KANNUR UNIVERSITY

(Abstract)

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

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ACADEMIC C SECTION

ACAD C/ACAD C3/25197/2023 Dated: 15.12.2023

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

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 Microbiology 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 Microbiology Programme to be implemented in the Dept.of Biotechnology & Microbiology, Dr Janaki Ammal Campus, Palayad of the University w.e.f.2023 admission.

5. 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 III of Kannur University Act 1996, ***approved the revised Scheme & Syllabus of M.Sc Microbiology 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.***

6.The revised Scheme and Syllabus of M.Sc Microbiology 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)

7. 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. 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

KANNUR UNIVERSITY * CIVIL STATION PO KANHUR PIN-670 002 * THAVAKKARA *

Forwarded / By Order

SECTION OFFICER

SCHEME AND SYLLABUS

M Sc MICROBIOLOGY

2023 ADMISSION ONWARDS

DEPARTMENT OF BIOTECHNOLOGY AND MICROBIOLOGY

KANNUR UNIVERSITY

Scheme and Syllabus of M Sc Microbiology 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 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. Microbiology 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 Microbiology 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. Microbiology 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. Microbiology program the students will be able to

PSO1: Explain the organization, structure and functions of prokaryotic and eukaryotic cells, cell culture methods and cell manipulation.

PSO2: Explain classification, growth and reproduction of prokaryotic and eukaryotic microbs.

PSO3: Explain the applications of microbes in various fields such as food processing, large scale production of useful products.

PSO4: Explain the function of genes, heredity and flow of genetic information, genetic modification.

PSO5: Explain the biosynthesis, structure, function of biological macromolecules, metabolism and flow of energy in living system.

PSO6: Apply various biophysical techniques and statistical methods to study biological systems.

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

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	MSMBY01DSC01	Biochemistry	3	2		60	40	100	3
2	MSMBY01DSC02	General Microbiology	3	2		60	40	100	3
3	MSMBY01DSC03	Cell Biology	3	2		60	40	100	3
4	MSMBY01DSC04	Genetics	3	2		60	40	100	3
5	MSMBY01DSC05	Biochemistry Practical			2	60	40	100	1
6	MSMBY01DSC06	General Microbiology Practical			2	60	40	100	1
7	MSMBY01DSC07	Cell Biology Practical			2	60	40	100	1
8	MSMBY01DSC08	Genetics Practical			2	60	40	100	1
	Inter Disciplinary Courses (Any 2 can be chosen from the following 3)								
9	MSMBY01IDC01	Biostatistics	3	2		60	40	100	3
10	MSMBY01IDC02	Biophysical techniques	3	2		60	40	100	3
11	MSMBY01IDC03	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	MSMBY02DSC09	Systematic Bacteriology	3	2		60	40	100	3
13	MSMBY02DSC10	Food Microbiology	3	2		60	40	100	3
14	MSMBY02DSC11	Systematic Bacteriology Practical			2	60	40	100	1
15	MSMBY02DSC12	Food Microbiology Practical			2	60	40	100	1
Discipline Specific Electives (Any 3 can be chosen from the following 5)									
16	MSMBY02DSE01	Microbial Physiology and Metabolism	3	2		60	40	100	3
17	MSMBY02DSE02	Immunology	3	2		60	40	100	3
18	MSMBY02DSE03	Microbial diversity and Ecology	3	2		60	40	100	3
19	MSMBY02DSE04	Molecular Biology	3	2		60	40	100	3
20	MSMBY02DSE05	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	MSMBY02VAC01	Science Writing and Communication	2	2		60	40	100	2

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	MSMBY03DSC13	Microbial Technology	3	2		60	40	100	3
25	MSMBY03DSC14	Environmental Microbiology	3	2		60	40	100	3
26	MSMBY03DSC15	Clinical and Diagnostic Microbiology	3	2		60	40	100	3
27	MSMBY03DSC16	Virology, Mycology and Parasitology	3	2		60	40	100	3
28	MSMBY03DSC17	Microbial Technology Practical			2	60	40	100	1
29	MSMBY03DSC18	Environmental Microbiology Practical			2	60	40	100	1
30	MSMBY03DSC19	Clinical and Diagnostic Microbiology Practical			2	60	40	100	1
31	MSMBY03DSC20	Virology, Mycology and Parasitology Practical			2	60	40	100	1
Discipline Specific Electives (Any 1 can be chosen from the following 4)									
32	MSMBY03DSE06	Bioinformatics	3	2		60	40	100	3
33	MSMBY03DSE07	Marine Microbiology	3	2		60	40	100	3

34	MSMBY03DSE08	Recombinant DNA technology	3	2		60	40	100	3
35	MSMBY03DSE09	Veterinary Microbiology	3	2		60	40	100	3
Multi-Disciplinary Course (For students from other departments)									
36	MSMBY03MDC01	Basic Microbiology	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	MSMBY04DSC21	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	MSMBY01DSC01	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:

1. To understand structure and function of biological macromolecules.
2. To understand chemical changes taking place in the living cells.
3. To understand transport across biological membranes.
4. 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**
	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	

Module 4	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*

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Semester	Type of Course	Course Code	Name of the Course
I	Core Course	MSMBY01DSC02	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	**10 hrs**

	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	
Module 4	4.1 Microbial nutrition and metabolism of bacteria: factors influencing bacterial growth, Photo autotrophy and bacterial photosynthesis. 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)

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Semester	Type of Course	Course Code	Name of the Course
I	Core Course	MSMBY01DSC03	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:

2. Molecular Cell Biology Gerald Karp ,Janet Iwasa, Wallace Marshall 9th Edition

Wiley 2020

3. Molecular Biology of the Cell Alberts 7th Edition 2022 W W Norton
4. Cell Biology Thomas Pollard, William C. Earnshaw, Jennifer Lippincott, Schwartz, Graham Johnson. 3rd Edition 2017 Elsevier.
5. 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)

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Semester	Type of Course	Course Code	Name of the Course
I	**Core Course**	**MSMBY01DSC04**	**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	**12 hrs**

	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.	

