the Student will be able to -

CO1	Students will explain about in viral taxonomy, viral replication and cultivation methods.
CO2	Students will describe about various viral diseases of human importance, its prevention, laboratory diagnosis and control with special emphasis on vaccines.
CO3	The students will get the knowledge about current and emerging human viral diseases.
CO4	Will acquired with knowledge of various human parasitic infections and its management.
CO5	To provide adequate knowledge explain pathogenic fungus which causes diseases to humans and it management.

Course Contents:

Module	Description	Teaching Hours
Module 1	1.1 General properties of viruses and bacteriophages: morphology of virus and bacteriophage classification and nomenclature of viruses. 1.2 Replication of viruses; steps in replication of RNA and DNA viruses. Mutation and viral interference. Cultivation of viruses: various culture methods. 1.3 Virus host interaction: Pathogenesis of viral infections, host immune response, 1.4 Laboratory diagnostics methods of viruses; Direct demonstration of viruses, detection of viral antigens and antibodies. Isolation of viruses- different methods. Detection of viral growth.	**5 hrs**
Module 2	2.1 General properties, pathogenesis, infections and Laboratory diagnosis of Herpesviruses, Poxviruses. 2.2. General properties, pathogenesis, infections and Laboratory	**14 hrs**

	diagnosis of Hepatitis viruses, Picornaviruses. 2.3. General properties, pathogenesis, infections and Laboratory diagnosis of Arbo viruses, Rhabdoviruses, Orthomyxoviruses, Paramyxoviruses. 2.4. General properties, pathogenesis, infections and Laboratory diagnosis of Oncogenic viruses, HIV and other retro viruses, miscellaneous DNA and RNA viruses. Antiviral chemotherapy.	
Module 3	3.1 Fungal diseases of humans: classification and lab diagnosis. 3.2 Study the morphology, pathogenesis and laboratory diagnosis of the causative agents of superficial and cutaneous mycoses, 3.3 Study the morphology, pathogenesis and laboratory diagnosis of the causative agents of subcutaneous mycoses, systemic/deep mycoses and opportunistic mycoses. 3.4 Study the morphology, pathogenesis and laboratory diagnosis of the causative agents of Pneumocystis. Mycotoxicoses, Antifungal agents and its mechanism of action, antifungal susceptibility testing.	**13 hrs**
Module 4	4.1 Classification of human parasites. Morphology, life cycle, pathogenesis, laboratory diagnosis of important protozoans and helminthes; 4.2 Morphology, life cycle, pathogenesis, laboratory diagnosis of Intestinal and hemoflagellates and tissue flagellates, 4.3 Morphology, life cycle, pathogenesis, laboratory diagnosis of cestodes, trematodes, 4.4 Morphology, life cycle, pathogenesis, laboratory diagnosis of nematodes. laboratory diagnosis of parasitic diseases. Other sporozoans: Cryptosporidium parvum, Toxoplasma gondii. Antiparasitic agents	**13 hrs**

Reading Lists:

1. Textbook of Microbiology. Ananthanarayanan R and Paniker CKJ. Orient Longman.
2. Principles of Virology. Flint SJ, Enquist LW, Krug RM, Racaniello VR, Skalka AM. ASM Press.
3. Medical Mycology, Jagadish Chandir, Jaypee publishers
4. Medical Mycology. Dey NC, Grueber HLE, Dey TK. Mc Graw Hill.
5. Human Parasitology. Bogitsh BJ, Carter CE, Oeltmann TN. Elsevier.
6. Animal Parasitology. Smyth JD. Cambridge University Press.
7. Diagnostic Microbiology. Forbes BA, Sahm DF, Weissfeld AS. Mosby Elsevier.
8. Essentials of medical microbiology, Apurba Sankar Sastri,Sandya Bhat.Jaypee Publications
9. Text book of microbiology, Dr.Prof.C.P Baveja, Arya Publications
10. Panikers text book of medical parasitology, jaypee publishers

