JECRC™
UNIVERSITY
BUILD YOUR WORLD

School of Science

Course Structure and Syllabus

B. Sc. Microbiology

Academic Programme

2025-2029

Programme Outcome: After completion of degree course the student will be acquainted with sufficient knowledge in Microbiology. The degree program combines the teaching of core principles with hands-on laboratory experience, preparing students for exciting careers in industry and academia.
The course also provides a wide range of opportunities in *industries, pharmaceutical companies, Health care services* and *teaching* after graduating the course.

The student outcomes are:

1. To familiarize students with fundamental concept of basic techniques and their applications in applied sciences.
2. It is expected that the knowledge gained through this course will make student competent to meet the challenges of academic and professional courses.
3. To train the student in various aspects related to applied microbiology and medical microbiology.
4. An ability to apply profound understanding of basic to applied microbiology.
4. An ability to design and perform experiments, as well as to analyze and interpret data.
5. An ability to communicate effectively with reference to speaking, reading, writing and listening clearly in person through electronic media in English and Hindi and able to get acquented with the people, ideas books media and technology.
6. A recognition of the need for, and an ability to engage in life-long learning.
7. A knowledge of contemporary and burning issues.

B.Sc. Microbiology Program Educational Objective (PEO's):

A Graduate of the Microbiology should:

PEO-I

Students will develop themselves as effective professionals by the knowledge gained with attention to team work, effective communication, critical thinking and problem solving skills.

PEO-II

Students will develop professional skills that prepare them for self employment as well as to qualify competitive examination and life-long learning in advanced areas of Microbiology and applied fields.

PEO-III

Students will demonstrate their ability to adapt to a rapidly changing environment by having learned and applied new skills and new technologies.

PEO-IV

Students will be provided with an educational foundation that prepares them for excellence, leadership roles along diverse career paths with encouragement to professional ethics and active participation needed for a successful career.

Program Outcome

A candidate who is conferred an UG (Hons) degree i.e. B.Sc. (Hons) degree in microbiology needs to have acquired/developed following competencies during the programme of the study:

PO1. Acquired knowledge and understanding of the microbiology concepts as applicable to diverse areas such as medical, industrial, environment, genetics, agriculture, food and others

PO2. Demonstrate key practical skills/competencies in working with microbes for study and use in the laboratory as well as outside, including the use of good microbiological practices.

PO3. Competent enough to use microbiology knowledge and skills to analyze problems involving microbes, articulate these with peers/ team members/ other stake holders, and undertake remedial measures/ studies etc.

PO4. Developed a broader perspective of the discipline of Microbiology to enable him/her to identify challenging societal problems and plan his professional career to develop innovative solutions for such problems.

PO5. Acknowledges health safety environment (HSE) and ethical issues in handling chemicals and biological materials; understands the environmental impacts associated with the activity; performs risk assessments and is familiar with safety instructions in his/her subject area.

PO6. Can communicate scientific results to the general public and experts by writing well-structured reports and contributions for scientific publications and by oral presentations

PO7. To demonstrate knowledge to understand the culture, essential facts, concepts, principles and theories relating to the subject areas identified and to recognize, analyze problems and plan strategies for their solution.

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Ref: JU/Reg/24/Const./Microbiology/ 16200

15th October, 2024

Sub: Constitution of Board of Studies – Microbiology & Zoology

To : All Members of Board of Studies

As recommended by the Dean-School of Science, the President of JECRC University, Jaipur is pleased to constitute a combined BOS of the Department of Microbiology and the Department of Zoology with effect from 15th October, 2024 to 14th October, 2027. Following is the list of members.

Sl.No.	Name	Designation	Status
1	Dr. Varsha Gupta	Professor & HOD, Microbiology	Convener
2	Dr. Rajesh Yadav.	Professor & HOD, Zoology	Member
3	Dr. Deepesh Neelam	Assistant Professor-I	Member
4	Dr. Ravi Kant Rahi	Assistant Professor-I	Member
5	Dr Devki	Assistant Professor-I	Member
6	Prof. Rashmi Sisodia	Professor & Former Head, Department of Zoology, University of Rajasthan.	External Member
7	Dean, School of Sciences will be a permanent invitee.		

Composition and term of office of the Board of Studies.-

(1) The duration of the Board of Studies shall be for a period of three years.

(2) The Convener shall convene meeting of the Board of Studies.

(3) The quorum of the meeting shall be one half of the total members.

(4) The Dean shall have right to be present and speak at the meetings of the Boards of Studies relating to his faculty.

Agrawal

Functions of the Board of Studies.- The Board of Studies shall perform the following functions, namely:-

(i) to recommend courses of study, curricula and scheme of examinations in its respective subject(s) and shall advise on all matters relating thereto referred to it by the Board of Management or the Academic Council or the Faculty concerned;

(ii) to bring to the notice of the Academic Council or the Board of Management matters connected with examination in its subject or subjects and may also address the Faculty concerned on any matter connected with the improvement of its courses;

(iii) to hold a joint meeting of two or more Boards of Studies, with the consent of the President, or on the advice of the Academic Council or the Board of Management, and act in concurrence and render a joint report upon any matter which lies within the province of such Boards of Studies. In such cases the joint meeting shall elect its own Chairman from amongst the Conveners of various Boards of Studies;

(iv) to prepare panels of examiners in their respective subjects:
Provided that no person shall be qualified for appointment as an examiner in final semester/annual examination in a subject unless he has taught the subject at least three years up to the standard of examination and possess five years' teaching experience in that subject.

Provided further that each Board of Studies shall prepare a panel consisting of,-

(i) all qualified internal examiners; and

(ii) as many external examiners as may be needed for conducting examinations of the university for a period of five years in each subject for each examination.

Provided also that in every final semester/annual examination at least 50% examiners shall be from higher educational institutions not connected with the University and which are not managed by the sponsoring body of the University;

(v) to advise the University Authorities on examination reforms; and

(vi) to advise the University Authorities on any matter referred to it.

Registrar
JECRC University, Jaipur-303905

Registrar

JECRC UNIVERSITY, JAIPUR

JU/2023/SOS/HOD Micro/Cir/BOS Meeting/ Dated: 27/10/2025

CIRCULAR

All members of Board of Studies of Microbiology & Zoology are requested to attend a meeting to revision of Syllabi & Credits of the courses in B.Sc.& M.Sc. Microbiology & Zoology under School of Sciences incorporating the changes/modifications as per Choice Based Credit System proposed by National Education Policy (NEP), 2020 and Learning Outcomes based Curriculum Framework (LOCF), 2019 of UGC guidelines & suggestions given by stakeholders catering industry demand for the Session 2024-25 on 27th October 2025 at 1:00 PM in the Microbiology Lab 105, Nyaya Bhawan.

Prof. (Dr) Varsha Gupta
Convener, BOS Microbiology
JECRC University, Jaipur

Member BOS

1. Prof. (Dr) Varsha Gupta (Professor & Head, Microbiology)- Convener BOS
2. Prof. (Dr) Rajesh Yadav (Professor & Head, Zoology) – Member
2. Dr Deepesh Neelam (Assistant Professor)- Member
3. Dr Ravi Kant Rahi (Assistant Professor)- Member
4. Dr Devki (Assistant Professor)- Member
5. Prof. (Dr) Widhi Dubey (Professor & Dean, School of Sciences)- Permanent Invitee

External Members

6. Prof. Rashmi Sisodia -Professor and Former Head, Department of Zoology, University of Rajasthan -External Member

Copy to:

1. The President- For information
2. Registrar

JECRC UNIVERSITY, JAIPUR

FACULTY OF SCIENCE

ATTENDANCE SHEET

BOARD OF STUDIES MICROBIOLOGY AND ZOOLOGY

MINUTES OF MEETING

Dated: 27/10/2025 Time: 01:00 PM Venue- NYB 105

S. No.	Name	Designation	Signature
1	Prof. (Dr) Varsha Gupta	Professor & Head – Convener	
2	Prof. (Dr) Widhi Dubey	Professor & Dean, School of Sciences – Permanent Invitee	
3	Dr Rajesh Yadav	Professor & Head, Zoology – Member	27/10/2025
4	Dr Deepesh Neelam	Assistant Professor – Member	
5	Dr Ravi Kant Rahi	Assistant Professor – Member	
6	Dr Devki	Assistant Professor – Member	
7	Prof. Rashmi Sisodia	Professor and Former Head, Department of Zoology, University of Rajasthan – External Member	

Minutes of the Meeting

Board of Studies Meeting – Microbiology & Zoology

Date: 27/10/2025

Time: 1:00 PM onwards

Venue: Microbiology Lab., NYB-105

Agenda: Revision of Syllabi & Credits of Microbiology & Zoology Courses as per NEP (UGC) Guidelines and Stakeholder Suggestions for the Session 2025-26

Attendees:

1. **Prof. (Dr) Varsha Gupta** (Professor & Head, Microbiology) – Convener
2. **Prof. (Dr) Rajesh Yadav** (Professor & Head, Zoology) – Member
3. **Dr. Deepesh Kumar Neelam** (Assistant Professor, Microbiology) - Member
4. **Dr. Ravi Kant Rahi** (Assistant Professor, Microbiology) - Member
5. **Dr. Devki** (Assistant Professor, Microbiology) - Member
6. **Prof. (Dr) Widhi Dubey** (Professor & Dean, School of Sciences) - Permanent Invitee
7. **Prof. Rashmi Sisodia** (Professor and Former Head, Department of Zoology, University of Rajasthan) - External Member

Meeting Commencement:

The Convener, Prof. (Dr.) Varsha Gupta, called the meeting. She welcomed all the members and expressed her gratitude for their presence at the meeting.

Introduction and Objectives:

Prof. (Dr.) Varsha Gupta explained the purpose of the meeting, which was to restructuring of syllabus for complete implementation of National Education Policy (NEP) 2020 by the University Grants Commission (UGC) and revise the final syllabi and credits of the Microbiology and Zoology courses under the School of Sciences. Additionally, the board would incorporate suggestions given by stakeholders to meet the industry demands effectively for the upcoming academic session 2025-26.

Discussion and Decision:

The board members engaged in a detailed discussion and considered the following points:

1. NEP Compliance: The board members discussed the specific changes and modifications required ensuring compliance with the NEP guidelines. They highlighted the need to focus on interdisciplinary aspects and skill-based courses to enhance the overall learning experience of students.

2. Industry Demands: The board members provided insights into the current demands of the industry and suggested incorporating practical training modules and industry-oriented projects in the curriculum. The board members agreed that such initiatives would enhance student's employability.

3. Credit Allocation: The board members proposed a credit allocation system that would allow for flexibility in choosing electives and encourage students to explore diverse areas within Microbiology. The board agreed to implement this system to enrich student's academic journey.

4. Course Modifications: The board members shared their views on updating certain existing courses to include recent research findings and advancements in the field. They recommended the inclusion of guest lectures by industry experts to provide practical exposure.

5. Incorporating Stakeholder Suggestions: The board recognized the significance of considering suggestions received from stakeholders, including alumni, current students, and potential employers. **Prof. Rashmi Sisodia**, as an external member, shared valuable inputs based on her experience, which the board decided to integrate into the syllabi revision process.

Action Plan:

Based on the discussion, the following action plan was agreed upon:

1. As per the NEP framework, the curriculum of the B.Sc. (Hons.) Microbiology course is converted into a four-year degree program beginning from the session 2025–2026.According to the NEP 2020 and detailed Guidelines issued by the UGC for Ability Enhancement Courses, Skill Enhancement Courses and Value Added Courses.

2. Syllabus of both UG and PG Programs designed according to the National Credit Framework(NCrF).
3. Credit Distribution and Certification: As per NEP guidelines: After completion of 1 year (39 credits) → Certificate will be awarded. After completion of 2 years (79 credits) → Diploma will be awarded. After completion of 3 years (120 credits) → Graduate Degree will be awarded. After completion of 4 years (160 credits) → B.Sc. (Hons.) Microbiology Degree will be awarded.
4. If any student discontinues after 1 year (Certificate) or 2 years (Diploma), he/she must complete a 1-month training program from a recognized Government/Private University, Research Institute, or Industry to fulfill the eligibility criteria.
5. All Undergraduate Programs shall have any of Indian Knowledge System (IKS) basic courses in Semester 3 and Semester 4 respectively according to UGC Guidelines. All IKS Courses shall be driven by Centre for Research in Indian Knowledge System (CRIKS) under which a Board of Studies has been constituted to define the names and syllabus of the courses (Annexure: 1).
6. For the Academic Year 2025–26, the Common Courses have been incorporated into the UG Schemes are Prompt Engineering (Generative AI) will be offered in the 3rd semester under Skill Enhancement Courses, while the 4th semester includes a 2-credit lab course using application software, R with Python, or Python Programming, along with Communication Skills, Professional Skills, and Management courses to enhance students' overall abilities (Annexure: 1).
7. Additional courses on Human Values, Professional Ethics, Universal Human Values, and Entrepreneurship Development (JIC) are also included. These courses are designed to implement NEP 2020, enhance graduate employability, and ensure measurable outcomes through effective monitoring and pre/post audit mechanisms by Dean IQAC and Dean Academic (Annexure: 1).
8. As per the new syllabus B.Sc. (Hons.) Microbiology four-year course Major core subjects are of 66 credits, Discipline specific elective (DSE) 28 credits, minor 32 credits, multidisciplinary 9 credits, Ability Enhancement course (AEC) 8 credits, Skill Enhancement course (SEC) 9 credits, Value Added Courses (VAC) 8 credits, Summer Internship 2 credits for exit from three-year B.Sc. Microbiology course. Project/Dissertation of 12 credit in eight semesters.