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.
2. 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
3. Snustad PD, Simmons MJ. 2015. Principles of Genetics, 7th edition. Wiley.
4. Klug WS, Cummings MR, Spencer CA, Palladino MA, Darrell Killian. 2018. Concepts of Genetics, 12th edition. Pearson.
5. Griffiths AJF, Wessler SR, Carroll SB, Doebley J. 2015. Introduction to Genetic Analysis, 11th edition. W.H. Freeman & Worth Publishers.
6. 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.
7. Hartl DL and Jones EW. 2011. Genetics: Analysis of Genes and Genomes, 7th edition. USA: Jones and Barlett Publishers.
8. Strickberger MW. 2015. Genetics, 3rd edition. Pearson.
9. Samuels ML, Witmer JA, Schaffner A. 2015. Statistics for the Life Sciences, 5th edition. Pearson.
10. Brooker R. 2017. Genetics: Analysis and Principles, 5th edition. McGraw-Hill Higher Education
11. Tamarin R, 7th edition. 2017. Principles of Genetics. McGraw Hill Education.
12. Elrod S, Stansfield W. 2010. Schaum's Outline of Genetics, 5th edition. McGraw-Hill Education.10
13. 14.. Hartl DL, Clark AG. 2006. Principles of Population Genetics 4th edition. Sinauer The associate is an imprint of Oxford University Press.
14. 15. Crow JF, Kimura M. 2009. An Introduction to Population Genetics Theory. The Blackburn Press.
15. 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. 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)

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Semester	**Type of Course**	**Course Code**	**Name of the Course**
I	**Core Course**	**MSMBY01DSC05**	**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:

1. To understand the method of testing biomolecules from biological samples
2. To understand the process of purification of biomolecules from biological samples
3. To understand the preparation of biochemical reagents
4. 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. 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.	**30 hrs**

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%

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Semester	Type of Course	Course Code	Name of the Course
I	Core Course	MSMBY01DSC06	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, M. K. Rai, H.B.T. Singh, 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%

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Semester	Type of Course	Course Code	Name of the Course
I	Core Course	MSMBY01DSC07	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
	1. Cell Fractionation: chloroplast: differential centrifugation.	

Module	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). 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)	**30 hrs**

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

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Semester	Type of Course	Course Code	Name of the Course
I	Core Course	MSMBY01DSC08	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
	1. Study of mutations by Ames test. 2. Assay of antibiotics and demonstration of antibiotic resistance.	

Module	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

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

I	Elective Course	MSMBY01IDC01	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	**11 hrs**

	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.	

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%

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

I	**Elective Course**	**MSMBY01IDC02**	**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 immunotechniques: 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.	**11 hrs**

	4.5: Isothermal Titration Calorimetry. 4.6: Differential Scanning Calorimetry.	

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**	**MSMBY01IDC03**	**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. 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.	**10 hrs**
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.	**12 hrs**

	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.	
Module 4	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 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)

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Semester	Type of Course	Course Code	Name of the Course
II	**Core Course**	**MSMBY02DSC09**	**SYSTEMATIC BACTERIOLOGY**

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 provides overview of the fundamental principles of bacterial classification, including the historical development of taxonomy. Students will explore the significance of bacterial diversity and its ecological, medical, and industrial implications. Students will learn about the principles and techniques used for bacterial classification, including morphological, physiological, biochemical, and molecular methods. Students will explore the diversity of Gram-positive and Gram-negative bacteria, as well as other specialized groups such as spirochetes, mycoplasmas. The role of molecular techniques, such as DNA sequencing and phylogenetic analysis, in resolving bacterial taxonomy and evolution will also be covered.

Course Objectives:

- To understand the Morphology and Characters different bacteria
- The course aims to enable the students how to identify, classify, and differentiate bacterial species using various laboratory techniques and tools.
- To understand the etiology, pathogenesis, laboratory diagnosis and epidemiology of major bacterial diseases of humans.
- To give an insight of current antibacterial therapy and related drug resistance.

Course Outcomes:

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

CO1	Isolation, cultivation, and identification of bacteria.
CO2	Interpret and analyse bacterial characteristics such as morphology, physiology, genetics, and metabolism.
CO3	Enable the students to identify, classify and differentiate bacterial species

	using various techniques and tool.
CO4	Explain the ecological and pathological roles of bacteria in various environments, including medical, agricultural, and environmental contexts.
CO5	The students will able to diagnose and interpret infectious diseases caused by bacterial pathogens.

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

Course Contents:

Module	**Description**	**Teaching Hours**
Module 1	1.1 History, Morphology, Virulent factors, cultural and staining characters, epidemiology pathogenicity and clinical manifestations, laboratory diagnosis, prevention and control of Gram positive cocci like *Staphylococcus* and *Streptococcus.* 1.2 History, Morphology, cultural and staining characters, pathogenicity and clinical manifestations, laboratory diagnosis, epidemiology, prevention and control of Gram negative cocci *Neisseria meningititidis and gonococci* 1.3 Morphology, classification, cultural and staining characters, pathogenicity and clinical manifestations, laboratory diagnosis, epidemiology, prevention and control of Spore forming Gram positive Bacilli: *Bacillus anthracis, Clostridium*. 1.4 History, Morphology, cultural and staining characters, pathogenicity and clinical manifestations, laboratory diagnosis, epidemiology, prevention and control of non-spore forming Gram positive Bacilli: *Corynebacterium*, other miscellaneous gram positive bacilli**.**	**10 hrs**
Module 2	2.1 History, Morphology, classification, cultural and staining characters, pathogenicity and clinical manifestations, laboratory diagnosis, epidemiology, prevention and control of Enteric Gram-negative rods: *Escherichia, Enterobacter, Klebsiella, Proteus, Yersinia.* 2.2 Morphology, classification, cultural and staining characters, pathogenicity and clinical manifestations, laboratory diagnosis, epidemiology, prevention and control of *Shigella*; *Salmonella.* 2.3 Morphology, classification, cultural and staining characters, pathogenicity and clinical manifestations, laboratory diagnosis, epidemiology, prevention and control of *Pseudomonas* and non-fermentative gram negative bacilli, *Vibrio* and *Aeronnas.*	**11 hrs**