Teaching Learning Strategies

- Assignments, Internal examinations/Unit tests, Seminar presentations

Mode of Transaction

- Off-line mode, Black Board and Chalk, PowerPoint presentation

Assessment Rubrics

	Weightage
End Semester Evaluation	60%
Continuous Evaluation	40%

Sample Questions

1. What is Paul - bunnel test? (3 marks)
2. What is Dermatophytosis ?(5 marks)
3. Explain the Morphology and life cycle of E.hystolytica (10 marks**)**

****

Semester	**Type of Course**	**Course Code**	**Name of the Course**
III	**Elective Course**	**MSBTC03DSE 09**	**ENVIRONMENTAL MICROBIOLOGY**

Credits			**Teaching Hours**			**Assessment weightage**		
L/T	P/I	Total	L/T	P/I	Total	CE	ESE	Total
3	-	3	45	-	45	40	60	100

L/T = Lecture/Tutorials, P/I=Practical/Internship, CE =Continuous Evaluation, ESE = End Semester Evaluation

Course Description

Students will learn about microbiology in the environment, the study of microbes in natural settings like land, water, and air, through this course. Along with commonly used biology techniques, the analysis will concentrate on microbial diversity, physiology, biochemistry, function, and ecology. Additionally covered may be topics in climate microbiology min extreme conditions.

Course Objectives:

- Microbialbiodiversityindifferentenvironmentsandfactorsaffectingmicrobial population.
- Environmental, Agricultural, Medical and Industrial applications of microorganisms.

Course Outcomes:
At the end of the Course, the Student will be able to -

CO1	Explain and demonstrate the dispersal and adaptability of diverse microorganisms in different environments
CO2	Evaluate the role of microorganisms and their beneficial aspects in environment
CO3	Evaluate the role of microorganisms and their beneficial aspects in agriculture, health and industry
CO4	Evaluate the role of microorganisms and theirbeneficialaspectsin healthand industry

Course Contents:

Module	Description	Teaching Hours
Module 1	1.1 Microbial behavior in ecosystems: Microbial biodiversity, Interactions among microbial populations. Animal-microbe and plant-microbe interactions. 1.2 Microbiology of soil: Soil as habitat for microorganisms. Soil microflora, Decomposition of organic matter - Soil as source of industrial strains. 1.3 Biodegradation of recalcitrants by soil microbes. 1.4 Geocycles of C, N, S, P. iron and sulphur oxidation. N2 fixation.	**11 hrs**
Module 2	2.1 Microbiology of water: Microbial communities in aquatic environments, factors affecting microbial population in natural waters, Air water interface, Microbial Corrosion, 2.2 Bacteriological analysis of drinking water. Water purification and various steps involved. 2.3 Microbiology of air: Composition of air micro flora, Significance of air micro flora, Airborne diseases, Hazards of laboratory techniques, Air sanitation. Biological weapons, their regulation and precautions. 2.4 Microorganisms in extreme environments: Environmental Determinants that Govern Extreme environments, Extremes of pH &	**11 hrs**

	temperature, salinity, Hydrostatic pressure, Nutrient limitation.	
Module 3	3.1 Pollution and environment, Biosensors and Biological indicators, 3.2 Waste water management and sewage treatment, BOD concepts, Solid waste management and landfilling, 3.3 Degradation of xenobiotics, Microbes and bioremediation. 3.4 Microbial Biofilms: Physiology, Morphology and Biochemistry of microbial bio films	**11hrs**
Module 4	4.1 Production of microbial biofertilizers– cyanobacteria, Rhizobium, Azotobacter, Azospirillum, Phospho bacteria and VAM, Biopesticides 4.2 Microbes as a health food (SCP)- Spirulina and its production methods. Probiotics- use of Lactobacilli and Bifidobacterium- therapeutic and nutritional value 4.3 Microbial enhanced oil recovery, Microbial production of fuels. 4.4 Microbial leaching of ores and biomining, Biopolymers and biosurfactants.	**12 hrs**

Reading Lists:

1. R.M. Atlas and R. Bartha (1998) Microbial Ecology-Fundamentals and Applications. Addison Wesley Longman Inc.
2. Buckley R G, Environmental Microbiology by, CBS
3. N.S. Subbarao, Biological Nitrogen Fixation
4. Alexander and Martin , Microbiology of Soil
5. Soil Microbiology. Mark Coyne Thompson Learning
6. Ivanov, Environmental Microbiology for Engineers, Taylor & Francis Exclusive (Cbs)