17. The program will incorporate Academic visits of CSIR, ICMR Central instrumentation Labs, industrial visits, seminars, workshops, conference and SWAYAM courses for skill enhancement and interdisciplinary learning.

18. The B.Sc. and M.Sc. program will emphasize skill-based learning through hands-on laboratory training, workshops, industrial visits, and research projects in various government and private institutes/industries. Students will gain practical expertise, scientific reasoning, and research-oriented skills essential for careers in microbiology and allied life sciences. These activities aim to enhance technical proficiency, analytical thinking, and research aptitude.

Zoology Department

Following changes have been done in the syllabus of Zoology offered in Graduation and Post-graduation Programme for the academic session 2025-26:

B.Sc. Zoology Minor

In BSc programme, Zoology is taken as a minor subject and for the current academic session, 46.25% revision has been done in the syllabi of Zoology Minor. Following changes in different semesters have been incorporated as the per scheme of NEP-

1. In B.Sc. 1st semester, 100% revision has been done. The course "Introductory Cytology and Histology" (BSZ014B) & its lab "Cytology and Histology Lab" (BSZ015B) is replaced by "Systematics and Diversity of Life–I (Non-Chordates)" (BSZ030A) & its lab "Systematics and Diversity of Life- I (Non-Chordates) Lab" (BSZ031A), which are new introductions representing a complete 100 percent change in both components.
2. In semester II, IV and VI no revision has been done. The courses and labs remains unchanged.
3. In semester III, 100% revision has been done by introducing, a new course of "Systematics and Diversity of Life-II (Chordates)" with a new course code (BSZ032A). Similarly, changes have been made in laboratory course also by adding experiments based only on chordates and is given a new course name and code as "Systematics and Diversity of Life- II (Chordates) Lab" (BSZ033A).
4. In semester V, 40% revision in the syllabus has been done. The course Ecology & Ethology (BSZ022A) have been revised by omitting topics of ecology from unit IV & V and adding topics of animal behavior. Accordingly, new course name and course code has been given to the course as "Ecology and Ethology (BSZ022B)". Similarly, 50% change have been made in Laboratory

9. The new syllabus scheme includes 15 Major, 8 Minor, 7 Discipline-Specific Elective (DSE), and 3 Open Elective papers. Major and DSE papers are offered by the Department of Microbiology except B.Sc. II Semester Biochemistry (BBI210A) Theory and Biochemistry Lab (BBI211A) and Bioinformatics Lab (BBI225A) in B.Sc. VIth Semester offered by Department of Biotechnology.

10. Minor papers are from other departments under the School of Sciences, and Open Elective courses are chosen by students from other UG programs across the University/SWAYAM.

11. Under the B.Sc. (Hons.) Microbiology new scheme, subject codes will range from BMI190A to BMI237A having three DSE track i.e. Food and Dairy Microbiology, Medical Microbiology, Environmental and Agriculture Microbiology.

12. All laboratory subjects are under Major, Minor, and DSE papers are mapped to the Program Outcomes (POs) defined by the Department.

13. The revised curriculum of B.Sc. Microbiology comprises a total of 63 courses, including 21 track-specific courses. Among these, 25 courses are newly introduced, reflecting an overall syllabus revision of approximately 57.18 % (Annexure: 2).

14. In M.Sc. Program 100% revision has been done. New five-paper scheme replaces the previous four-paper scheme, with theory credits reduced to 3 per paper and five practical added, each carrying one credit instead of just one subject-specific practical.

15. In Master Degree program 80 credit course offered out of which first semester with 20 credits of one core Microbiology course and four subjects with MLS common to all life sciences with 3 credit each whereas second semester is with 20 credits of advanced level courses and in third semester discipline specific courses of 20 credit were added. Further, fourth semester is with Industrial internship or Dissertation of 20 credit.

16. In Master degree program during 1st semester Molecular Biology (MLS001A) and Immunology (MLS003A) course is offered from Biotechnology Department, Bioinstrumentation (MLS005A) from the Department of Zoology and Advanced Biochemistry (MLS007A) is offered by Microbiology Department, are common courses for all the M.Sc. Microbiology, Biotechnology, Botany and Zoology.

course also by adding 5 experiments of Ethology and is given a new course name and code as "Ecology and Ethology Lab (BSZ023B)".

5. In semester VII, in one course only 40% revision in the syllabus has been done. The course Applied Zoology (BSZ026A) have been revised by omitting and rearranging some topics from Unit I, II, III and IV and adding topics from Medical Zoology in Unit IV & V. Accordingly, a new course name and course code have been given to the course as "Applied Zoology and Medical Zoology (BSZ026B)". Similarly, 10% change have been made in Laboratory course also by adding experiments of Medical Zoology and is given a new course name and code as "Applied Zoology and Medical Zoology Lab (BSZ027B)". Whereas in another offered course of VII semester, 100% revision has been done by introducing a new course with new course name and code as "Quantitative Biology & Biomedical Techniques (BSZ032A)". Similarly, Changes have been made in laboratory course by adding new experiments accordingly and is given a new course name and code as "Lab of Quantitative Biology & Biomedical Techniques" (BSZ033A). The course "Behaviour and Chronobiology (BSZ028A)" and its Lab offered in previous session is completely changed.

M.Sc. Zoology

1. In M.Sc. Programme for the academic session 2025-26, the number of courses offered per semester and total credits of the courses have been revised. The course system have been revised from the standard setup of 4 theory and 1 lab to a 5 course and 5 labs corresponding to the offered course per semester and 3 credit for theory and 1 credit for lab has been given according to the NEP 2020.
2. In semester 1, along with four common core papers offered by different departments of life sciences, one paper of specialization have been offered by the parent department of the student. All the courses in I semester now has been given a common New code to core courses Viz. 'Molecular Biology (MLS001A)', 'Immunology (MLS003A)', 'Bio-instrumentation (MLS005A)', 'Advance Biochemistry (MLS007A)' and 'Ethology & Applied Zoology (MZO036A)'. New laboratory courses have been added and given new course name and code as Molecular Biology Lab (MLS002A), Immunology Lab (MLS004A), Bio-instrumentation Lab (MLS006A), Advanced Biochemistry Lab (MLS008A), Ethology and Applied Zoology Lab (MZO037A).
3. In semester II, new Major courses and Labs are added. In Biology of chordates (MZO038A) course, 40% change are done adding few new topics in each unit and new lab course 'Biology of Chordates Lab' (MZO039A) has been offered in compliance to the theory. New courses viz. Comparative Animal Physiology (MZO040A), Biosystematics, taxonomy and Evolution (MZO042A), Biostatistics and Research Methodology (MZO044A), Histology and Histopathology (MZO046A)

and their New Lab courses have been offered with a new course codes viz. Comparative Animal Physiology Lab (MZO041A), Biosystematics, taxonomy and Evolution Lab (MZO043A), Biostatistics and Research Methodology Lab (MZO045A), Histology and Histopathology Lab (MZO047A). The course codes MZO045A, MZO046A, MZO047A and MZO048A have been offered as Elective courses and rest of the courses have been offered as the Major Courses.

4. In semester III, 3 specialized tracks as Major Discipline Specific Electives (DSE) have been offered. Each track consisting of 5 papers and their labs with credit distribution as 3+1 (Theory+ Lab). The specialized tracks offered are-Track 1: Ecology and Environmental Biology, Track 2: Genetics and Track 3: Entomology.
5. Major DSE I- "Ecology and Environmental biology" includes theory and Lab courses viz. Principles of Ecology (MZO048A & MZO049A), Natural Resources (MZO050A & MZO051A), Ecotoxicology (MZO052A & MZO053A), Biodiversity and Conservation (MZO054A & MZO055A), Environmental Pollution & Bioremediation (MZO056A & MZO057A). In Theory Courses of Principles of Ecology, Natural resources and Eco-toxicology minor revisions of 10%, 20% and 30% respectively, have been done whereas all the labs and the remaining two courses of this track are the newly introduced one and thus has 100% revision.
6. Major DSE II- "Genetics" includes theory and respective lab courses as Cytogenetics (MZO058A & MZO059A), Population & Evolutionary genetics (MZO060A & MZO061A), Basic Human Genetics (MZO062A & MZO063A), Microbial Genetics (MZO064A & MZO065A) and Developmental Genetics (MZO066A & MZO067A). All the courses in this track are the newly added course and thus marking 100% revisions.
7. Major DSE III- "Entomology" includes theory and Lab courses viz. Principles of Taxonomy & Classification of insects (MZO068A & MZO069A), Insect Diversity and Insect Physiology (MZO070A & MZO071A), Insect Toxicology & Ecology (MZO072A & MZO073A), Principles of Integrated Pest Management (MZO074A & MZO075A) and Commercial Entomology (MZO076A & MZO077A). In the Courses of Insect diversity and Insect Physiology (MZO070A) and Insect toxicology & ecology (MZO072A) no changes in their syllabi have been done whereas all the remaining courses are the newly introduced courses and thus has 100% revision.
8. In Semester IV, Dissertation or Industrial Internship (MZO078A) of 20 credits have been offered.
9. There is no change in the total credits for MSc Zoology Programme, it is 80 only same as was in the last academic session of 2024-25.
10. The overall % revision done in BSc and MSc Zoology Courses in the academic session 2025-26 is-

S. No.	Program Code of revised syllabus	Program name of revised syllabus	Total % revision done in the courses (X)	Total no of courses in the program (Y)	%age of revision
1	BSZ	B.Sc. (Hons)	740	16	46.25
2	MZO	M.Sc. (Zoology)	3745	51	73.43

11. The program Outcomes (Po's) and Course Outcomes (CO's) of B.Sc. and M.Sc. courses, their mapping and course-related books and references have also been updated in the revised courses.

Meeting Adjournment:

With no further points to discuss, Prof. (Dr.) Varsha Gupta thanked all the attendees for their active participation. The meeting was concluded.

Thanks, and Regards

Prof. (Dr.) Varsha Gupta
Convener, BOS Biotechnology
Head, Department of Biotechnology

Copy to,

1. The Registrar
2. External Expert (Industry expert via email)
3. Dean, School of Science
4. Invited members and other Members

JECRC UNIVERSITY
Department of Microbiology
SESSION 2025-2029

Semester I

Sem	Course code	Course	Course Type	Lecture Hours	Tutorial Hours	Practical Hours	Total Hours	Lecture Credit	Tutorial Credit	Practical Credit	Total Credits
1	BMI190A	Molecular Biology	Major Core	3	0	0	3	3	0	0	**3**
1	BMI191A	Molecular Biology lab	Major Core	0	0	2	2	0	0	1	**1**
1	BMI92A	Diversity of Microbiology	Major Core	3	0	0	3	3	0	0	**3**
1	BMI193A	Diversity of Microbiology Lab	Major Core	0	0	2	2	0	0	1	**1**
1		Minor 1	Minor	3	0	0	3	3	0	0	**3**
1		Minor Lab 1	Minor	0	0	2	2	0	0	1	**1**
1	DEN001C	Communication Skills	AEC	1	0	0	1	1	0	0	**1**
	DEN001D	Communication Skills Lab	AEC	0	0	2	2	0	0	1	**1**
1	DCH010A	Environment Education	VAC	2	0	0	2	2	0	0	**2**
1	DCO021A	Digital Data and AI Literacy	SEC	0	0	4	4	0	0	2	**2**
	Total			12	0	12	24	12	0	6	**18**

Semester II

2	BMI153A	Microbial Techniques & Instruments	Major Core	3	0	0	3	3	0	0	**3**
2	BMI154A	Microbial Techniques & Instruments Lab	Major Core	0	0	2	2	0	0	1	**1**
2	BMI157B	Basic Biochemistry	Major Core	3	0	0	3	3	0	0	**3**
2	BMI158A	Basic Biochemistry lab	Major Core	0	0	2	2	0	0	1	**1**
2		Minor 2	Minor	3	0	0	3	3	0	0	**3**
		Minor Lab 2	Minor	0	0	2	2	0	0	1	**1**
2		Open Elective 1	Multidisciplinary	3	0	0	3	3	0	0	**3**
2	DEN002C	Professional Skills	AEC	1	0	0	1	1	0	0	**1**
	DEN002D	Professional Skills Lab	AEC	0	0	2	2	0	0	1	**1**
2	IKS001A	Inculcation of Human Values and Professional Ethics in Higher Education Institutions	VAC	2	0	0	2	2	0	0	**2**
2	DCO018A	Advance Excel	SEC	0	0	4	4	0	0	2	**2**
	Total			15		12	27	15	0	6	**21**