	2.4 Morphology, cultural and staining characters, pathogenicity and clinical manifestations, laboratory diagnosis, epidemiology, prevention and control of Gram Helicobacter and miscellaneous gram negative bacilli.	
Module 3	3.1 Morphology, cultural and staining characters, pathogenicity and clinical manifestations, laboratory diagnosis, epidemiology, prevention and control of Hemophilus, HACEK group 3.2 Morphology, virulent factors, cultural and staining characters, pathogenicity and clinical manifestations, laboratory diagnosis, epidemiology, prevention and control of Bordetella, Brucella, 3.3 History, classification, Morphology, cultural and staining characters, pathogenicity and clinical manifestations, laboratory diagnosis, epidemiology, prevention and control of Mycobacterium; M. tuberculosis, and other Mycobaterias 3.4 Morphology, classification, cultural and staining characters, pathogenicity and clinical manifestations, laboratory diagnosis, epidemiology, prevention and control of M.leprae and Atypical Mycobacterium.	**12 hrs**
Module 4	4.1 History, Morphology, classification, cultural and staining characters, Virulent factors, pathogenesis, laboratory diagnosis, prevention and control of Spirochetes & other spiral microorganisms: Treponema pallidum, 4.2 Morphology, cultural and staining characters, pathogenicity and clinical manifestations, laboratory diagnosis, epidemiology, prevention and control of Leptospira and Borrelia etc 4.3 Morphology, cultural and staining characters, pathogenicity and clinical manifestations, laboratory diagnosis, epidemiology, prevention and control of Mycoplasma & ureaplasma. 4.4 Morphology, cultural and staining characters, pathogenicity and clinical manifestations, laboratory diagnosis, epidemiology, prevention and control of Rickettsiae, Coxiella, Bartonella and Chlamydiae	**12 hrs**

Reading Lists:

1. Medical Microbiology. Brooks GF, Butel JS, Morse SA. Mc Graw Hill.
2. Textbook of Microbiology. Ananthanarayanan R and Paniker CKJ. Orient Longman.
3. Diagnostic Microbiology. Forbes BA, Sahm DF, Weissfeld AS. Mosby Elsevier.

4. Bergey's Manual of Determinative Bacteriology. Holt JG, Krieg NR, Sneath PHA, Staley JT, Williams ST. Lippincott Williams& Wilkins.
5. District laboratory practice in tropical countries. Cheesbrough M. Cambridge University Press.
6. Manual of Clinical Microbiology. Murray PR, Jo Baron E, Pfaller MA, Tenover FC, Yolken RH. ASM Press.
7. Essentials of Medical Microbiology. Apoorva Sankar Sastry, Sandhya bhatt. Jaypee pulications.

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 satellitism? (3 marks)
2. Explain the morphological features of *C.diphtheriae* (5 marks)
3. What is enteric fever? Explain the laboratory diagnosis of Enteric fever?

(10 marks)

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Semester	Type of Course	Course Code	Name of the Course
II	**Core Course**	**MSMBY02DSC10**	**FOOD MICROBIOLOGY**

Credit			Teaching Hours			Assessment weightage		
L/T	P/I	Total	L/T	P/I	Total	CE	ESE	Total
3	0	3	45		45	40	60	100

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	Demonstrate the knowledge about the type and analysis of microbial communities and loads in food and beverages
CO2	Analyse types of food poisoning microorganisms that are present in the food and beverages
CO3	Formulate strategies for preservation of food and beverages
CO4	Explain the concepts of quality checking in food industry

Course content:

Module	Description	Teaching Hours
Module 1	1.1 Factors which influence microbial growth, survival and death in foods, spores and theirsignificance 1.2 Indicator microorganisms and microbiological criteria. 1.3 Microbialspoilageof foods 1.4 Factorsaffecting food spoilage atdifferent levels– intrinsicand extrinsicfactors	**13hrs**
Module 2	2.1 Spoilage of meat, poultry and sea foods, milk and dairy products, fruits, vegetables andgrains. 2.2 Preservationmethodsandpreservatives: 2.3 Physical methods of preservation, chemical preservatives and natural antimicrobial compounds, biologically based preservation system. 2.4 Problems associatedwith 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 Probioticsand prebiotics	**12hrs**
	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.	

Module 4	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. DairyMicrobiology–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%

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Semester	Type of Course	Course Code	Name of the Course
II	**Core Course**	**MSMBY02DSC11**	**SYSTMATIC BACTERIOLOGY 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

The course, allowing students to gain hands-on experience in microbial cultivation, isolation, and identification techniques. They will learn how to apply selective and differential media, biochemical tests, and molecular tools to characterize and classify bacterial isolates. The laboratory exercises will enhance the students' understanding of the theoretical concepts taught in lectures and develop their practical skills in bacterial identification.

Course Objectives:

- To understand the Morphology and Characters different bacteria
- The course aims to enable the students how to identify, classify, and differentiate bacterial species using various laboratory techniques and tools.
- To enable the students to diagnose the major bacterial diseases of humans.

Course Outcomes:

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

CO1	Upon the completion of the course, the students able to use laboratory techniques for the isolation, cultivation, and identification of bacteria.
CO2	Interpret and analyze bacterial characteristics such as morphology, physiology, genetics, and metabolism.
CO3	Able to do the isolation and identification of bacteria in various environments,

	including medical, agricultural, and environmental contexts
CO4	The students will able to diagnose and interpret infectious diseases caused by bacterial pathogens.
CO5	Able to perform antimicrobial tests and its interpretation in various infectious diseases.

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

Course Contents:

Module	Description	Teaching Hours
Module	1. Grams staining, acid fast staining, endospore staining, Albert staining. 2. Phenotypic characterization of bacteria 3. Biochemical characters of important bacteria 4. Identification of gram positive bacteria by different methods. 5. Identification of gram negative bacteria by different methods 6. Antibiotic sensitivity test by Kirby-Bauer method. 7. In vitro susceptibility testing of bacteria by CLSI: broth macro dilution and mi-crodilution	**30 hrs**

Reading Lists:

1. District laboratory practice in tropical countries. Cheesbrough M. Cambridge University Press.
2. Manual of Clinical Microbiology. Murray PR, Jo Baron E, Pfaller MA, Tenover FC, Yolken RH. ASM Press
3. Bailey & Scott's Diagnostic Microbiology
4. Mackie and McCartney practical Medical Microbiology.
5. Textbook of Diagnostic Microbiology (Mahon, Textbook of Diagnostic Microbiology) Publisher: Saunders;

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%

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Semester	Type of Course	Course Code	Name of the Course
II	Core Course	MSMBY02DSC12	FOOD 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

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

Course Description

The main objective of this course will be to learn about the scope of food microbiology and food safety, as well as important genera of microorganisms related to food and their characteristics. It will also teach students about various techniques for listing and controlling food-related microbes and how to use these techniques in order to preserve food.