Teaching Learning Strategies

- Assignments, Internal examinations/Unit tests, Seminar presentations

Mode of Transaction

- Off-line mode, Black Board and Chalk, PowerPoint presentation

Assessment Rubrics

	Weightage
End Semester Evaluation	60%
Continuous Evaluation	40%

****

ABILITY ENHANCEMENT COURSES

Semester	Type of Course	Course Code	Name of the Course
II	**Ability Enhancement Course**	**MSBTC02AEC01**	**INTRODUCTION TO BIOLOGICAL DATABASES**

Credit			Teaching Hours			Assessment weightage		
L/T	P/I	Total	L/T	P/I	Total	CE	ESE	Total
2		2	30	0	30	40	60	100

Lecture/Tutorials, P/I=Practical/Internship, CE =Continuous Evaluation, ESE = End Semester Evaluation

Course Description

The course Introduction to Biological databases helps students to acquire information from different biological databases. The course also provides basic information about different tools in sequence alignment, structure prediction and proteomic data analysing. An introduction to

next generation sequencing technologies is also included as a part of the course.

Course Objectives:

- To understand different biological databases
- To familiarize different methods for sequence alignment
- To familiarize protein and RNA structure prediction
- To understand different NGS technologies

Course Outcomes:

At the end of the Course, the Student will be able to -

CO1	Acquire information from different biological databases
CO2	Explain sequence similarity search
CO3	Explain different structural prediction methods
CO4	Explain NGS technologies and its different file types

Course Contents:

Module	Description	Teaching Hours
Module 1	1.1 Biological databases: primary, secondary and composite databases; types of biological data. Database file formats: GenBank; FASTA; ALN/ClustalW2; PDB; PIR. 1.2 Information retrieval from biological databases: Nucleotide sequence databases: GenBank; EMBL; DDBJ. Protein databases: Uniprot; UniProtKB/TrEMBL; PIR; PDB, BMRB. Secondary and composite databases: Prosite; Interpro, MMDB; CATH; SCOP; BRENDA; KEGG. Specialist databases: OMIM, EST databases; SNP databases.	**8 hrs**
Module 2	2.1 Database searching for similar sequences: introduction, FASTA sequence database similarity search, BLAST, Database searches with the smith waterman dynamic programming method, Database searches with a scoring matrix or Profile, searching sequence database with a position specific scoring matrix or sequence profile 2.2 Introduction to Genomics and Proteomics. Tools for analysis of proteomics data (tools available at ExPASy proteomics server). Structure visualization tools: Rasmol, SPDBV, PyMol.	**7 hrs**
Module 3	3.1 Protein classification and structure prediction: introduction, alignment of protein structures, secondary structure prediction - Chou Fasman, GOR method. Tertiary structure prediction- Homology Modelling, Threading, Ab-initio method., evaluating the success of structure predictions 3.2 RNA structure prediction: introduction, self-complimentary regions in RNA sequences, minimum free energy method for	**7 hrs**

	RNA secondary structure prediction, suboptimal structure predictions by Mfold, RNA databases: RNA structure analysis and prediction tools.	
Module 4	4.1 Introduction to next generation sequencing (NGS): how to sequence DNA; typical NGS experimental workflow; Illumina sequencing principle; ion torrent sequencing principle; pacific biosciences SMRT sequencing principle; nanopore sequencing technology. 4.2 Common file types used in NGS Data Analysis- BAM, BCF, BCL, FASTQ, SAM, VCF, WIG. Workflow for genome sequence data analysis.	**8 hrs**

Reading Lists:

1. Bioinformatics: Databases and Algorithms by N. Gautham; Alpha Science, 2006
2. Bioinformatics Sequence and Genome Analysis (2nd edition) by D. W. Mount; Cold Spring Laboratory Press, 2004
3. Structural Bioinformatics: An Algorithmic Approach by F. J Burkowski; CRC Press, 2008
4. Introduction to Bioinformatics (5th edition) by A. M Lesk, Oxford University Press, 2019
5. BLAST by J. Bedell, I. Korf and M. Yandell; O'Reilly Press, 2003
6. Bioinformatics Vol. 1, Data, sequence analysis & evolution (2nd edition) by J. M. Keith; Humana Press, 2017