Semester III

3	BMI159A	Bacteriology and Systematics	Major Core	3	0	0	3	3	0	0	3
3	BMI160A	Bacteriology and Systematics lab	Major Core	0	0	2	2	0	0	1	1
3	BMI161A	Mycology and Phycology	Major Core	3	0	0	3	3	0	0	3
3	BMI162A	Mycology and Phycology Lab	Major Core	0	0	2	2	0	0	1	1
3		Minor 3	Minor	3	0	0	3	3	0	0	3
3		Minor Lab 3	Minor	0	0	2	2	0	0	1	1
3	DBA112A	Leadership and Management	AEC	2	0	0	2	2	0	0	2
3		Any of IKS Basic Courses	VAC	2	0	0	2	2	0	0	2
3		Prompt Engineering (Generative AI) Program Specific	SEC	0	0	4	4	0	0	2	2
3	JIC001A	Entrepreneurship Development program	SEC	0	0	2	2	0	0	1	1
3		Open Elective 2	Multidisciplinary	3	0	0	3	3	0	0	3
	Total			16	0	12	28	16	0	6	22

Semester IV

4	BMI163C	Microbial Genetics	Major Core	3	0	0	3	3	0	0	3
4	BMI164C	Microbial Genetics Lab	Major Core	0	0	2	2	0	0	1	1
4	BMI167A	Virology	Major Core	3	0	0	3	3	0	0	3
4	BMI168A	Virology lab	Major Core	0	0	2	2	0	0	1	1
4		Minor 4	Minor	3	0	0	3	3	0	0	3
4		Minor Lab 4	Minor	0	0	2	2	0	0	1	1
4	IKS002A	Universal Human Value	AEC	2	0	0	2	2	0	0	2
4		Any of IKS Elective Courses	VAC	2	0	0	2	2	0	0	2
4	DCO022A	R with Python	SEC	2	0	0	2	2	0	0	2
	Total			15	0	6	21	15	0	3	18

Semester V

5	BMI183C	Microbial Physiology & Metabolism	Major Core	3	0	0	3	3	0	0	**3**
5	BMI184A	Microbial Physiology & Metabolism Lab	Major Core	0	0	2	2	0	0	1	**1**
5		Major Discipline Elective 1	Major DSE	3	0	0	3	3	0	0	**3**
5		Major Discipline Elective Lab 1	Major DSE	0	0	2	2	0	0	1	**1**
5		Major Discipline Elective 2	Major DSE	3	0	0	3	3	0	0	**3**
5		Major Discipline Elective Lab 2	Major DSE	0	0	2	2	0	0	1	**1**
5		Major Discipline Elective 3	Major DSE	3	0	0	3	3	0	0	**3**
5		Major Discipline Elective Lab 3	Major DSE	0	0	2	2	0	0	1	**1**
5		Minor 5	Minor	3	0	0	3	3	0	0	**3**
5		Minor Lab 5	Minor	0	0	2	2	0	0	1	**1**
	Total			15	0	10	25	15	0	5	**20**

Semester VI

6	BMI173A	Biostatistics	Major Core	3	1	0	4	3	1	0	**4**
6		Major Discipline Elective 4	Major DSE	3	0	0	3	3	0	0	**3**
6		Major Discipline Elective Lab 4	Major DSE	0	0	2	2	0	0	1	**1**
6		Minor 6	Minor	3	0	0	3	3	0	0	**3**
6		Minor Lab 6	Minor	0	0	2	2	0	0	1	**1**
6	BMI194A	Project	Major Core	0	0	8	8	0	0	4	**4**
6		Open Elective 3	Multidisciplinary	3	0	0	3	3	0	0	**3**
6	BBI225A/ BMI174A	Bioinformatics Lab/ Summer Intersihip	Major Core	0	0	4	4	0	0	2	**2**
	Total			12	1	16	29	12	1	8	**21**

Semester VII

7		Major Discipline Elective 5	Major DSE	3	0	0	3	3	0	0	**3**
7		Major Discipline Elective Lab 5	Major DSE	0	0	2	2	0	0	1	**1**
7		Minor 7	Minor	3	0	0	3	3	0	0	**3**
7		Minor Lab 7	Minor	0	0	2	2	0	0	1	**1**
7	BMI181A	Advanced Microbiology	Major Core	3	0	0	3	3	0	0	**3**
7	BMI182A	Advanced Microbiology lab	Major Core	0	0	2	2	0	0	1	**1**
7		Minor 8	Minor	3	0	0	3	3	0	0	**3**
7		Minor Lab 8	Minor	0	0	2	2	0	0	1	**1**
7	BMI138A	Research Methodology	Major Core	3	1	0	4	3	1	0	**4**
	Total			15	1	8	24	15	1	4	**20**

Semester VIII

8		Major Discipline Elective 6	Major DSE	3	0	0	**3**	3	0	0	**3**
8		Major Discipline Elective Lab 6	Major DSE	0	0	2	**2**	0	0	1	**1**
8		Major Discipline Elective 7	Major DSE	3	0	0	**3**	3	0	0	**3**
8		Major Discipline Elective Lab 7	Major DSE	0	0	2	**2**	0	0	1	**1**
8	BMI187A	Dissertation	Major Core	0	0	24	**24**	0	0	12	**12**
	Total			6	0	28	**34**	6	0	14	**20**
		OR									
8	BMI195A	Industry Internship	Major Core	0	0	40	40	0	0	20	20

Annexure 1

Semester	Course code	Course	Course Type	Type	Recipient Departments	Lecture Hours	Tutorial Hours	Practical Hours	Total Hours	Lecture Credit	Tutorial Credit	Practical Credit	Total Credits
1	DEN001C	Communication Skills	AEC	Theory	All UG	1	0	0	1	1	0	0	1
	DEN001D	Communication Skills Lab	AEC	Practical	All UG	0	0	2	2	0	0	1	1
1	DCH010A	Environment Education	VAC	Theory	All UG Except Law	2	0	0	2	2	0	0	2
1	DCO021A	Digital Data and AI Literacy	SEC	Practical	All UG Except Law	0	0	4	4	0	0	2	2
2	DEN002C	Professional Skills	AEC	Theory	All UG Except Law	1	0	0	1	1	0	0	1
	DEN002D	Professional Skills Lab	AEC	Practical	All UG Except Law	0	0	2	2	0	0	1	1
2	IKS001A	Inculcation of Human Values and Professional Ethics in Higher Education Institutions	VAC	Theory	All UG	2	0	0	2	2	0	0	2
2	DCO018A	Advance Excel	SEC	Practical	All UG Except Law	0	0	4	4	2	0	0	2
3	DBA112A	Leadership and Management	AEC	Theory	All UG Except Law	2	0	0	2	2	0	0	2
3	IKS Code	Any of IKS Basic Courses	VAC	Theory	All UG Except Law	2	0	0	2	2	0	0	2
3	Program Code	Prompt Engineering (Generative AI) Program Specific	SEC	Practical	All UG Except Law	0	0	4	4	2	0	0	2

3	JIC001A	Entrepreneurship Development Program	SEC	Project	All UG	0	0	2	2	0	0	1	1
4	IKS002A	Universal Human Value	AEC	Theory	All UG Except Law	2	0	0	2	2	0	0	2
4	IKS Code	Any of IKS Elective Course	VAC	Theory	All UG Except Law	2	0	0	2	2	0	0	2
4	DCO022A	R with Python	SEC	Practical	Slected Schools	0	0	4	4	2	0	0	2
4	DCO023A	Python Programing	SEC	Practical	Slected Schools	0	0	4	4	2	0	0	2
1	DLW001A	Indian Constitution		Theory	SET	2	0	0	2				NC

Annexure 2: Percentage of Revision of B.Sc. Syllabus

S No	Course Name	Course Code	Revision Made	% Revision
1	Molecular Biology	BMI190A	New Course	100
2	Diversity of Microorganism	BMI192A	1 Unit Change	20
3	Biochemistry (Biotech)	BBI210A	New Course	100
4	Microbial genetics	BMI163B	1 Unit Change	20
5	Microbial Physiology and metabolism	BMI183C	1 Unit Change	20
	Project	BMI194A	New Course	100
6	Food and dairy microbiology (7 courses)	DSE	New Course	700
7	Medical microbiology (7 courses)	DSE	New Course	700
8	Environmental & Agricultural Microbiology (7 courses)	DSE	New Course	700
9	Communication Skills	AEC	New Course	100
10	Communication Skills Lab	AEC	New Course	100
11	Environment Education	VAC	New Course	100
12	Digital Data and AI Literacy	SEC	New Course	100
13	Professional Skills	AEC	New Course	100
14	Professional Skills Lab	AEC	New Course	100
15	Inculcation of Human Values and Professional Ethics in Higher Education Institutions	VAC	New Course	100
16	Advance Excel	SEC	New Course	100
17	Leadership and Management	AEC	New Course	100
18	Any of IKS Basic Courses	VAC	New Course	100
19	Prompt Engineering (Generative AI) Program Specific	SEC	New Course	100
20	Entrepreneurship Development Program	SEC	New Course	100
21	Universal Human Value	AEC	New Course	100
22	Any of IKS Elective Course	VAC	New Course	100
23	R with Python	SEC	New Course	100
24	Python Programing	SEC	New Course	100
25	Communication Skills	AEC	New Course	100
26	Communication Skills Lab	AEC	New Course	100
27	Environment Education	VAC	New Course	100
	Total % Revision			4060
	Total Courses			71
	Percentage of Revision			57.18

B.Sc. (Hons.) Programme Four year Structure For Batch 2025-2026												
DSE Track	Paper	Course code	Course	Course Type	Lecture Hours	Tutorial Hours	Practical Hours	Total Hours	Lecture Credit	Tutorial Credit	Practical Credit	Total Credits
Food and dairy Micro biology	1	BMI196A	Basic of food Microbiology	DSE	3	0	0	3	3	0	0	3
	1	BMI197A	Basic of food Microbiology lab	DSE	0	0	2	2	0	0	1	1
	2	BMI198A	Principles of food chemistry	DSE	3	0	0	3	3	0	0	3
	2	BMI199A	Principles of food chemistry Lab	DSE	0	0	2	2	0	0	1	1
	3	BMI200A	Food packaging engineering	DSE	3	0	0	3	3	0	0	3
	3	BMI201A	Food packaging engineering Lab	DSE	0	0	2	2	0	0	1	1
	4	BMI202A	Food safety and public health	DSE	3	0	0	3	3	0	0	3
	4	BMI203A	Food safety and public health Lab	DSE	0	0	2	2	0	0	1	1
	5	BMI204A	Applied dairy microbiology	DSE	3	0	0	3	3	0	0	3
	5	BMI205A	Applied dairy microbiology Lab	DSE	0	0	2	2	0	0	1	1
	6	BMI206A	Food safety laws and standards	DSE	3	0	0	3	3	0	0	3
	6	BMI207A	Food safety laws and standards lab	DSE	0	0	2	2	0	0	1	1
	7	BMI208A	Microbial toxins in food systems	DSE	3	0	0	3	3	0	0	3
	7	BMI209A	Microbial toxins in food systems lab	DSE	0	0	2	2	0	0	1	1
Medical Micro biology	1	BMI210A	Medical Bacteriology	DSE	3	0	0	3	3	0	0	3
	1	BMI211A	Medical Bacteriology Lab	DSE	0	0	2	2	0	0	1	1
	2	BMI212A	Immunology	DSE	3	0	0	3	3	0	0	3
	2	BMI213A	Immunology Lab	DSE	0	0	2	2	0	0	1	1
	3	BMI214A	General Pathology	DSE	3	0	0	3	3	0	0	3
	3	BMI215A	General Pathology Lab	DSE	0	0	2	2	0	0	1	1
	4	BMI216A	Medical Mycology and Parasitology	DSE	3	0	0	3	3	0	0	3
	4	BMI217A	Medical Mycology and Parasitology Lab	DSE	0	0	2	2	0	0	1	1

	5	BMI218 A	Diagnostic Microbiology and Laboratory Techniques	DSE	3	0	0	3	3	0	0	3
	5	BMI219 A	Diagnostic Microbiology and Laboratory Techniques	DSE	0	0	2	2	0	0	1	1
	6	BMI220 A	Antimicrobial resistance	DSE	3	0	0	3	3	0	0	3
	6	BMI221 A	Antimicrobial Resistance Lab	DSE	0	0	2	2	0	0	1	1
	7	BMI222 A	Epidemiology and Public Health Microbiology	DSE	3	0	0	3	3	0	0	3
	7	BMI223 A	Epidemiology and Public Health Microbiology Lab	DSE	0	0	2	2	0	0	1	1
Environmental & Agricultural Microbiology	1	BMI224 A	Soil Microbiology	DSE	3	0	0	3	3	0	0	3
	1	BMI225 A	Soil Microbiology lab	DSE	0	0	2	2	0	0	1	1
	2	BMI226 A	Microbial Ecology and Diversity	DSE	3	0	0	3	3	0	0	3
	2	BMI227 A	Microbial Ecology and Diversity Lab	DSE	0	0	2	2	0	0	1	1
	3	BMI228 A	Environmental Biotechnology	DSE	3	0	0	3	3	0	0	3
	3	BMI229 A	Environmental Biotechnology Lab	DSE	0	0	2	2	0	0	1	1
	4	BMI230 A	Bioremediation and Pollution Control	DSE	3	0	0	3	3	0	0	3
	4	BMI231 A	Bioremediation and Pollution Control Lab	DSE	0	0	2	2	0	0	1	1
	5	BMI232 A	Waste Microbiology	DSE	3	0	0	3	3	0	0	3
	5	BMI233 A	Waste Microbiology Lab	DSE	0	0	2	2	0	0	1	1
	6	BMI234 A	Bioindicators and Microbial Biomonitoring	DSE	3	0	0	3	3	0	0	3
	6	BMI235 A	Bioindicators and Microbial Biomonitoring Lab	DSE	0	0	2	2	0	0	1	1
	7	BMI236 A	Agricultural Microbiology	DSE	3	0	0	3	3	0	0	3

			and Crop Protection									
	7	BMI237 A	Agricultural Microbiology and Crop Protection Lab	DSE	0	0	2	2	0	0	1	1

Sum of Total Credits	Column Labels							
Row Labels	AEC	Major Core	Major DSE	Minor	Multidisciplinary	SEC	VAC	Grand Total
1	2	8		4		2	2	18
2	2	8		4	3	2	2	21
3	2	8		4	3	3	2	22
4	2	8		4		2	2	18
5		4	12	4				20
6		10	4	4	3			21
7		8	4	8				20
8		12	8					20
Grand Total	8	66	28	32	9	9	8	160

Total Credits

Semester	**1**	**2**	**3**	**4**	**5**	**6**	**7**	8	**Total**
Credit	18	21	22	18	20	21	20	20	**160**

Course code	Course Title	L	P	Contact Hr	Contact Hr	Total Credit
BMI190A	Molecular Biology	4	1	4	2	5

Course Outcomes (COs)

After completing this course, students will be able to:

CO1: Describe the structure of DNA, RNA, and chromatin organization.