Course Objectives:

- Isolation, identification and enumeration of bacterial cultures from various food sources

Course Outcomes:

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

CO1	Demonstrate isolation, identification and enumeration of bacterial cultures from various food sources

Course contents:

Module	Description	Teaching Hours
Module	1. Isolation identification and characterization of bacteria and fungi from food products. 2. Impact of heat, chemicals and radiation on preservation/shelf life of food	**30 hrs**

	3. Detection/Estimation of indicator microorganisms 4. Production of bread 5. Production of yoghurt 6. Detection of contaminating microorganisms in food by molecular methods	

Reading Lists:

1. Laboratory Manual of Food Microbiology, Neelima Garg, K L Garg & K.G. Mukerji, ISBN: 9789380578019, IK Books
2. Microbiology Practical Manual, 1st Edition Paperback – 15 September 2018

   by Amita Jain (Author), Jyotsna Agarwal (Author), Vimala Venkatesh (Author). Elsevier
3. Laboratory Manual For Food Microbiology (4th ed.) - By W. C. Frazier; E. H. Marth; and R. H. Deibel. Minneapolis, Minn. 55415: Burgess Publishing Co.

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%

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Semester	Type of Course	Course Code	Name of the Course
II	**Elective Course**	**MSMBY02DSE01**	**MICROBIAL PHYSIOLOGY AND METABOLISM**

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 Objectives:

Course Description

Students will gain knowledge about the basics of different nutritional groups of microorganisms, their growth and reproduction, culture techniques. They also will be able to explain the physiological and metabolic pathways of microorganisms

- To understand the physiological characters of microorganisms
- To understand growth conditions of microorganisms
- To understand the metabolic pathways and energy production in microorganisms
- To understand metabolisms of different nutrient molecules in microorganisms

Course Outcomes:

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

CO1	Explain the physiological characters, growth, and reproduction in microorganism
CO2	Explain the metabolic pathways present in the microorganism
CO3	Demonstrate alteration in the metabolic pathways lead to biological impairment
CO4	Elucidate the role metabolic enzymes in the microorganism

Course contents:

Module	Description	Teaching Hours
Module 1	1.1 Nutritional groups of bacteria, 1.2 Photoautotrophy and bacterial photosynthesis, 1.3 Chemoautotrophy, photoheterotrophy, chemoheterotrophy, heterotrophic metabolism. 1.4 Aerobic and anaerobic respiration (fermentation)	**6 hrs**
Module 2	2.1 Different trophic media for bacteria, fungi, and algae, defined and undefined media, basal media, differential media, maintenance media, transport media. 2.2 Aerobic culturing and anaerobic culturing methods. Environmental requirements of growth. 2.3 Microbial growth, spores, and sporulation. Synchronous culture and continuous culture, capsular materials 2.4 Bacterial toxins. Pathogenesis and virulence. Lab methods for testing bacterial virulence	**10 hrs**
Module 3	3.1 Glycolysis, citric acid cycle, Glyoxylate cycle, pentose phosphate pathway of glucose oxidation, 3.2 Gluconeogenesis, glycogen synthesis, biosynthesis of polysaccharides. 3.3 Biosynthesis and degradation of fatty acids, biosynthesis and degradation of phospholipids, sterol biosynthesis, 3.4 Conversion of cholesterol to other important molecules, formation of prostaglandins.	**16 hrs**
Module 4	4.1 Pathways of amino acid degradation, urea cycle 4.2 Biosynthesis of amino acids- essential and non-essential. 4.3 De novo biosynthesis of purine and pyrimidine nucleotides, 4.4 Catabolism and interconversion of purines and pyrimidines.	**16 hrs**

Reading list

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 aerobic and anaerobic respiration in microorganisms
2. Illustrate bacterial photosynthesis
3. Explore mechanism of action of ribonucleotide reductase
4. Estimate the amount of NADH produced during TCA cycle
5. Discuss the role of glyoxylate pathway

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Semester	Type of Course	Course Code	Name of the Course
II	**Elective Course**	**MSMBY02DSE02**	**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	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, immune electrophoresis, 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

- 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. 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)

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Semester	Type of Course	Course Code	Name of the Course
II	**Elective Course**	**MSMBY02DSE03**	**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 ecology
CO2	Evaluate the techniques used to identify and enumerate microbal 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**	**MSMBY02DSE04**	**MOLECULAR BIOLOGY**

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 "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	**12 hrs**

	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	
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 blotting 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. 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. 14. Stent, G. S. and Calender, R. Molecular Genetics 1986. An Introductive Narrative, CBS Publishers and Distributors, NewDelhi.

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	MSMBY02DSE 05	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

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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	**9 hrs**

	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.	

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)

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Semester	Type of Course	Course Code	Name of the Course
III	**Core Course**	**MSMBY03DSC13**	**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:

On successful completion of the course, students 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. 1.3: The improvement of industrially important microorganisms with special reference to primary and secondary metabolites production.	**7 hrs**
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 waste watertreatment, 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**	**MSMBY03DSC14**	**ENVIRONMENTAL 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

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 a pectsin environment
CO3	Evaluate the role of microorganisms and their beneficial as pectsin agriculture, health and industry
CO4	Evaluate the role of microorganisms and their beneficial as pectsin health and industry

Course contents:

Module	Course contents	Teaching Hours
	1.1 Microbial behavior in ecosystems: Microbial biodiversity, Interactions among microbial populations. Animal-microbe and plant-microbe interactions.	