Semester	Type of Course	Course Code	Name of the Course
II	**Ability Enhancement Course**	**MSBTC02AEC02**	**BIOETHICS AND BIOSAFETY**

Credit			Teaching Hours			Assessment weightage		
L/T	P/I	Total	L/T	P/I	Total	CE	ESE	Total
2		2	30		30	40	60	100

Lecture/Tutorials, P/I=Practical/Internship, CE =Continuous Evaluation, ESE = End Semester Evaluation

Course Description

The course bioethics and biosafety is focusing on the core bioethical concerns of the twenty-first century and also provides good practices on biological laboratory safety. This includes the identification, assessment, and control of the broad variety of risks encountered in the lab. Every risk—no matter how small—must be considered, assessed, and properly mitigated. Biological safety and bioethics protocols are essential to the reputation and responsibility of

every scientific institution, irrespective of whether research, academic, or industrial.

Course Objectives:

- To describe the ethical issues in biological research.
- To explain the ethical issues in healthcare sector
- To provide students with biosafety skills and the ability to identify the risks involved
- To familiarize students with the Biosafety guidelines in India

Course Outcomes:

At the end of the Course, the Student will be able to -

CO1	Explain the ethical issues associated with human genome project
CO2	Explain the ethical issues associated with biological research.
CO3	Explain the different levels of biosafety in biological laboratory
CO4	Explain the biosafety guidelines in India and its management

Course Contents:

Module	Description	Teaching Hours
Module 1	1.1 Introduction to Bioethics, need of bioethics, definition of bioethics, application to bioethics, ethical concerns involved with genetic research 1.2 Human genome project and its ethical issue: history of Human Genome Project, five perspectives on genomics, criteria for selection of genomes for sequencing, ethical, legal and social implications (ELSI) of HGP.	**6 hrs**
Module 2	2.1 Ethical aspects of interfering in the natural process, ethical issues associated with ART, prenatal diagnosis, bioethics in animal cloning, ethical issues associated with stem cell research, ethical issues with the use of animal models. 2.2 Evidence-based medicine and bioethics: Utilitarian and Deontological evidence-based medicine approaches, patient autonomy and bias, ethical issues in health care sector in India.	**7 hrs**
Module 3	3.1 Biosafety: Introduction, definition of biosafety, Biosafety Level (BSL) Practices – BSL 1, 2,3 & 4. Hazard levels, Standard microbiological practices, Safety equipment, Laboratory facilities, Biological Safety Cabinets an Overview 3.2 Bio hazard Level and Significance- risk assessment of biological hazards, protozoa and helminths, mycotic agents, bacterial pathogens, viral agents of human diseases. Hazards Control-primary barriers, personal respiratory protection, standard	**9 hrs**

	precautions for handling fluids, tissues and cells. Decontamination in the microbiology laboratory, packing and shipping of biological materials.	
Module 4	3.1 Biosafety guidelines in India, Institutional Biosafety Committee: Role & Functioning, Categorization of GE Experiments and Approval requirements in India, RCGM, GEAC etc. for GMO applications in food and agriculture; Environmental release of GMOs; 3.2 Risk Analysis: Risk Assessment; Risk management and communication. guidelines for research in recombinant DNA research and genetically modified plants. Measuring biosafety program effectiveness. Cartagena Protocol on Biosafety (BSP)-Socio-Economic Impacts.	**8 hrs**

Reading Lists:

1. Contemporary Issues in Bioethics by Tom L. Beauchamp, LeRoy Walters, 5th edition, Thomson/Wadsworth, 2008
2. Bioethics and Biosafety By M. K. Sateesh, I.K. International Publishing House Pvt. Limited, · 2013
3. An Introduction to Ethical, Safety and Intellectual Property Rights Issues in Biotechnology By Padma Nambisan, Elsevier Science, ·2017
4. Safety, Ethics and Regulations, edited by Achim Rosemann, Phuc Van Pham, Springer International Publishing, 2017
5. Biological Safety Principles and Practices edited by Dawn P. Wooley, Karen B. Byers, Wiley, 2020