CO2: Explain the basic process of DNA replication and repair.

CO3: Understand the transcription process and RNA modifications.

CO4: Outline the steps of protein synthesis and its regulation.

CO5: Recognize key concepts in gene regulation and genetic engineering.

Unit I

Structure and types of DNA and RNA, properties of nucleic acids, basic organization of genetic material in prokaryotes and eukaryotes, concept of gene and genome.

Unit II

DNA replication in prokaryotes, enzymes involved (polymerase, ligase, helicase), semi-conservative model, DNA damage and repair mechanisms.

Unit III

Transcription process in prokaryotes, role of RNA polymerase, basic concept of promoters and terminators, Types of RNA, RNA splicing and capping.

Unit IV

Structure and role of ribosomes and tRNA, genetic code, steps of translation – initiation, elongation, and termination, post-translational changes.

Unit V

Operon model of gene regulation: Lac operon, Trp operon, Arabinose operon. Gene expression, restriction enzymes, vectors, gene cloning.

Suggested Readings

1. Verma, P. S., & Agarwal, V. K. (2020). *Cell biology, genetics, molecular biology, evolution and ecology* (Rev. ed.). S. Chand Publishing.
2. De Robertis, E. D. P., & De Robertis, E. M. F. (2017). *Cell and molecular biology* (8th ed.). Lippincott Williams & Wilkins.

3. Watson, J. D., Baker, T. A., Bell, S. P., Gann, A., Levine, M., & Losick, R. (2014). *Molecular biology of the gene* (7th ed.). Pearson Education.
4. Karp, G. (2013). *Cell and molecular biology: Concepts and experiments* (7th ed.). Wiley.
5. Malacinski, G. M. (2008). *Essentials of molecular biology* (4th ed.). Jones & Bartlett Learning.
6. Satyanarayana, U. (2019). *Biotechnology* (Rev. ed.). Books & Allied (P) Ltd.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

Course Outcome	Program Outcome						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	2	2	3	2	2
CO2	3	2	2	2	3	2	2
CO3	3	2	2	1	2	2	2
CO4	3	2	2	1	2	2	2
CO5	3	3	3	2	3	3	3

3 = Highly Related; 2 = Medium; 1= Low

Molecular Biology Lab (BMI191A)

CO1: Perform basic experiments to isolate DNA and RNA from biological samples.

CO2: Visualize DNA using agarose gel electrophoresis.

CO3: Understand and perform basic steps of PCR.

CO4: Use restriction enzymes to cut DNA and observe the results.

CO5: Use simple online tools for DNA sequence analysis.

1. Preparation of buffers used in molecular biology
2. Isolation of Genomic DNA from Bacteria
3. Estimation of DNA concentration using Diphenylamine method
4. Preparation of reagents and casting of agarose gel for electrophoresis
5. Agarose Gel Electrophoresis of DNA
6. Visualization of DNA Bands and Interpretation of Gel Results
7. Plasmid DNA Isolation from E. coli
8. RNA Isolation from Plant Tissue
9. PCR Amplification (Polymerase Chain Reaction)

10. Restriction Digestion of DNA Using Restriction Enzymes

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

Course Outcome	Program Outcome						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	2	2	3	2	2
CO2	3	2	2	1	3	2	2
CO3	2	2	2	1	2	1	2
CO4	3	2	2	1	2	2	3
CO5	3	2	3	2	3	2	2

3 = Highly Related; 2 = Medium; 1= Low

Course code	Course Title	L	P	Contact Hr	Contact Hr	Total Credit
BMI192A	Diversity of Microorganism	3	1	3	2	4

Course outcome (CO)

On completion of the course, students are able to:

CO1- Understand the history of microbiology and classification of microorganism.
CO2- Understand the classification system and bacterial classification.
CO3- Analyze the structural organization of microorganism.
CO4- Understand the cellular structure, biosynthesis and function of bacterial system.
CO5- Understand the various methods of isolation and identification of microorganisms

Unit-I

History of Microbiology – Overview, Biogenesis and abiogenesis, golden age of microbiology and development in the field of medical microbiology, immunology, environmental microbiology, contributions of Robert Hooke, Antonie von Leeuwenhoek, Redi, Spallanzani, Needham, Pasteur, Tyndal, Joseph Lister, Robert Koch (Germ Theory), Edward Jenner and Alexander Flemming, Martinus Beijerinck

Unit -II

Principles of classification, systematics and taxonomy, conventional, molecular and recent approaches to polyphasic bacterial taxonomy. Binomial Nomenclature, Whittaker's five kingdom and Carl Woese's three kingdom classification systems and their utility.

Unit -III

General characteristics, occurrence, structure, reproduction and importance of bacteria, Algae, Fungi, Protozoa, wall-less forms - MLO (mycoplasma and spheroplasts); Beneficial and harmful microbes and their role in daily life.

Unit -IV

Bacterial morphology and subcellular structures; Slime layer, Capsule, Cell wall, cell membrane, Ribosome, inclusion bodies - inorganic, organic; Exospores & Cysts: types & structure. Plasmids and episomes. Differences between eubacteria and archaebacteria.

Unit –V

Methods of studying microorganism; Staining techniques: simple staining, Gram staining, negative staining and acid-fast staining. Sterilization techniques (physical & chemical sterilization). Culture media & conditions for microbial growth. Pure culture isolation: Streaking, serial dilution and plating methods; cultivation, maintenance and preservation of pure cultures.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

Course Outcome	Program Outcome						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	2	3	3	1	1	2	2
CO2	3	3	3	2	1	1	2
CO3	3	3	3	3	2	1	2
CO4	2	2	3	3	3	2	1
CO5	2	3	3	3	2	2	1

3 = Highly Related; 2 = Medium; 1 = Low

Suggested Readings:

1. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR, General Microbiology, 5th edition, 2005, McMillan.
2. Atlas, Principles of Microbiology, 2nd ed.,1997, McGraw-Hill
3. Alexopoulos CJ, Mims CW, and Blackwell M, Introductory Mycology. 4thedition, 1996, John and Sons, Inc.
4. Cappucino J and Sherman N., Microbiology: A Laboratory Manual. 9thedition, 2010, Pearson Education limited.
5. Kumar HD., Introductory Phycology, 2ndedition, 1990, Affiliated East Western Press.
6. Madigan MT, Martinko JM and Parker J., Brock Biology of Microorganisms.12th edition, 2009, Pearson/Benjamin Cummings.
7. Pelczar MJ, Chan ECS and Krieg NR., Microbiology. 5thedition, 1993, McGraw Hill Book Company.
8. Tortora GJ, Funke BR, and Case CL., Microbiology: An Introduction, 9th edition, 2008, Pearson Education.

Diversity of Microorganism Lab (BMI193A)

CO1- Analyze the simple techniques of the bacteria and fungi.
CO2- Analyze the morphological structure of microbes.
CO3- Evaluate the identification of cyanobacteria, algae and fungi.
CO4- Analyze the identification of viruses.
CO5- Analyze the motility of bacteria and examination of free living protozoan.

1) Demonstration of sterilization by moist heat using autoclave.
2) Preparation of culture media – liquid and solid media.
3) Preparation of bacterial smear.
4) Simple staining of bacteria and fungi.
5) Identification of common morphological forms of bacteria.
6) Identification of Cyanobacteria (blue-green algae).
7) Identification of some common fungi (*Aspergillus, Penicillum, Mucor* and *Rhizopus*).
8) Identification of common algae.
9) Demonstration and explanation of different types of viruses.
10) Demonstration of Simple staining.
11) Microscopic examination of free-living protozoa of a pond.
12) Hanging drop technique demonstrating motility of Bacteria.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

Course Outcome	Program Outcome						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	2	2	3	2	2
CO2	3	3	2	1	3	1	2
CO3	3	3	2	2	3	1	2
CO4	3	2	2	1	2	1	2
CO5	2	3	2	1	2	1	2

3 = Highly Related; 2 = Medium; 1 = Low

Course code	Course Title	L	P	Contact Hr.	Contact Hr.	Total Credit
BMI153A	Microbial Techniques & Instruments	3	1	3	2	4

Course outcome (CO)

On completion of the course, students are able to:

CO1- Understand the general principle, working and applications of laboratory instruments.
CO2- Understand the basic principle, working and applications of centrifugation and electrophoresis technique.
CO3- Understand the basic of Chromatography and, Spectroscopic Techniques.

CO4- Understand the Microbial media and staining techniques used in microbial lab.
CO5- Understand the microbial culture and microbial culture preservation.

Unit-I

General lab Instruments: Principle, Working and Applications of pH meter, Autoclave, Laminar air flow, Water bath, Oven, Incubator and colony counter.

Microscopy: History of microscopy, Optical spectrum, Bright field Microscope, Dark field Microscope, Scanning Electron microscopy, Transmission Electron microscopy.

Unit -II

Centrifugation: Relative centrifugal force (RCF), centrifuges rotors, Benchtop centrifuge, High-speed centrifuge, Micro centrifuge, Analytical centrifuge, Density gradient centrifuge, Differential centrifugation, Isopycnic centrifugation, Rate-zonal density gradient centrifugation.

Electrophoresis: Electrophoresis Principle, Paper electrophoresis, Gel electrophoresis, Thin layer electrophoresis, Isotachophoresis, Isoelectric Focusing.

Unit – III

Chromatography: History and principle, Planar and column Chromatography, Gas and liquid chromatography, Ion-exchange chromatography, partition chromatography, affinity chromatography and adsorption chromatography

Spectroscopic Techniques: Beer-Lambert law, light absorption and its transmittance, application of visible and UV spectroscopic techniques

Unit IV

Microbiological Media: Natural and synthetic basal, defined, complex, enrichment, selective, differential, maintenance and transport media.

Staining techniques: simple staining, Gram staining, negative staining and acid-fast staining and Sterilization techniques (physical & chemical sterilization).

Unit V

Microbial cultures: Concept of pure culture, Methods of pure culture isolation, Enrichment culturing techniques, single cell isolation, and pure culture development.

Microbial Culture Preservation: Concept of preservation, Methods of preservation: Agar Slant, Petri Plate method, Saline method, Low temperature, Vacuum Drying, Freeze drying.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

Course Outcome	Program Outcome						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	2	1	2	1	2
CO2	3	2	3	2	3	1	2

CO3	3	3	2	3	3	1	2
CO4	3	2	3	1	2	1	2
CO5	3	2	3	2	2	1	3

3 = Highly Related; 2 = Medium; 1 = Low

Suggested Readings:

1. Khandelwal P.P., Textbook of optics and atomic physics,2015, Himalaya Publishing House
2. Patel S.B., Nuclear physics an introduction, 2nd edition , 2011, New Age International
3. Pattabhi and Gautha, Biophysics, 2nd edition , 2009, Narosa Publishing House
4. Nakara and Choudhary, Instrumentation measurements and analysis, 3rd Edition , 2010, Tata Mc Graw Hill
5. Khandpur R.S., Handbook of analytical instruments, 3rd Edition , 2015,Tata Mc Graw Hill
6. Beiser A, Perspectives of modern physics, 1969, Mc Graw Hill
7. White H.E., Introduction to atomic spectra , 2005, Mc Graw Hill
8. Lodish, Berk, Matsudara, Kaiser, Krieger, Zipursky, Darnell, Molecular cell biology,8th edition 2016, W.H. Freeman and Co.

Microbial Techniques and Instruments Lab (BMI154A)

CO1- Apply the basic knowledge of instruments and microscopy during demonstration.
CO2- Analyze the pH and centrifugation technique of a given sample.
CO3- Apply the knowledge to perform electrophoresis and paper chromatography.
CO4- Analyze the working of TLC and Spectroscopy of protein sample.
CO5- Apply the knowledge to perform isolation and preservation of bacterial culture.