Module 1	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.	**11hrs**
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 microflora, Significance of air microflora, 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 & temperature, salinity, Hydrostatic pressure, Nutrient limitation.	**16hrs**
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 biofilms	**11hrs**
Module 4	4.1 Production of microbial biofertilizers– cyanobacteria, Rhizobium, Azotobacter, Azospirillum, Phosphobacteria and VAM, Biopesticides 4.2 Microbes as a health food (SCP)-Spirulina and its production methods. Probiotics- use of Lactobacilli and Bifido bacterium- 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.	**12hrs**

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%

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Semester	Type of Course	Course Code	Name of the Course
III	**Core Course**	**MSMBY03DS C15**	**CLINICAL AND DIAGNOSTIC 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

Clinical and Diagnostic Microbiology is an advanced course that focuses on the study of microorganisms and their role in human health and disease. This course provides students with an in-depth understanding of the principles and techniques used in the clinical laboratory for the identification and characterization of microorganisms. Students will learn about the major groups of bacteria, viruses, fungi, and parasites that are of clinical importance, as well as their associated diseases.

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Course Objectives:

- Identify and differentiate the major types of microorganisms that cause human diseases, including bacteria, viruses, fungi, and parasites.
- Students get knowledge to perform laboratory procedures for collection, transport, processing of different clinical specimens from infectious diseases.

- Interpret laboratory test results and correlate them with clinical findings to aid in the diagnosis and treatment of infectious diseases.
- Understand the principles of antimicrobial therapy and the mechanisms of antimicrobial resistance.
- To understand the importance of infection control measures in preventing the spread of infectious diseases.
- Understand the role of microbiology in public health, including epidemiology, outbreak investigation, and disease surveillance.

Course Outcomes:

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

CO1	Explain the Collection, transport and processing of clinical specimens for the isolation, cultivation, and identification of pathogenic microorganisms, and perform antibiotic susceptibility testing.
CO2	Interpret laboratory test results and correlate them with clinical findings to aid in the diagnosis and treatment of infectious diseases.
CO3	Apply the principles of antimicrobial therapy and the mechanisms of anti-microbial resistance and apply this knowledge to the selection and use of appropriate antimicrobial agents.
CO4	Apply infection control measures and their importance in preventing the spread of infectious diseases.
CO5	Students will be able to work in clinical microbiology labs and research institutes.

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

Course contents:

Module	**Description**	**Teaching Hours**
Module 1	1.1 Normal flora of human body. 1.2 Epidemiology, Etiology, Pathogenesis, diseases, Laboratory diagnostic procedures and prophylactic measures of the following infections: Respiratory tract infections: Upper respiratory tract- etiology, transmission, pathogenesis, epidemiology and clinical features of the following Common cold, pharyngitis and tonsillitis, otitis and sinusitis, acute epiglottitis, oral cavity infections, laryngitis and diphtheria etc. 1.3 Lower respiratory tract- whooping cough, bronchitis, RSV infections, bacterial pneumonia, viral pneumonia, tuberculosis, cystic fibrosis, lung abscesses. Diagnosis of	**11 hrs**

	respiratory tract infections. 1.4 Urinary tract infections and sexually transmitted diseases.Bacterial, viral and fungal infections of urinary tract-etiology, pathogenesis, transmission, clinical features, complications and diagnosis.Etiology, transmission, clinical features, and diagnosis of sexually transmitted diseases (syphilis, gonorrhea, chlamydial infections, HIV, bacterial vaginitis, genital herpes, papilloma virus infections, opportunistic STDs etc.)	
Module 2	2.1 Gastrointestinal tract infections: Etiology, pathogenesis, clinical features and diagnosis of diarrheal diseases (bacterial and viral), Helicobacter pylori, food poisoning. 2.2 Parasites in the GI tract 2.3 Central nervous system infections: infections caused by bacteria, virus, fungi and protozoa, viral encephalitis, brain abscesses, tetanus, botulism etc. 2.4 Infections of the skin, ear and eye: Etiology, transmission, diagnosis and prevention.	**13 hrs**
Module 3	3.1 Pyrexia of unknown origin, Blood Infections: Etiology, transmission, diagnosis and prevention. 3.2 Organization, design and structure of a diagnostic Microbiology Laboratory. Biological safety measures Quality control. Modern techniques employed in Clinical Microbiology laboratory.	**11 hrs**
Module 4	4.1 Nosocomial infections: epidemiology, bacterial and viral infections, diagnosis and control programmes, 4.2 Zoonotic infection, Food, water and air borne infections. 4.3 Collection, transport, processing and storage of the following clinical specimens like Blood, Urine, Pus, Sputum, Swabs, 4.4 Collection, transport, processing and storage of the following clinical specimens like Stool, Body fluids, Vomits, CSF, Biopsy specimens, Scrapings (Skin, Eye, Hair, Nail)	**10 hrs**

Reading Lists:

1. Medical Lab manual – Monica.

2. Text book of Microbiology - Anantha Narayan & Jayaram Panicker

3. Clinical and Pathogenic Microbiology – Barbara.

4. Bailey & Scott’s Diagnostic Microbiology. Sauders

5. Text Book of Medical Mycology – Jagadish Chander.

6. Fundamentals in diagnostic Mycology –F.Fissure

7. Medical Microbiology – Jawetz

8. Topley and Wilson's principles of Bacteriology

9. Virology – Fields

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 significant bacteriuria? (3 marks)

2. Describe zoonotic infections? (5 marks)

3. Explain the Biological safty measure employed in a clinical microbiology laboratory? (10 marks**)**

Semester	Type of Course	Course Code	Name of the Course
III	Core Course	MSMBY03DSC16	VIROLOGY, MYCOLOGY AND 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 outcomes based on revised Bloom's taxonomy*

Course Contents:

Module	**Description**	**Teaching Hours**
Module 1	4.1 General properties of viruses and bacteriophages: morphology of virus and bacteriophage classification and nomenclature of viruses. 4.2 Replication of viruses; steps in replication of RNA and DNA viruses. Mutation and viral interference. Cultivation of viruses: various culture methods. 4.3 Virus host interaction: Pathogenesis of viral infections, host immune response, 4.4 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 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.	**14 hrs**

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**)**

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Semester	Type of Course	Course Code	Name of the Course
III	**Core Course**	**MSMBY03DSC 17**	**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 offer the students, to provide hands on training on Fermentation techniques.