****

VALUE ADDITION COURSE

Semester	**Type of Course**	**Course Code**	**Name of the Course**
II	**Value Addition Course**	**MSBTC02VAC01**	**SCIENCE WRITING AND COMMUNICATION**

Credit			**Teaching Hours**			**Assessment weightage**		
L/T	P/I	Total	L/T	P/I	Total	CE	ESE	Total
2		2	30	0	30	40	60	100

Lecture/Tutorials, P/I=Practical/Internship, CE =Continuous Evaluation, ESE = End Semester Evaluation

Course Description

The course ‘Science Writing and Communication’ is designed to impart the basic elements of good scientific communication skills to students.

Course Objectives:

This course is meant to develop and enhance the reading, analysing, written, verbal and visual media presentation skills required in areas of scientific research and communication.

Course Outcomes:

At the end of the course, the student will be able to

CO1	Learn the basic elements of good scientific writing
CO2	Learn structure of sentences and paragraphs
CO3	Develop effective communication and different presentation skills using professional ICT media and verbal communication formats
CO4	Learn different styles, sentence construction and identify common mistakes in written formats
CO5	Understand stages of the scientific communication (prewriting, drafting, revising, final edits, analyse the audience and purpose)
CO6	Understand plagiarism and learn how it can be avoided
CO7	Recognize authentic scientific literature sources and predatory journals
CO8	How to present scientific papers and posters at scientific forums

*Course Outcomes based on revised blooms taxonomy

Course Content:

Module	Description	Teaching Hours
Module 1	1.1 An overview on designing a research work -experimental design – format for writing thesis and papers – Formulation of hypothesis., ISBN & ISSN. Peer review. Impact factor and H-index of journals. 1.2 Essential features of abstract, Introduction, Review of literature, Materials and methods, results and discussion, Effective illustration, Tables and figures, reference style-Harvard and Vancouver system. Citation and Acknowledgement	**8 hrs**
Module 2	2.1 Speaking Skills – Importance of verbal and non-verbal communication. Voice modulation and emphasizing key phrases.	**6 hrs**
Module 3	3.1 Writing Skills – Common mistakes in sentence structuring. Importance of punctuation and grammar. – Identification of authentic scientific literature sources. Publishing and predatory journals. Identification of strong points in classic journal articles.	**8 hrs**
	4.1 Presentation tools: oral and poster, Microsoft PowerPoint and PDF slide ICT tools – Features of a good oral presentation.	**8 hrs**

Module 4	Effective utilization of ICT tools- PPTs and multimedia. 4.2 Effective PowerPoint presentations: Feature of a good PPT presentation. Contribution to scientific forums – Posters– Identification of scope of scientific forums- conferences, seminars and symposiums. Poster presentation techniques. Key features of an attractive scientific poster. Strategies for effective communication.	

Reading Lists:

1. Effective Science Communication - A practical guide to surviving as a scientist. Sam Illingworth and Grant Allen Published, IOP Publishing Ltd., 2016. ISBN: 978-0-7503-1171-7.
2. Science Communication - A Practical Guide for Scientists. Laura Bowater, Kay Yeoman, Wiley-Blackwell, 2013, ISBN: 978-1-119-99312-4.
3. Communication Skills for Engineers and Scientists. Sangetha Sharma and Binod Mishra. Prentice Hall India Learning Private Limited. 2009. ISBN-13: 978-8120337190.
4. On-line Sources
5. https://iversity.org/en/courses/scientific-writing-skills
6. https://esajournals.onlinelibrary.wiley.com/doi/full/10.1002/bes2.1258

Teaching Learning Strategies:

Assignments, Seminar Presentation on selected topics, Debates and projects.

Assessment:

Continuous evaluation / Formative Assessment by the faculty in charge of the course based on assignments, tests and presentation

****

MULTI DISCIPLINARY COURSE

Semester	Type of Course	Course Code	Name of the Course
III	**Multi-Disciplinary Course**	**MSBTC03MDC01**	**BASICS OF BIOTECHNOLOGY**

Credit			Teaching Hours			Assessment weightage		
L/T	P/I	Total	L/T	P/I	Total	CE	ESE	Total
4		4	60		60	40	60	100

Lecture/Tutorials, P/I=Practical/Internship, CE =Continuous Evaluation, ESE = End Semester Evaluation

Course Description

The course Basic Biotechnology was designed to equip the students with the basic techniques of Biotechnology, to explicate the tools required for genetic engineering, to figure out transgenic technology, and to demonstrate the advanced applications of Biotechnology.