1) Demonstration of laboratory rules, basic requirements in a microbiological laboratory and safety measures.
2) Demonstration of the components, use and care of bright field microscope.
3) Demonstration of the pH meter and determination of pH of a given sample.
4) Demonstration of centrifuge for the given sample.
5) Demonstration of electrophoresis.
6) Separation of chlorophyll a and b using paper chromatography.
7) Separation of amino acids using TLC.
8) Preparation of standard curve of proteins by spectroscopy.
9) Isolation of pure cultures of bacteria by streaking method.
10) Preservation of bacterial cultures by various techniques.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

Course Outcome	Program Outcome						
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
CO1	2	3	2	1	2	3	2
CO2	3	3	2	2	3	3	2
CO3	2	2	3	3	2	2	2

CO4	2	3	2	2	3	3	2
CO5	3	3	2	1	3	3	3

3 = Highly Related; 2 = Medium; 1 = Low

Course code	Course Title	L	P	Contact Hr	Contact Hr	Total Credit
BBI210A	**Biochemistry**	**3**	**1**	**3**	**2**	**4**

Course Outcome

At the end of this course students will able to

CO-1 *Explain* the classification, structure, and biological significance of carbohydrates, including key reactions such as mutarotation and osazone formation.

CO-2 *Describe* the structure, classification, and physiological roles of lipids, including fats, phospholipids, steroids, and prostaglandins.

CO-3 *Illustrate* the classification of amino acids and structural organization of proteins from primary to quaternary levels.

CO-4 *Differentiate* the structure and biological functions of DNA and RNA, including their nucleotide components.

CO-5 *Interpret* enzyme classification, catalytic mechanisms, kinetics, inhibition, and clinical significance.

Unit- I

Carbohydrates: Introduction, biological importance. Definition, Classification, Monosaccharides other than glucose, glycosidic, bond, disaccharides, polysaccharides (starch, glycogen, peptidoglycan) Hetero polysaccharides, Mutarotation, osazone formation, Inversion of Sucrose.

Unit- II

Lipids: Introduction Structure, distribution and biological importance of fats and fatty acids; Chemical properties and characterization of Fats, Waxes, Cerebrosides, gangliosides, phospholipids and their types and proteolipids; Steroids and Prostaglandins

Unit- III

Amino acids: Definition, Classification, Structure and types; Proteins: Classification, structure and properties, biologically active peptides, classification and properties of proteins, structure of proteins-primary, secondary, tertiary and quaternary structure of proteins.

Unit- IV

Nucleic acids: Structure of purines, pyrimidines, nucleosides and nucleotides; Structure, types and biological role of RNA and DNA.

Unit-V

Enzymology: Classification, Principles of catalysis, Mechanism of enzyme action, Enzyme kinetics, types of enzyme inhibition, Enzyme regulation, Isozymes, clinically important enzymes.

Text / Reference Books

1. Outlines of Biochemistry: Eric C. Conn, Paul K., G. Bruening, Roy H. Doi, 2006, Wiley
2. Principles of Biochemistry: Geffory L. Zubey, William W.Parson, Dennis E. Vance, 1995, Wm.C. Brown.
3. Biochemistry: Lubert Stryer, John Tymoczko, Gregory Gatto, 2019, WH Freeman

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

Course Outcome	Program Outcome						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	0	2	1	2	2
CO2	0	2	2	1	0	1	1
CO3	3	2	2	1	2	2	2
CO4	3	2	2	1	1	0	1
CO5	2	3	2	1	0	0	1

3 = Highly Related; 2 = Medium; 1 = Low

BBI211A: Biochemistry Lab

Course Outcomes

At the end of this course students will able to

CO1- Understand the physiological pH and biological buffer preparations.
CO2- Perform the qualitative estimation of biomolecules.
CO3- Study the mathematical calculations.
CO4- Understand the biochemical composition of biological macromolecules
CO5- Perform the titration estimations.

1. To prepare the solutions of given normality and its standardization.
2. To Calibrate the pH meter by using different buffer solutions.
3. To Prepare the buffer solutions.
4. To determine the pKa value and hence the Dissociation constant of a given acid by using pH meter.
5. To prepare buffer solutions in the pH range of 2.2 to 8.0.
6. To perform Qualitative estimation of carbohydrates.
7. To perform Qualitative estimation of proteins.
8. To perform Qualitative estimation of lipids.
9. To perform the Titrimetric estimation of molar and mass concentration of sulfuric acid.
10. To Determine the acid value of oil.
11. To verify Lambert and beer law's.
12. To calibrate spectrophotometer using $K_2Cr_2O_7$ solution.
13. To study activity of any enzyme under optimum conditions.
14. To study the effect of pH, temperature on the activity of salivary amylase enzyme.
15. To study relation between absorbance and % transmission.

Virtual Labs link

S.No.	Course name	Sources	Link
1	Biochemistry Virtual Lab I	Amrita Vishwa Vidyapeetham	http://biotech01.vlabs.ac.in/
2	Biochemistry Virtual Lab II	Amrita Vishwa Vidyapeetham	https://vlab.amrita.edu/?sub=3&brch=64

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

CO/PO	Program Outcome						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	3	2	2	1	1
CO2	2	2	2	2	1	1	0
CO3	3	1	3	1	1	1	0
CO4	2	2	2	1	1	0	1
CO5	3	3	1	1	0	0	2

3 = Highly Related; 2 = Medium; 1 = Low

Course code	Course Title	L	P	Contact Hr	Contact Hr	Total Credit
BMI159A	Bacteriology and Systematics	3	1	3	2	4

Course outcome (CO)

On completion of the course, students are able to:

CO1- Understand the the bacterial classification, growth, control and preservation.
CO2 Understand the physical and chemical controls, preservation technique of bacteria.
CO3- Analyze the various shapes, habitat and function of Gram negative.
CO4- Analyze the archeabacteria structure, habitat and its type.
CO5- Analyze the various shapes, habitat and usefulness of Gram positive.

Unit I

Salient features of major bacterial groups according to Bergey's manual of systematic Bacteriology Volume I and II. Cultivation of Bacteria: growth of bacteria, growth curve, environmental factors affecting growth, quorum sensing. Nutritional requirements in bacteria and nutritional categories. Culture media: components of media, natural and synthetic media, chemically defined media, complex media, selective, differential, enriched and enrichment media.

Unit II

Physical methods of microbial control: heat, low temperature, high pressure, filtration, desiccation,

osmotic pressure, radiation. Chemical methods of microbial control: disinfectants, types and mode of action. Asexual methods of reproduction. Preservation techniques of microbial culture.

Unit III

Gram negative Eubacteria: The Spirochetes, Aerobic/microaerophilic, motile, helical/vibroid, Gram negative Bacteria, Non motile, Gram negative curved bacteria. Aerobic, anaerobic and facultative anaerobic bacteria.

Unit IV

Sulphur reducing bacteria. Anaerobic Gram negative Cocci. *Neisseria*, Rickettsia, Chlamydia, Anaerobic Gram negative rods: *Rhizobium, Agrobacterium, Salmonella*, Archaeobacteria: Introduction to Nanoarchaeota (*Nanoarchaeum*), Crenarchaeota (*Sulfolobus, Thermoproteus*) and Euryarchaeota [Methanogens (*Methanobacterium, Methanocaldococcus*), thermophiles (*Thermococcus, Pyrococcus, Thermoplasma*), and Halophiles (*Halobacterium, Halococcus*).

Unit V

Gram positive Eubacteria: Gram positive Cocci; Streptococcus, staphylococcus, Gram Positive rod; Bacillus, Clostridium, endospore forming Gram positive bacteria, Non-spore forming Gram positive Rods of regular shape, Nonspore forming Gram positive Rods of irregular shape; *Corynebacterium*

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

Course Outcome	Program Outcome						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	2	3	1	1	2
CO2	3	3	2	2	2	2	1
CO3	3	3	1	3	2	2	2
CO4	3	2	2	3	2	2	2
CO5	3	3	2	3	2	2	2

3 = Highly Related; 2 = Medium; 1 = Low

Suggested Readings:

1. SchlegelH S, General Microbiology, 7th edition,1995,Cambridge University Press
2. Pelczar M J, Chan E C S, Kreig N R, Microbiology ,5th edition, 2006, Tata Mc Graw Publication
3. Cappuccino J G and Sherman N, Microbiology-a Laboratory Manual, 6th edition, 2006, Addison Wesley, Pearson Education, Inc.
4. Tortora G J, Funke B R, Case C L, Microbiology-an introduction, 9th edition, 2008, Pearson Education, Inc.,
5. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR, General Microbiology. 5th edition, 2005, McMillan
6. Atlas, Principles of Microbiology, 2nd ed., 1997, McGraw-Hill

Bacteriology and Systematics Lab (BMI160A)

CO1 Analyse the bacteria from various techniques.
CO2 Demonstration of the various culture media preparation and sterilisation.
CO3 Apply the various techniques of culture inoculation.

CO4 Analyse the bacteria growth curve
CO5 Analyse the preservation techniques of microbes.

1) Negative staining of bacteria
2) Flagella staining of bacteria
3) Endospore staining of bacteria
4) Acid fast staining of bacteria
5) Gram Staining
6) Demonstration of selective and differential media.
7) Demonstration of culture inoculation techniques – spread plate, streak plate, pour plate methods and serial dilution.
8) Demonstration of cultivation of Anaerobic bacteria.
9) Bacterial growth curve formation by turbidity measurement method.
10) Preservation of microbes culture by paraffin method.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

Course Outcome	Program Outcome						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	3	3	3	2	3
CO2	3	3	3	3	2	2	2
CO3	3	3	3	3	2	2	3
CO4	3	3	3	3	2	2	2
CO5	3	3	3	3	3	2	2

3 = Highly Related; 2 = Medium; 1= Low

Course code	Course Title	L	P	Contact Hr	Contact Hr	Total Credit
BMI161A	Mycology & Phycology	3	1	3	2	4

Course outcome (CO)

On completion of the course, students are able to:

CO1- Understanding the diversity of the fungi
CO2- Understanding the various fungus genera and its role in the environment.
CO3- Understanding the general organization of algae.
CO4- Understand the various type of algae and its economic importance.
CO5- Understand the application of fungi and economic importance of various algae.

Unit I

Characteristics, classification and cellular & thallus organization of fungi. General features, structure, nutrition, reproduction of different fungi group - Phycomycetes, Ascomycetes, Basidiomycetes and Deuteromycetes. Homothallism and Heterothallism; Parasexuality; Sex hormones in fungi.

Unit II

General features, taxonomic status and evolutionary significance economic importance of important fungal genera - *Mucor, Saccharomyces, Neurospora, Agaricus, Fusarium, Alternaria,* General account and importance of lichen.

Unit III

General characteristics and evolution of algae. Occurrence, thallus organization, algae cell ultra-structure, pigments, flagella, eye- spot food reserves and vegetative, asexual and sexual reproduction. Classification of algae.

Unit IV

General features, structure and reproduction and economic importance of *Chlamydomonas, Oscillatoria, Polysiphonia , Ectocarpus.* Mass cultivation of algae as a source of protein.

Unit V

Application of fungi in food industry (Flavour & texture, Fermentation, Baking, Organic acids, Enzymes, Myco -proteins); Secondary metabolites (Pharmaceutical preparations); Agriculture (Biofertilizers); Mycotoxins; Biological control (Mycofungicides, Mycoherbicides, Mycoinsecticides). Economic importance of algae.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

Course Outcome	Program Outcome						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	1	2	1	1	2
CO2	3	3	1	2	2	1	2
CO3	3	3	1	2	2	1	2
CO4	3	2	1	2	1	1	2
CO5	3	2	2	3	2	1	2

3 = Highly Related; 2 = Medium; 1= Low

Suggested Readings:

1. Alexopoulus, C.J., Mims,C.W. and Blackwel, M, Introductory Mycology. John Wiley, New York.
2. Mehrotra, R.S. and K.R.Aneja An Introduction to Mycology. New Age International Press, New Delhi.
3. Webster, J. Introduction to fungi. Cambridge University Press. Cambridge, U.K. (1985).
4. Bessey E.A. Morphology and Taxonomy of fungi. Vikas Publishing House Pvt. Ltd., New Delhi.
5. Jhon Webster and R W S Weber. Introduction to Fungi. Cambridge University Press 2007.
6. A. V. S. S. .Sambamurty. A Textbook of Algae. I.K. International Publishing House Pvt. Limited, 2010
7. H.D. Kumar and H.N. Singh.A Textbook on Algae (Macmillan international college edition)

Mycology & Phycology Lab (BMI162A)

CO1 Analyze the culture, isolation of fungi.
CO2 Evaluation and identification of fungi from various infected sources
CO3 Apply the various type of pathogen interaction.

CO4 Analyze the culture of the algae
CO5 Evaluate the identify of various algal group.