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

Mode of Transaction

- Off-line mode, Laboratory work, PowerPoint presentation

Assessment Rubrics

	Weightage
End Semester Evaluation	60%
Continuous Evaluation	40%

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Semester	Type of Course	Course Code	Name of the Course
III	**Core Course**	**MSMBY03DSC18**	**ENVIRONMENTAL 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

The main objective of this course will be to learn about the practical aspects of isolation, identification and enumeration of microorganism that are important for environment and Agricultural productivity. The scope of environment and agricultural microbiology, as well as important genera of microorganisms related to this will enable students to understand their role

Course Objectives:

- Isolation, identification and enumeration of bacterial cultures from various Environmental and Agricultural sources

Course Outcomes:

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

CO1	Demonstrate isolation, identification and enumeration of bacterial cultures from various Environmental and Agricultural sources

Course contents:

Module	Description	Teaching Hours
Module	1. Study of various types of Micro-organisms present in soil, water and air 2. Isolation of bacteria from root nodules of different legumes 3. Enrichment of *Azotobacter* and *Rhizobium* as biofertilizers and testing its efficacy. 4. Isolation of starch degraders from soil. 5. Isolation of cellulose degraders from soil 6. Isolation of phosphate solubilizers from soil. 7. Standard qualitative analysis of water. 8. Comparison of microflora in Bt-treated/chemical pesticide-treated soils. 9. Extracellular enzyme activities of microorganisms 10. Amylase, cellulose, protease, lipase, phosphatase	**30 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)

7. Spencer, Environmental Microbiology Methods and Protocols, Springer
8. Ralph Mitchell, Ji-Dong Gu, Environmental Microbiology, wiley
9. Ian L. Pepper, Charles P. Gerba, Terry J. Gentry, Environmental Microbiology

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%

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

	Course		
III	**Core Course**	**MSMBY03DS C19**	**CLINICAL AND DIAGNOSTIC 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

The diagnostic aspect of the course emphasizes laboratory methods for the isolation, cultivation, and identification of microorganisms from clinical specimens. Students will gain hands-on experience in performing various microbiological techniques such as microscopy, culture media preparation, staining procedures, biochemical testing, and molecular diagnostics. They will also learn about antimicrobial susceptibility testing and the interpretation of laboratory results.

Course Objectives:

- Students get knowledge to perform laboratory procedures for collection, transport, processing of different clinical specimens from infectious diseases.
- Interpret laboratory test results and correlate them with clinical findings to aid in the diagnosis and treatment of infectious diseases.
- Understand the principles of antimicrobial therapy and the mechanisms of antimicrobial resistance.
- To understand the importance of infection control measures in preventing the spread of infectious diseases.

Course Outcomes:

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

CO1	Perform laboratory procedures like collection, transport and processing of clinical specimens for the isolation, cultivation, and identification of pathogenic microorganisms, and perform antibiotic susceptibility testing.
CO2	Interpret laboratory test results and correlate them with clinical findings to aid in the diagnosis and treatment of infectious diseases..
CO3	Develop an understanding of infection control measures and their importance in preventing the spread of infectious diseases.

CO4	Students will be able to work in clinical microbiology labs and research institutes

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

Course Contents:

Module	Description	Teaching Hours
Module	1. Study of normal flora of human body 2. Isolation, characterization and identification of pathogens from various clinical specimens 3. Study of antibiotic sensitivity of common pathogens 4. Microbiological investigations on specimens like Urine, feces, purulent material, CSF, blood, Sputum and Body fluids. 5. Blood smear for parasites. 6. Feces examination for parasites. 7. Microbiological examination of specimens for fungal elements	**30 hrs**

Reading Lists:

1. Microbiology in clinical Practice – Shannon.
2. Bailey & Scotts Diagnostic Microbiology
3. Medical Lab manual – Monica.
4. Koneman's colour atlas and text book of diagnostic microbiology-Winn Washington .C
5. Diagnostic Microbiology- Mahron C.R; George Munuselis
6. Essentials of Diagnostic Microbiology- Shimeld Lish Ann
7. Parasitology – K.D. Chatterjee.
8. Text book of Parasitology – C.K. Jayaram Panicker.
9. Text book of Medical Parasitology-Subhash Chandra Parija
10. Mackie and McCartney practical Medical Microbiology

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%

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Semester	Type of Course	Course Code	Name of the Course
III	Core Course	MSMBY03DSC20	VIROLOGY, MYCOLOGY AND PARASITOLOGY 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 and practical skills in the laboratory techniques and methods used in the study of viruses, fungi, and parasites. The course aims to deepen the understanding of these microorganisms, their structure, , pathogenesis, and methods for their detection, isolation, and characterization. Through a combination of lectures, laboratory exercises, and independent projects, students will develop proficiency in various laboratory techniques and gain insights into the practical applications of virology, mycology, and parasitology.

Course Objectives:

- Identify and differentiate the major types of viruses, parasites, funguses and understand their cultivation, identification and laboratory diagnosis.
- To enable students to understand the pathogenesis, clinical presentation, laboratory diagnosis, prevention/ control of various Parasitic, viral and fungal diseases.

Course Outcomes:

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

CO1	Viral isolation methods.
CO2	Enable the students to perform laboratory methods for the diagnosis of viral infections.
CO3	The students will able to identify the current and emerging human viral diseases.

CO4	Enable the students to perform laboratory methods for the diagnosis of various human parasitic infections and its management.
CO5	Enable the students to perform laboratory methods for the diagnosis of pathogenic fungus which causes diseases to humans and its management.

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

Course Contents:

Module	Description	Teaching Hours
Module	1. Embryonated eggs for cultivation of viruses 2. ELISA, Western blotting 3. Study of pathogenic yeasts and molds 4. In vitro antifungal susceptibility testing of yeasts by CLSI: broth macro dilution and microdilution 5. Identification of eggs and cysts of parasites from stool sample: saline wet mount, iodine wet mount, sedimentation and flotation technique 6. Observation of permanent slides of pathogenic protozoans	**30 hrs**

Reading Lists:

1. District laboratory practice in tropical countries. Cheesbrough M. Cambridge University Press.
2. Manual of Clinical Microbiology. Murray PR, Jo Baron E, Pfaller MA, Tenover FC, Yolken RH. ASM Press
3. Medical Parasitology.Jayaram Panicker, Jay pee publications.
3. Medical Mycology, Jagadish Chandir, Jaypee publishers
4. Medical Mycology. Dey NC, Grueber HLE, Dey TK. Mc Graw Hill