Course Objectives:

- To explain the basic concept of Biotechnology.
- To explicate the important steps in genetic engineering.
- To explain the applications of genetic engineering.
- To expound the technology behind transgenic animals.

Course Outcomes:

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

CO1	Explain basic techniques of Biotechnology.
CO2	Apply essential tools required for genetic engineering
CO3	Expound the applications of genetic engineering
CO4	Explicate the applications of transgenic animals and transgenic plants.

Course Contents:

Module	Description	Teaching Hours
Module 1	1.1 Biotechnology: Definition, Concept. 1.2: Traditional biotechnology 1.3: Development of modern biotechnology and Genetic engineering 1.4: Historical events that led to recombinant DNA technology.	**12 hrs**
Module 2	2.1: Gene cloning, Basic steps in gene cloning. 2.2: Enzymes used in gene cloning 2.3: Vectors used in gene cloning, Selectable marker genes. 2.4: Host cells. 2.5: Various methods for the transfer of foreign genes to host cells, Transformation, Transfection. 2.6: Preparation of gene libraries, Screening of the genomic libraries, Storage of library.	**17 hrs**
Module 3	3.1: Various techniques in rDNA technology, PCR, FISH, Chromosome microdissection, DNA finger printing. 3.2: Gene therapy, Somatic cell gene therapy, germline gene	**17 hrs**

	therapy, Gene augmentation therapy, Gene inhibition therapy.	
Module 4	4.1: Genetic engineering of animals and Generation of transgenic animals, Transgenic mouse models and its applications. 4.2: Transgenesis of plants, genetically modified crops. 4.3: Genetically modified microbes.	**14 hrs**

Reading Lists:

1. Introduction to Biotechnology (4th Edition) by William J. Thieman, Michael A. Palladino. Global Edition. Pearson Education Limited, 2020.
2. Gene Cloning an introduction (3rd Edition) T.A. Brown. Stanley Thornes (Publishers) Ltd, 1995.
3. DNA and Biotechnology (3rd Edition) by Molly Fitzgerald- Hayes and Frieda Reichsman. Academic press, 2010
4. Biotechnology. Applying the Genetic Revolution. By David P. Clark and Nanette J. Pazdernik. Elsevier Academic Press, 2009.
5. Molecular Biology. Structure and Dynamics of Genomes and Proteomes. By Jordanka Zlatannova and Kensal E. van Holde, Garland Science. Taylor & Francis Group, 2016.
6. Gene cloning an Introduction (3rd Edition) by T.A. Brown, Stanley Thornes (Publishers) Ltd.
7. From Genes to Clones. Introduction to Gene Technology by Ernst Winnacker. Translated by Horst Ibelgaufts. Panima Publishing Corporation. New Delhi.
8. Molecular Biotechnology Principles and Applications of Recombinant DNA (3rd Edition) by Bernard R. Glick and Jack J. Pasternak. ASM Press.
9. Introduction to Biotechnology (4th Edition) by William J. Thieman, Michael A. Palladino. Pearson Education Limited 2020.

Teaching Learning Strategies

ICT enabled classes, Assignments and Seminar presentations

Assessment Rubrics

	Weightage
End Semester Evaluation	60%
Continuous Evaluation	40%

Sample Questions:

1.What are vectors? (3 marks)
2. Molecular pharming? (3 marks)
3. Adapters? (3 marks)
4.Write note on selectable marker gene? (5 marks)
5. M13 phage is a good cloning vector. Explain? (5 marks)

****

Pattern of Question Papers

Time : 3 Hours Total Weightage: 60

Part A

Answer any five questions. Each question carries a weightage of 3

1.

2.

3.

4.

5.

6.

Part B

Answer any three questions. Each question carries a weightage of 5

7.

8.

9.

10.

11.

Part C

Answer any three questions. Each question carries a weightage of 10

12.

13.

14.

15.

16.