1. Preparation of Potato Dextrose Medium.
2. Isolation and identification of fungal plant pathogen from leaves, stems and other aerial parts of the plants.
3. Study of the vegetative and reproductive structures of following genera through temporary and permanent slides: *Mucor, Saccharomyces, Penicillium, Agaricus* and *Alternaria*
4. Study of the various diseases caused by fungi.
5. Purification and preservation of pure cultures of common algae and fungi.
6. Identification of edible and poisonous mushrooms.
7. Isolation and identification of blue-green algae from pond water.
8. Isolation and identification of algae from soil.
9. Study of class work material by making suitable temporary slides of *Nostoc, Volvox, Chlamydomonas, Chlorella, Vaucheria, Ectocarpus, Polysiphonia.*
10. Demonstration of algae growth.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

Course Outcome	Program Outcome						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	1	2	3	2	1
CO2	3	3	1	2	3	1	1
CO3	3	3	1	2	3	2	2
CO4	3	3	1	2	3	1	2
CO5	3	3	2	2	2	2	1

3 = Highly Related; 2 = Medium; 1= Low

Course code	Course Title	L	P	Contact Hr	Contact Hr	Total Credit
BMI163C	Microbial Genetics	3	1	3	2	4

Course outcome (CO)

On completion of the course, students are able to:

CO1-Understand the organization of prokaryotic genomes.

CO2-Understand the process and mechanism of genetic exchange.

CO3-Understand the molecular mechanism of gene regulation in prokaryotes.

CO4-Understand the bacterial genetics by conjugation, transformation and transduction.

CO5- Understand the molecular mechanisms and gene expression.

Unit I

Prokaryotic Genomes - Physical organization of bacterial genomes (Structure of the bacterial nucleoid). Mutations and mutagenesis: Definition and types of Mutations, Physical and chemical mutagens.

Unit II

Mechanism of genetic exchange : Plasmid, Types of plasmids (F Plasmid : a Conjugate plasmid', Mobilization of Non-conjugative plasmid, R plasmid, Col plasmid Copy number and incompatibility), Episomes. Transposable elements.

Unit III

Molecular Mechanism of gene regulation in prokaryotes - Transcriptional regulation in prokaryotes (inducible and repressible system, positive regulation and negative regulation); Operon concept – lac, trp, Ara operons.

Unit IV

Bacterial Genetics (Mutant phenotype, DNA mediated Transformation; Conjugation (Cointegrate Formation and Hfr Cells, Time–of–Entry Mapping, F' Plasmid); Transduction (Generalized transduction, Specialized Transduction).

Unit V

Quorum sensing, two-component regulatory systems, post-transcriptional regulation mechanisms (riboswitches, antisense RNAs, and attenuation), Sigma factors in transcription initiation and stress response.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

Course Outcome	Program Outcome						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	1	3	2	2	2	2
CO2	3	2	1	2	1	2	1
CO3	2	2	1	2	2	1	1
CO4	1	3	1	1	1	2	1
CO5	3	2	2	1	2	1	1

3 = Highly Related; 2 = Medium; 1 = Low

Suggested Readings:

1. Gardner, E.J., Simmons, M.J., Snustad, D.P., 8th edition, 2008, Principles of Genetics, Wiley India

2. Karp G,Cell and Molecular Biology, 4th edition, 2005, John Wiley and Sons
3. Elliott W H and Elliot D C, Biochemistry and Molecular Biology, 3rd edition, 2005, Oxford University Press
4. Malacinski G.M. and Freifelder D., Essentials of Molecular Biology, 3rd edition, 1998, Jones and Bartlett Publishers
5. Scheeler P. and BianchiD.E., Cell and Molecular Biology, 3rd edition,1987, John Wiley and Sons

Microbial Genetics Lab (BMI164C)

CO1 Analyse the isolation of antibiotic-resistant bacteria by various techniques.

CO2 Analyse the genetic recombination in bacteria by conjugation.

CO3 Analyse the genetic recombination in bacteria by transduction.

CO4 Analyse the genetic recombination in bacteria by transformation.

CO5 Analyse the mutagens effect on bacteria by various methods.

1) Isolation of antibiotic resistant bacteria population by gradient plate method.
2) Isolation of antibiotic resistant mutants by Replica plating technique.
3) Demonstration of genetic recombination in bacteria by conjugation.
4) UV-induced auxotrophic mutants production and isolation of the mutants by replica plating.
5) Demonstration of picking and patching colonies.
6) Synthesis of inducible enzyme beta-galactosidase in *E.coli.*
7) Demonstration of genetic recombination in bacteria by transformation.
8) Demostration of carcinogens/mutagens by the Ames test.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

Course Outcome	Program Outcome						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	3	3	2	2	2
CO2	3	3	3	3	2	2	3
CO3	3	3	3	2	2	2	3
CO4	3	3	3	2	2	2	3
CO5	3	3	2	2	3	3	2

3 = Highly Related; 2 = Medium; 1= Low

Course code	Course Title	L	P	Contact Hr	Contact Hr	Total Credit
BMI167A	Virology	3	1	3	2	4

Course outcome (CO)

On completion of the course, students are able to:

CO1 Understand the history, classification, morphology of virus.
CO2 Understand the Bacteriophage and its life cycle
CO3 Understand the plant virus transmission and cultivation of viruses.
CO4 Understand the Oncogenic viruses and emerging viruses.
CO5 Understand the viral vaccines.and their action.

Unit I

Virology: Discovery of viruses, nature and definition of viruses, general properties, concept of viroids, virusoids, satellite viruses and Prions. Theories of viral origin; Structure of Viruses. Viral taxonomyClassification and nomenclature of different groups of viruses. Baltimore system of classification.

Unit II

Isolation, purification and cultivation of bacterial viruses. Study of one step growth curve of bacterial viruses. Types of bacteriophages, lytic and lysogenic phages (lambda phage) concept of early and late proteins, regulation of transcription in lambda phage. T even, T odd, ϕX174 and M13 phages

Unit III

Modes of viral transmission: Persistent, non- persistent, vertical and horizontal. Replication Assembly, maturation and release of viruses. Salient features of viral nucleic acid and the presence of unusual bases. Influenza and Hepatitis B virus, HIV, polio virus, Vaccinia virus, Rabies Virus. TMV, Cauliflower Mosaic Virus.Cultivation of virus on embryonated eggs, experimental animals and cell cultures

Unit IV

Introduction to oncogenic viruses. Types of oncogenic DNA and RNA viruses: Concepts of oncogenes and proto-oncogenes. Emerging viruses, their management and control strategies: H1N1, Chikungunya, Dengue, Ebola, Zika and Nipah virus, Covid 19.

Unit V

Prevention and control of viral diseases: Antiviral compounds and their mode of action: AZT, aciclovir, ganciclovir. Interferons and their mode of action. General principles of viral vaccines: live attenuated vaccines, inactivated viral vaccine, subunit vaccine, recombinant viral vaccine.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

Course Outcome	Program Outcome						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	2	1	2	2	3	1	2
CO2	2	3	1	2	2	3	1

CO3	3	3	2	1	2	2	2
CO4	3	2	2	2	3	2	2
CO5	3	3	2	2	2	1	2

3 = Highly Related; 2 = Medium; 1 = Low

Suggested Readings:-

1. Dimmock NJ, and Primrose SB., Introduction to Modern Virology. 4th edition1994, Blackwell Science Ltd.
2. Dimmock, NJ, Easton, AL, Leppard, KN,Introduction to Modern Virology.6thedition, 2007, Blackwell Publishing Ltd.
3. Carter J and Saunders V,Virology: Principles and Applications,2007, John Wiley and Sons.
4. Flint SJ, Enquist, LW, Krug, RM, Racaniello, VR, Skalka, AM Principles of Virology, Molecular biology, Pathogenesis and Control. 2nd edition, 2004, ASM pressWashington DC.
5. Levy JA, Conrat HF, Owens RA., Virology. 3rdedition, 2000, Prentice Hall publication.
6. Wagner EK, Hewlett MJ.,Basic Virology,2ndedition, 2004, Blackwell Publishing.
7. Mathews.,Plant Virology, 2004,Hull R. Academic Press, New York.
8. Nayudu MV.,Plant Viruses, 2008, Tata McGraw Hill, India.
9. Bos L., Plant viruses-A text book of plant virology by1999. Backhuys Publishers.

Virology Lab (BMI168A)

CO1 Analyse the viral diseases in plants.
CO2 Analyse the viral diseases in humans.
CO3 understand the various type of plant and animal viruses.
CO4 Analyse the viruses culture techniques.
CO5 Analyse the pandemic case study of various viruses.

1. Demonstration of the diseases of plants caused by viruses viz. Tobacco Mosaic Disease and Cualiflower Mosaic disease.
2. Demonstration of the human diseases caused by viruses viz. AIDS, Mumps, Small pox and Chicken pox etc.
3. Demonstration of different types of plant viruses.
4. Demonstration of different types of animal viruses.
5. Cultivation of animal viruses in embryonated eggs.
6. Demonstration of Plaque test for the bacteriophages.
7. Case study of Pandemic COVID-19, MERS-CoV, Ebola virus disease, Zika virus disease, H1N1 Swine Flu disease, AIDS

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

Course Outcome	Program Outcome						
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
CO1	3	3	3	2	3	1	2
CO2	3	3	3	2	3	1	2
CO3	3	3	3	2	3	1	2

CO4	3	3	3	2	3	1	2
CO5	3	3	2	2	3	1	2

3 = Highly Related; 2 = Medium; 1= Low

Course code	Course Title	L	P	Contact Hr	Contact Hr	Total Credit
BMI183C	**Microbial Physiology & Metabolism**	**3**	**1**	**3**	**2**	**4**

Course outcome (CO)

On completion of the course, students are able to:
CO1-Understand the bacterial growth and response to environment
CO2-Understand the nutrition type and transport of nutrients in microorganism.
CO3- Analyze the different physiological pathways and cycles in microbes.
CO4- Understand the phototropic and aerobic bacteria.
CO5-Apply Assimilation and dissimilation of nitrogen bacteria in environment.

Unit 1

Definition of growth, measurement of microbial growth, Batch culture, Continuous culture, generation time and specific growth rate, synchronous growth, diauxic growth curve. Microbial growth in response to environment -Temperature (psychrophiles, mesophiles, thermophiles, extremophiles, thermodurics, psychrotrophs), pH (acidophiles, alkaliphiles), solute and water activity (halophiles, xerophiles, osmophilic), Oxygen (aerobic, anaerobic, microaerophilic, facultative aerobe, facultativeanaerobe),barophilic.

Unit II

Microbial growth in response to nutrition and energy – Autotroph/Phototroph, heterotrophy, Chemolithoautotroph, Chemolithoheterotroph, Chemoheterotroph, Chemolithotroph, photolithoautotroph, Photoorganoheterotroph. Passive and facilitated diffusion. Primary and secondary active transport, concept of uniport, symport and antiport Group translocation.Iron uptake

Unit III

Concept of aerobic respiration, anaerobic respiration and fermentation Sugar degradation pathways i.e. EMP, ED, Pentose phosphate pathway TCA cycle. Electron transport chain: components of respiratory chain, comparison of mitochondrial and bacterial ETC, electron transport phosphorylation, uncouplers and inhibitors. Fermentation - Alcohol fermentation and Pasteur effect; Lactate fermentation (homofermentative and heterofermentative pathways), concept of linear and branched fermentation pathways

Unit IV

Introduction to aerobic and anaerobic chemolithotrophy with an example each. Hydrogen oxidation (definition and reaction) and methanogenesis (definition and reaction). Introduction to phototrophic metabolism - groups of phototrophic microorganisms, anoxygenic vs. oxygenic photosynthesis with reference to photosynthesis in green bacteria, purple bacteria and Cyanobacteria

Unit V

Anaerobic respiration with special reference to dissimilatory nitrate reduction(Denitrification; nitrate/nitrite and nitrate/ammonia respiration; fermentative nitrate reduction). Introduction to biological nitrogen fixation Ammonia assimilation. Assimilatory nitrate reduction, dissimilatory nitrate reduction, denitrification.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

Course Outcome	Program Outcome						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	2	3	1	2	2
CO2	2	2	3	3	2	2	1
CO3	3	2	3	2	2	2	2
CO4	3	3	3	2	2	3	2
CO5	2	3	2	3	3	1	2

Suggested Reading:

1.Devlin R. M. and WithamF.H., Plant Physiology. 4thedition, 1987, Belmont; Calif.; Wadsworth
2.Gottschalk G.,Bacterial Metabolism, 2nd edition,1986, Springer
3.Madigan M. T., Martinko J. M. and Parker J., Brock Biology of Microorganisms. 11thedition, 2005, Pearson/ Benjamin Cummings.
4.Moat A. G., Foster J. W., Spector M.P.,Microbial Physiology. 4th edition, 2002, John Wiley & Sons.
5.Reddy S. R. and Reddy S. M., Microbial Physiology, 2008, Scientific PublishersIndia.
6.Stanier R.Y., Ingraham J.L., Wheelis M.L. and Painter P. R.,General Microbiology, 5th edition, 2005, McMillan
7.Willey J.M., Sherwood L.M., Woolverton C.J., Prescott, Harley and Klein's Microbiology, 9th edition, 2014, McGraw Hill Publishers.

Microbial Physiology & Metabolism Lab (BMI184C)

On completion of the course, students are able to:
CO1- Analyze the factors influencing bacterial growth and demonstrate their effects.
CO2- Analyze enzyme production and its relation to bacterial growth.
CO3- Evaluate the role of nitrogen sources in bacterial growth.
CO4- Analyze the process of alcoholic fermentation and its applications.
CO5- Apply techniques for measuring bacterial growth and analyzing growth curves.