Teaching Learning Strategies

- Laboratory Experiments

Assessment Rubrics

	Weightage

End Semester Evaluation	60%
Continuous Evaluation	40%

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Semester	Type of Course	Course Code	Name of the Course
III	**Elective Course**	**MSMBY03DSE06**	**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:

On successful completion of the course, students 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.	**12 hrs**

	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.	
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 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.	**11 hrs**

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 (4^{th} Ed) - Baxevanis AD, Bader GD Wishart DS (Eds), 2020, Wiley

7. Bioinformatics: Methods and applications (4^{th} 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

- 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. 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	MSMBY03DSE07	MARINE 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

This program discusses the recent advancements in the microbial biodiversity and will provide a summary of their structure and operation, neighborhoods in the oceans, as well as discussions of cutting-edge techniques, findings, and theories. The topics covered include marine organisms, interactions between bacteria and their grazers, coexistence and mixotrophy among oceanic microorganisms, coastal infections and their biological effect. Metagenomics, individual cell activity in marine microorganisms.

Course Objectives:

- To study the diversity of bacteria, and archaea in marine environments.
- To analyze the roles of microbes in ocean processes.
- To learn the metabolic diversity of microbes in marine environments.
- To learn natural products originated from microbial sources in marine environments.

Course Outcomes:

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

CO1	Explain and demonstrate the dispersal and adaptability of microorganisms in marine environment.
CO2	Evaluate the role of microorganisms and their beneficial aspects in drinking water
CO3	Role of microorganisms and their effect in bioluminescence.
CO4	Learn the types of enzymes produced by marine organisms and their beneficial use for human welfare

Course contents:

Module	Description	Teaching Hours
Module 1	1.1 Marine environment – sea-benthic and littoral zone, salt pan, mangroves and estuarine microbes, 1.2 Microbial loop – marine microbial community – planktons, bacteria, fungi, protozoa. 1.3 Methods of collection and estimation of marine microbes. 1.4 Influence of physical, chemical and biological factors on marine microbes.	**11 hrs**
Module 2	2.1Microbiology of water: Microbial communities in aquatic environments, factors affecting microbial population in natural waters, Air water interface, 2.2 Microbial Corrosion, Bacteriological analysis of drinking water. 2.3 Water purification and various steps involved 2.4 Pathogenic marine bacteria: pathogenic human viruses in coastal waters. Public health risk.	**10 hrs**
Module 3	3.1 Microorganisms responsible for bioluminescence in marine environment. Uses of bioluminescence. 3.2 Mechanism of quorum sensing in Vibrio fischeri. 3.3 Microbial indicators of marine pollution and control, biofouling, biocorrosion, biofilms, biodegradation and bioremediation of marine pollutants. 3.4 Use of genetically engineered microorganisms in biodegradation.	**13 hrs**
Module 4	4.1 Marine natural products, bioactive compounds from marine microorganisms, 4.2 Marine biosensor. 4.3 Biosurfactants, biopolymers 4.4 Novel enzymes from marine organisms.	**11 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, Tayor & Francis Exclusive

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%

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Semester	Type of Course	Course Code	Name of the Course
1II	Elective Course	MSMBY03DSE08	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 Objectives:

- To explain the genetic engineering techniques.

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.

- 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

On successful completion of the course, students 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 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.	**8 hrs**
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	**14 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.	**9 hrs**

	4.5: Antisense RNA technology and its application. 4.6: CRISPR-Cas9 Genome editing technology	

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

- 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	**Elective Course**	**MSMBY03DSE09**	**VETERINARY 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

Veterinary microbiology is the study of microorganisms that cause disease in animals, as well as the host response to infection. It is a broad field that encompasses the study of bacteria, viruses, fungi, and parasites. Veterinary microbiology is an important field for both animal and human health. Many infectious diseases can be transmitted between animals and humans (zoonoses), so it is important to control these diseases in animals

Course Objectives:

- Understand the important bacteria, fungi and viruses of veterinary relevance
- Recognize the microorganisms of veterinary importance
- Understand the bacteria, fungi and viral pathogenesis of veterinary importance
- Understand the control measures of veterinary diseases

Course Outcomes:

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

CO1	Acquire knowledge in the type and distribution of microbial communities in field of Veterinary
CO2	Analyze the type of bacterial species that cause disease in animals
CO3	To learn and know the types of fungi that are associated with infection in animals
CO4	To learn and know the types of viruses that cause infection in animals

Course contents:

Module	Description	Teaching Hours
Module 1	1.1 Introduction to Veterinary Microbiology 1.2 Microbes as infectious agents of Animals and Birds. Host-pathogen relationship. Bacterial and fungal toxins- production and mode of action 1.3 Veterinary Bacteriology and their bacterial species 1.4 Studies on Animal/Avian Bacteria belonging to various families, and prion agents and pathogenesis, epidemiology, and control –	**8 hrs**
	2.1 Gram negative- aerobic rods and cocci, family	

Module 2	Pseudomonadaceae, Legionellaceae, Neisseriaceae, and genus Brucella. Facultative anaerobic Gram-negative rods, family-Vibrionaceae, Pasteurellaceae, 2.2 Enterobacteriaceae and other genera: Gram positive cocci, family Micrococaceae, endospore forming Gram positive rods and cocci, family Bacillaceae genus Bacillus, Sporolactobacillus and Clostridium. 2.3 Spirochetes. Family Spirochetaceae and other families like Spirillaceae, coryneform bacteria, Dermatophillaceae, Streptomycetaceae. Mycobacteria and Nocardia, family Actinomycetaceae. Atypical prokaryotes such as Chlamydia, Rickettsiae, Mycoplasma, Acholeplasma, Spiroplasma, Anaeroplasma and Thermoplasma. 2.4 Regular non-sporing Gram-positive rods such as Listeria and Erysipelas. Anaerobic Gram negative straight, curved and helical rods, family Bacteriodaceae and genus Bacteroides and Fusobacterium	**14 hrs**
Module 3	3.1 Introduction to Veterinary Mycology 3.2 Systematic study of animal mycoses such as aspergillosis, candidiasis, cryptococcosis 3.3 Epizootic lymphangitis, mycetom as, sporotrichosis, histoplasmosis, blastomycosis, coccidioidomycosis, haplomycosis, rhinosporidiosis, 3.4 Zygomycosis, mycotic abortion, mycotic mastitis, mycotic dermatitis, dermatophytoses, mycotoxicosis	**10 hrs**
Module 4	4.1 Introduction to Veterinary Virology, Studies on Animal/Avian viruses belonging to various families, and prion agents and pathogenesis, epidemiology, and control – 4.2 Capripoxvirus, avipoxvirus, cowpox virus; bovine herpes viruses, equine herpes viruses, infectious laryngotracheitis virus, Marek's disease virus, pseudorabies virus, malignant cattarrh fever virus; infectious canine hepatitis virus, egg drop syndrome virus, inclusion body hepatitis, hydropericardium virus, papillomatosis,	**13 hrs**