1)Demonstration of effect of temperature on bacterial growth.
2)Demonstration of effect of pH on bacterial growth.
3)Demonstration of effect of salt/sugar concentration on bacterial growth.
4)Demonstration of metals on bacterial growth.
5)Amylase production test.

6)Effect of nitrogen sources on growth of Bacteria.
7)Demonstration of alcoholic fermentation.
8)Measurement of bacterial growth by turbidity measurements.
9)Preparation of growth curve for bacterial growth in a batch culture and calculate the mean generation time (doubling time).
10)Demonstration of the thermal death time of Bacteria.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

Course Outcome	Program Outcome						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	3	2	2	2	3
CO2	3	3	3	2	2	2	2
CO3	3	3	3	2	2	2	1
CO4	3	3	3	2	2	2	2
CO5	3	3	3	3	1	2	3

3 = Highly Related; 2 = Medium; 1= Low

Course code	Course Title	L	T	Contact Hr	Total Credit
BMI173A	Biostatistics	3	1	4	4

Course outcome (CO)

On completion of the course, students are able to:
CO1-Evaluate the frequency distribution by data and graphical methods.
CO2- Evaluate the measure of central tendency.
CO3- Evaluate the dispersion from the data.
CO4- Evaluate the statistical inference tools.
CO5- Evaluate the correlation and regression analysis.

Unit I

Introduction, Definition, Functions, scope and application of biostatistics. Understanding the concepts of descriptive and inferential stastics. Frequency distribution, Collection of data : Primary and secondary data, tabulation of data, discrete and continuous series. Graphical presented: Types of diagrams, Graphs of frequency distribution- Bar diagrams, Histogram, frequency Polygon, smooth frequency curve, Ogives.

Unit II

Measures of Central Value, Introduction, Definition and Limitation of Average; Mathematical Average–Mean; Arithmetic, Geometric, Harmonic and Positional Average- Mode, Median.

Unit III

Measures of Dispersion, Introduction, Definition, various measures of variation; Range, Quartile deviation, Mean Deviation, Standard Deviation, Variance.

Unit IV

Statistical Inference, Testing of Hypothesis; Procedure, test of significance of mean; Standard error, student's 't' test , chi-square test.

Unit V

Correlation, Introduction, definition, kinds- negative, positive and zero correlation, coefficient of correlation, methods of studying correlation-scatter diagram, Graphical method, Karl pearson's coefficient of correlation. Regression Analysis, Introduction, definition, regression equation, regression lines and regression coefficients.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

Course Outcome	Program Outcome						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	3	2	3	2	3
CO2	2	2	3	3	2	2	2
CO3	3	3	3	2	3	3	2
CO4	2	2	2	3	2	3	2
CO5	1	3	3	2	1	3	2

3 = Highly Related; 2 = Medium; 1 = Low

Suggested Readings:

1. Edmondson and Druce D., Advanced Biology Statistics, 1996, Oxford University Press;.
2. Danial W., Biostatistics: A foundation for Analysis in Health Sciences, 2004, John Wiley and Sons Inc.
3. Gupta S.C. and Kapoor V.K., Fundamental of mathematical Statistics, 2017, sultan chand & sons
4. Sundar Rao P.S.S. and Richard J., Introduction to biostatics and research methodology, 5th edition, 2012, PHI Learning Pvt. Ltd.
5. Banarjee P.K. , Introduction to biostatics, 3rd edition, 2006, S. Chand Publication, India
6. Rastogi V.B. Biostastics, 3rd revised edition,2015, Rastogi publication

Course code	Course Title	L	P	Contact Hr	Contact Hr	Total Credit
BMI194A	Project	0	8	0	8	4

Course outcome (CO)

On completion of the course, students are able to:

CO1- Have developed a very good understanding of areas where microbiology has social importance
CO2 Build the knowledge by thorough training of major equipment used during dissertation work
CO3 Analyze the results of dissertation work by the use of conventional microbial techniques.
CO4 Make use of new and recent technology for creating technical reports
CO5 Effective presentation and improve soft skills

The Project work will involve practical work on a problem suggested by the supervisor of the candidate. The student will submit the project report at the end of VI semester. This project report will be examined by the supervisor of the student, Head of the Department and any other person appointed by Dean, SSC.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

Course Outcome	**Program Outcome**						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	2	3	3	2	3
CO2	2	3	2	2	3	2	3
CO3	3	3	2	2	2	3	3
CO4	2	2	2	3	2	3	3
CO5	2	2	2	2	3	3	3

3 = Highly Related; 2 = Medium; 1= Low

Bioinformatics Lab (BBI225A)

At the end of this course students will able to

CO1 Understand the different data bases.

CO2 Retrieve and analyze 3D structures of proteins and nucleic acids from structural databases such as PDB.

CO3 Visualize and interpret structural features of biomolecules using tools like PyMOL, Chimera, or RasMol.

CO4 Compare and classify protein structures using SCOP, CATH, and related classification systems.

CO5 Perform homology modeling and validate predicted structures using tools like SWISS-MODEL and PROCHECK.

1. To study the different data bases.
2. To retrieve the protein sequences from NCBI database and to interpret the results.
3. To study protein X-ray diffraction data by using Protein Structure Database.
4. To find the conserved Domains in Protein Sequences.
5. To analyse the retrieve protein sequence for Ramachandran Plot by using PSVS.
6. To study structural features of RNA by using different RNA database and softwares.
7. To determine the motifs, present in your target proteins.
8. To perform homology alignment by using pdb-BLAST.

9. **MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:**

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	2	3	1	1	2
CO2	2	3	2	3	1	2	2
CO3	2	2	3	3	1	2	2
CO4	2	2	3	3	1	2	3
CO5	3	2	3	3	2	2	3

3 = Highly Related; 2 = Medium; 1= Low

Course code	Course Title	L	P	Contact Hr	Contact Hr	Total Credit
BMI181A	**Advanced Microbiology**	**3**	**1**	**3**	**2**	**4**

Course outcome (CO)

On completion of the course, students are able to:

CO1- Understand the Evolution of Microbial Genomes and Evolution of bacterial virulence.
CO2- Understand the Brief history and development of metagenomics and Biofilms.
CO3- Understand the Systems and Synthetic Biology and Basics of synthesis.
CO4- Understand the importance of microbial communities and Modern Tools.
CO5- Understand the mammalian cell culture and characterization of cultured cells.

Unit I

Evolution of Microbial Genomes: Salient features of sequenced microbial genomes, core genome pool, flexible genome pool and concept of pan genome, Horizontal gene transfer (HGT).

Evolution of bacterial virulence: Genomic islands, Pathogenicity islands (PAI) and their characteristics.

Unit II

Metagenomics: Brief history and development of metagenomics, Basic knowledge of viral metagenome, meta transcriptomics, metaproteomics and metabolomics.

Biofilms: types of microorganisms, molecular aspects and significance in environment, health care, virulence and antimicrobial resistance

Unit III

Systems and Synthetic Biology: Networking in biological systems, Quorum sensing in bacteria, Coordinated regulation of bacterial virulence factors.

Basics of synthesis: poliovirus in laboratory, Future implications of synthetic biology with respect to bacteria and viruses.

Unit IV

Microbiomes: importance of microbial communities, VBNC (viable but not culturable bacteria). Genetically modified organisms and their uses.

Modern Tools: Modern methods of rapid identification of microbes (PCR, mass spectrometry, fluorescence based techniques). CRISPR-Cas system.

Unit V

Mammalian cell culture: Primary Cell culture – Isolation and separation of cells, viable cell count, maintenance of cell culture.

Characterization of cultured cells: Contamination Testing of Culture, Viability measurement and cytotoxicity, Measurement of growth parameters, Cell cycle analysis and Synchronization of cultures.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

Course Outcome	Program Outcome						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	2	2	1	1	3
CO2	2	2	1	1	2	2	2
CO3	2	2	3	2	2	3	2
CO4	3	2	1	3	3	2	1
CO5	3	2	1	2	1	1	1

3= Highly Related; 2= Medium; 1 = Low

Suggested Readings:

1. Benjamin Lewin, Gene VII, Oxford University Press, (2000).
2. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter, Molecular biology of the Cell, 4th Edition. Garland publishing Inc, (2002).
3. Darnell, Lodish and Baltimore, Molecular Cell Biology, Scientific American Publishing Inc.(2000).
4. Watson .J. D, Baker. T. A, Bell. S. P, Gann. A. Levine. M. Losick. R, Molecular Biology of Gene, 5th Edition. The Benjamin/Cummings Pub.Co.Inc (2003).
5. David Frifielder, Stanely R. Maloy, Molecular biologyand microbial genetics. 2ndEdition, Jonesand Barlett Publishers. (1994).
6. Brown T.A., Gene Cloning and DNA analysis. 2nd Edition, ASM press. (2004).
7. Sandy Primrose. Principles of Gene Manipulation and Genomics. 7th Ed., Blackwell Publishers. (2006).
8. Glick B R and Pasternak J J, Molecular Biotechnology, 2nd Ed.ASM press. (2003).

Advanced Microbiology Lab (BMI182A)

CO1 Analyze the metagenomics data of isolated bacterial population from soil.
CO2 Analyze the PCR amplification of metagenomics data.
CO3 Analysis of the synthesis of polio virus in-situ and bacterial metabolomics.
CO4 Analyze encapsulation and Isolation of cells from chick embryo.
CO5 Apply the knowledge to establishment and maintenance of cell cultures.

1) Extraction of metagenomics DNA from soil.
2) Understand the impediments in extracting metagenomics DNA from soil.

3) PCR amplification of metagenomics DNA using universal 16s ribosomal gene primers.
4) Case study to understand how the polio virus genome was synthesized in the laboratory.
5) Case study to understand how networking of metabolic pathways in bacteria take palce
6) Genotyping of candidate genes for diseases by RFLP.
7) Encapsulation of mammalian cells.
8) Isolation of cells from Chick embryo.
9) Establishment and maintenance of primary cell cultures.
10) Subculture of monolayer cells.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

Course Outcome	Program Outcome						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	2	3	3	3	2	2	2
CO2	2	3	1	2	3	2	3
CO3	3	2	2	2	3	1	3
CO4	1	2	3	1	3	1	3
CO5	1	1	3	1	2	3	3

3= Highly Related; 2= Medium; 1 = Low

Course code	Course Title	L	P	Contact Hr	Contact Hr	Total Credit
BMI138A	Research Methodology	3	0	3	0	3

Course outcome (CO)

On completion of the course, students are able to:

CO1-Understand the problem, significance and approaches of research
CO2- Understand the concept of review paper writing and gap in research
CO3- Understand the IPR in research publication
CO4- Understand the writing methods of research articles
CO5- Analyse the interpretation of results data with statistical tools.

Unit I

Meaning of Research, Objectives of Research, Types of Research, Research Approaches, Significance of Research, Defining and formulating the research problem, selecting the problem, necessity of defining the problem

Unit II

Importance of literature review in defining a problem, literature review-primary and secondary sources, research databases, web as a source, searching the web, critical literature review, identifying gap areas from literature and research database, development of working hypothesis.

Unit III

Ethics-ethical issues, ethical committees (human & animal); IPR- intellectual property rights and patent law, copy right, royalty, scholarly publishing-citation and acknowledgement, plagiarism, reproducibility and accountability.

Unit IV

Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Types of Reports, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing Research Reports.

Unit V

Meaning of interpretation, technique of interpretation, precaution in interpretation, tools used in interpretation of data. Software used to analyze data (SPSS, GraphPad Prism).

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

Course Outcome	Program Outcome						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	2	3	2	1	2
CO2	3	3	2	2	3	3	2
CO3	3	2	2	3	3	3	3
CO4	1	3	3	2	3	3	2
CO5	3	2	2	3	2	2	3

3= Highly Related; 2= Medium; 1 = Low

Suggested Readings:

1. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002. An introduction to Research Methodology, RBSA Publishers.
2. Kothari, C.R., 1990. Research Methodology: Methods and Techniques. New Age International. 418p.
3. Sinha, S.C. and Dhiman, A.K., 2002. Research Methodology, Ess Ess Publications. 2 volumes.
4. Trochim, W.M.K., 2005. Research Methods: the concise knowledge base, Atomic Dog Publishing. 270p.
5. Wadehra, B.L. 2000. Law relating to patents, trademarks, copyright designs and geographical indications. Universal Law Publishing.