	canine parvoviruses, feline panleucopenia virus. 4.3 Newcastle disease virus, canine distemper virus, rinderpest virus, PPR virus; infectious bursal disease virus; rotavirus, blue tongue virus, African horse sickness virus; rabies virus, ephemeral fever virus, borna virus. 4.4 Infectious bronchitis virus, transmissible gastroenteritis virus; equine arteritis virus, equine encephalomyelitis viruses; swine fever virus, BVDV mucosal disease virus; foot and mouth disease virus, duck hepatitis virus; visna/maedi virus, equine infectious anemia virus, avian leucosis complex virus, Avian flu Virus, bovine leukemia virus, chicken anemia virus; prions: scrapie, bovine spongiform encephalopathy, Immune response to viruses and viral vaccines	

Reading lists:

1. Glen Sonder J & Karen W Post. Veterinary Microbiology: Bacterial and Fungal Agents of Animal Diseases. Cold Spring Harbor Lab. Press.
2. Wayne Roberts, Gordon R. Carter, and M. M. Chengappa, Essentials of Veterinary Microbiology
3. Frank J. Fenner, Peter A. Bachmann, E. Paul J. Gibbs, Veterinary Virology
4. B. K. Markey, Ann Cullinane, Marie Archambault, Finola Leonard, Dores Maguire, Clinical Veterinary Microbiology
5. Yuan Chung Zee, Veterinary Microbiology
6. Prescot LM, Harley JP & Klen DA. Microbiology. W. C. Brown Publ.
7. TortoraGJ, Funke BR & Case CL. Microbiology: An Introduction. Benjamin/Cummins Publ
8. Carter J & Saunders V. Virology: Principles and Applications. 1st Ed. Wiley.
9. Murphy FA, Gibbs, EPJ, Holzmek MK & Studdert MJ. Veterinary Virology. 3rd Ed. Academic Press.
10. Dodds WJ & Schulz R. (Eds). Veterinary Vaccines and Diagnostics. Vol. 41 (Advances in Veterinary Medicine) I st Ed. Academic Press.
11. Levine MM, Kaper JB, Rappuoli R, Liu MA & Good MF. 2004. New Generation Vaccines. 3rd Ed.
12. Marcel-Dekker. Pastoret PP, Blancou J, Vannier C & Verschueren C. Veterinary Vaccinology. Elsevier
13. Veterinary Microbiology and Microbial Disease Paperback – Illustrated
14. P. J. Quinn, B. K. Markey, F. C. Leonard, P. Hartigan, S. Fanning

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%

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ABILITY ENHANCEMENT COURSE

Semester	**Type of Course**	**Course Code**	**Name of the Course**
II	**Ability Enhancement Course**	**MSMBY02AEC01**	**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**
	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	

Module 3	the success of structure predictions 3.2 RNA structure prediction: introduction, self-complimentary regions in RNA sequences, minimum free energy method for RNA secondary structure prediction, suboptimal structure predictions by Mfold, RNA databases: RNA structure analysis and prediction tools.	**7 hrs**
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**	**MSMBY02AEC02**	**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 precautions for handling fluids, tissues and cells. Decontamination in the microbiology laboratory, packing and shipping of biological materials.	**9 hrs**
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

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VALUE ADDITION COURSE

Semester	Type of Course	Course Code	Name of the Course
II	**Value Addition Course**	**MSMBY02VAC01**	**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 Outcome:

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 Contents:

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**
Module 4	4.1 Presentation tools: oral and poster, Microsoft PowerPoint and PDF slide ICT tools - Features of a good oral presentation. 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.	**8 hrs**

Suggested Classroom Activities:

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

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.

On-line Sources

1. https://iversity.org/en/courses/scientific-writing-skills
2. https://esajournals.onlinelibrary.wiley.com/doi/full/10.1002/bes2.1258

Assessment:

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

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MULTI DISCIPLINARY COURSE

Semester	Type of Course	Course Code	Name of the Course
III	**Multi-Disciplinary Course**	**MSMBY03MDC01**	**BASIC MICROBIOLOGY**

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

Basic 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, role in environment. It explores the fascinating word 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 Outcome:

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

CO1	Characteristics of microorganisms, their structure, and function.
CO2	Basic operations in a Microbiology Laboratory and foundational understanding of the principles and applications of microbiology techniques used to study microorganisms.
CO3	The role of microorganisms in human health and disease, including the pathogenesis of infectious diseases and the principles of antimicrobial therapy.
CO4	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	**14 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.	**14 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 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	**18 hrs**
Module 4	4.1 Microbial nutrition and metabolism of bacteria: factors influencing bacterial growth, Photo autotrophy and bacterial photosynthesis. 4.2 Methods of testing antimicrobial substances, Drug resistance of microbes.	**14 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
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. Textbook of Microbiology 9th Edition, Ananthanarayan, Paniker, Universities Press
9. Essentials of Medical Microbiology, Apurba Sankar Sastry. Jaypee Publications.
10. Textbook of Microbiology Prof C P Bhaveja, Arya publications

Teaching Learning Strategies

- Assignments, Internal examinations/Unit tests, Seminar presentations

Mode of Transaction

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

Assessment Rubrics

	Weightage
End Semester Evaluation	60%
Continuous Evaluation	40%

Sample Questions

1. What is continuous culture? (3 marks)
2. Explain anaerobic culture methods? (5 marks)
3. Define sterilization? Describe different methods of moist heat sterilization? (10 marks)

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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.