Course code	Course Title	L	P	Contact Hr	Contact Hr	Total Credit
BMI187A	Dissertation	0	24	0	0	12

CO1 Analysis of recent problem related microbiology for dissertation work
CO2 Build the knowledge by thorough training of major equipment used during dissertation Work.
CO3 Analyze the results of dissertation work by the use of conventional microbial techniques.
CO4 Make use of new and recent technology for creating technical reports
CO5 Effective presentation and improve soft skills

Prerequisites:	Knowledge of various techniques in Microbiology and Laboratory training obtained during B.Sc. practical
Objective:	Planning and execution of various research related practical's independently or as a group
Contents:	
1.	Identification of research problem in Microbiology.
2.	Review of literature associated with project.
3.	Listing the various objectives.
4.	Planning and conducting experiments related to project work.
5.	Collection and analysis of data for preparation of project report.
6.	Final preparation of project report to be submitted as dissertation in partial fulfillment of B.Sc. Programme

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

Course Outcome	**Program Outcome**						
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
CO1	3	3	2	3	3	2	3
CO2	2	3	2	2	3	2	3
CO3	3	3	2	2	2	3	3
CO4	2	2	2	3	2	3	3
CO5	2	2	2	2	3	3	3

3 = Highly Related; 2 = Medium; 1= Low

Major Discipline Elective Papers
DSE Track

DSE -Food Microbiology

Course code	Course Title	L	P	Contact Hr	Contact Hr	Total Credit
BMI196A	Basics of Food Microbiology	3	1	3	2	4

Course outcome (CO)

On completion of the course, students are able to:
CO1- Understand the food microorganism and its classification and importance.
CO2- Apply the principle of food preservation and removal of microorganism.
CO3- Understand and analyze about microorganism responsible for food contamination and spoilage.
CO4- Analyze the food infection and intoxication.
CO5- Understand and apply the health standard, fermentation of food and, disposal and treatment process.

Unit I

Microorganisms important in food microbiology; Molds, yeasts and bacteria - General Characteristics - Classification and importance, Nutritional requirements of bacteria and fungi.

Unit II

Principles of food preservation - Asepsis - Removal of micro organisms, anaerobic conditions - High temperature - Low temperature - Drying - Food additives

Unit III

Contamination and spoilage - Cereals, sugar products, vegetables and fruits, meat and meat products, milk and milk products - Fish and sea food - Poultry, Spoilage of canned foods. Spoilage and defects of fermented dairy products - oriental fermented foods

Unit IV

Food borne infections and intoxications - bacterial, non -bacterial - Food borne disease outbreaks, Laboratory testing, preventing measures, Food sanitation, plant sanitation

Unit V

Employees' health standards, waste treatment and disposal, quality control, Food fermentations : Bread cheese, vinegar, fermented vegetables, fermented dairy products

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

Course Outcome	Program Outcome						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	2	2	3	1	1
CO2	2	1	1	1	2	1	3

CO3	3	2	3	3	2	1	2
CO4	2	2	3	2	2	3	1
CO5	2	2	2	2	1	1	1

3 = Highly Related; 2 = Medium; 1 = Low

Suggested Readings:

1. Adams MR and Moss MO, Food Microbiology, Revised edition,2008, New Age International (P) Limited Publishers, New Delhi, India.
2. Banwart JM, Basic Food Microbiology. 2nd edition, 2004, CBS Publishers and Distributors, Delhi, India.
3. Davidson PM and Brannen AL, Antimicrobials in Foods. 1993, Marcel Dekker, New York.
4. Dillion VM and Board RG, Natural Antimicrobial Systems and Food Preservation, 1996, CAB International, Wallingford, Oxon.
5. Frazier WC and Westhoff DC, Food Microbiology. 3rd edition,1992, Tata McGraw-Hill Publishing Company Ltd, New Delhi, India.
6. Gould GW. New Methods of Food Preservation, 1995, Blackie Academic and Professional, London.
7. Jay JM, Loessner MJ and Golden DA , Modern Food Microbiology. 7th edition, 2005, CBS Publishers and Distributors, Delhi, India.
8. Lund BM, Baird Parker AC, and Gould GW, The Microbiological Safety and Quality of Foods. Vol.1-2, .2000, ASPEN Publication, Gaithersberg, MD.
9. Tortora GJ, Funke BR, and Case CL, Microbiology: An Introduction. 9th edition, 2008,Pearson Education.

Basics of Food Microbiology Lab (BMI197A)

CO1: Perform qualitative and quantitative analysis of milk to assess its microbial quality using standard microbiological techniques.
CO2: Evaluate the efficiency of milk pasteurization through enzymatic and microbiological tests.
CO3: Demonstrate the process of curd/yogurt and bread production using microbial fermentation techniques.
CO4: Isolate, identify, and characterize spoilage microorganisms from different food materials such as milk, fruits, vegetables, and bread.
CO5: Apply basic principles of food microbiology to assess food quality, safety, and spoilage in laboratory settings.

1) Determination of quality of milk sample by methylene blue reductase test.
2) Detection of number of bacteria in milk by standard plate count (SPC).
3) Alkaline phosphate test to check the efficiency of pasteurization of milk.
4) Production of yogurt/curd.
5) Isolation of spoilage microorganisms from spoiled milk.
6) Isolation of spoilage microorganisms from spoiled fruits and vegetables.
7) Isolation of spoilage microorganisms from spoiled bread.
8) Production of bread.
9) To determine the microbial load of water used in food processing by the pour plate method.
10) To study the effect of temperature on microbial growth in food samples.
11) To evaluate the efficiency of common food preservatives (e.g., sodium benzoate, vinegar) against

bacterial growth.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

Course Outcome	Program Outcome						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	2	2	3	2	2
CO2	2	2	1	1	2	2	1
CO3	3	2	2	2	2	1	2
CO4	2	2	3	2	2	1	1
CO5	2	2	2	2	1	1	1

3 = Highly Related; 2 = Medium; 1 = Low

Course code	**Course Title**	**L**	**P**	**Contact Hr**	**Contact Hr**	**Total Credit**
BMI198A	**Principles of Food Chemistry**	**3**	**1**	3	**2**	4

Course outcome (CO)

On completion of the course, students are able to:

CO1 Understand the properties and reactions of carbohydrates, lipids and proteins during storage and processing of foods and the effect of these on the quality and property of foods.
CO2 Analyze the main factors influencing the colour and flavour of food.
CO3 Understand the composition of foods and the effect of these factors on foods.
CO4 Evaluate large scale and profit motivated production of microorganisms or their products for direct use or as inputs in the manufacture of other products.
CO5 Understand the process of browning reactions in food.

Unit I

Introduction to Chemistry of Foods: Carbohydrates Composition and factors affecting composition of foods - Moisture in foods and determination of moisture - Carbohydrates - Chemistry of cellulose, starches, other polysaccharides - starch enzymes, starch degradation - Pectic substances, their occurrence structure, properties and use in foods - Plant acids, acidity, taste

Unit II

Classification of proteins, physical and chemical properties of proteins, functional properties of proteins in foods, hydrolysis of proteins - Major food - Proteins and their sources, Changes in proteins during processing - Determination of Proteins

Unit III

Physical and chemical properties of fats, rancidity and flavour reversion, fat hydrolysis and inter-esterification, hydrogenation, Emulsions, Definition, surface activity, surface film theory of emulsions, properties and types of emulsions, emulsifying agents, their chemistry during processing - Essential oils, Chemistry of occurrence, Extraction - Terpene oils and their use in foods.

Unit IV

Cereals: Cereal varieties and their suitability for processing - Structure of wheat, rice - Chemical compositions and nutritional values of prominent cereals; Distribution of vitamins, proteins, minerals, carbohydrates and fats in different grains Pulses: Nutritional value of prominent pulses (Moong,black gram and soyabeans) Oilseeds: Chemical composition and nutritional value of prominent oilseeds (Sunflower mustard, ground nut and coconut) – Distribution of vitamins, proteins, minerals, carbohydrates and fats in different oilseeds

Unit V

Browning Reactions in Foods, Nonenzymatic Browning, Pigment Formation, Melanoidin - Maillard Polymers, Caramelization, Ascorbic Acid Oxidation, Antioxidant Activity of Nonenzymatic Browning Products, Inhibition of nonenzymatic browning.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

Course Outcome	Program Outcome						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	1	1	1	1	1	2	1
CO2	2	2	1	2	2	1	2
CO3	3	1	2	1	1	1	2
CO4	2	2	1	2	1	1	3
CO5	3	3	2	1	2	2	1

3 = Highly Related; 2 = Medium; 1 = Low

Suggested Readings:

1. Food Science and experimental foods, Swaminathan, N. (1987) Ganesh Publications, Madras.
2. Food chemistry, Meyer L.M.(1969) Van Noustrand Reinhold co., New York.
3. Foundations of Food Preparation, Peckham, C.G. (1979),The Macmillan co., London.
4. Food Theory and Applications, Paul P.C. and Palmer H.H. (1972), John wiley and Sons, New York.

5. The experimental study of foods, Griswald R.M. (1962), Houghton, Muffin Co., New York.
6. Introductory foods, Bennion M. and Hughes, D. (1975), Macmillan publishing Co., New York.
7. Food facts and principles, SakuntalaManay and shadaksaraswamy, M (1987) Allied Publishers, New Delhi.

Principles of Food Chemistry Lab (BMI199A)

CO1: Perform qualitative tests for detection and differentiation of amino acids and proteins using characteristic color reactions.
CO2: Identify and classify carbohydrates based on their chemical reactivity in standard qualitative tests.
CO3: Detect the presence and nature (saturated/unsaturated) of lipids using biochemical assays.
CO4: Analyze non-protein nitrogenous compounds (urea, creatinine, uric acid) through qualitative tests.
CO5: Apply biochemical principles to systematically identify biomolecules present in various biological samples.

1. To perform the Biuret test for the detection of peptide bonds in proteins.
2. To detect tyrosine-containing proteins using Millon's test.
3. To detect sulfur-containing amino acids by Nitroprusside test.
4. To identify amino acids through the Ninhydrin test.
5. To detect the presence of arginine using Sakaguchi test.
6. To perform Molisch's and Benedict's tests for the detection of carbohydrates.
7. To differentiate monosaccharides and disaccharides using Barfoed's and Seliwanoff's tests.
8. To detect and confirm the presence of galactose by the Mucic acid test and starch by the Iodine test.
9. To detect the presence of lipids and determine their saturation and unsaturation.
10. To detect non-protein nitrogenous (NPN) substances using Urease test, Jaffe's test, and Uric acid test.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

Course Outcome	Program Outcome						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	2	2	2	1	2
CO2	3	2	2	2	1	2	1
CO3	2	2	3	2	2	2	1
CO4	3	3	2	2	2	2	1
CO5	2	2	2	2	2	2	1

3 = Highly Related; 2 = Medium; 1 = Low

Course code	Course Title	L	P	Contact Hr	Contact Hr	Total Credit
BMI200A	Food Packaging engineering	3	1	3	2	4

Course outcome (CO)

On completion of the course, students are able to:

CO1 Understand the fundamentals of packaging technology.
CO2 Understand the safety evaluation of materials used for packing.
CO3Apply and examine the knowledge of properties for selection of packaging materials for foods & food product.
CO4 Analyze the different techniques of food packaging.
CO5 Understand the packaging equipments and machinery.

Unit I

Introduction of Food packaging - Need of food packaging - Role of packaging in extending shelf life of foods - Designing of package materials - Testing of package materials - Testing of package performance - Principles in the development of safe and protective packing - Safety assessment of food packaging materials

Unit II

Food packaging systems, product characteristics and package requirements - Introduction of food packaging system - Different forms of packaging - Rigid, semi-rigid, flexible forms of packaging - Different packaging system for-Dehydrated foods, Frozen foods, Dairy products, Fresh fruits, Vegetables, Meat, Poultry, Sea foods

Unit III

Types of packaging materials their characteristics and uses - Use of paper as a packaging material-Pulping - Fibrillation, Beating, Types of papers ,Testing methods - Use of glass as a packaging material-Composition, Properties, Types, Use of metals as a packaging material - Tinplate containers, Tinning process, Aluminium containers, Lacquers - Use of plastics as a packaging material-Types of plastics, Plastic films, laminated plastic materials

Unit IV

Package accessories and advances in Packaging technology-Introduction - Active packaging - Modified atmosphere packaging–Controlled atmosphere packaging - Aseptic packaging - Packages for microwave ovens - Biodegradable plastics - Edible gums – Coatings

Unit V

Packaging equipment and machinery- Vacuum packaging machine - CA & MA packaging machine - Gas packaging machine - Seal and shrink packaging machine - Form & fill sealing machine - Aseptic

packaging systems - Retort pouches - Bottling machines - Carton making machines - Package printing machines

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

Course Outcome	Program Outcome						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	2	2	2	1	2	1	2
CO2	1	1	1	2	1	2	1
CO3	2	2	3	1	2	1	2
CO4	1	1	1	2	1	1	2
CO5	2	2	3	1	1	1	1

3 = Highly Related; 2 = Medium; 1 = Low

Suggested Readings:

1. Srilakshmi,B.,2005, Food Science., New Age International (P) Limited., New Delhi.
2. Subalakshmi, G and Udipi, S.A, 2001, Food processing and preservation. New Age International Publishers, New Delhi.
3. Potter, N. N, Hotchkiss, J. H, 2000 Food Science. CBS Publishers, New Delhi.
4. Manay, N.S, Shadaksharaswamy, M.,2004, Foods- Facts and Principles, New Age International Publishers, New Delhi
5. Miquel Angelo P R C, Ricardo Nuno C P, Oscar Leandro D S R, Jose Antonio C T, Antonio Augusto V , 2016, Edible Food Packaging: Materials and Processing Technologies, CRC Press. Taylor &Francis ,Boca Raton , FL
6. Luciano P, Sara L,2016, Food Packaging Materials, Springer cham Heildelberg, New York
7. Robertson, G.L. 2006 Food Packaging: Principles and Practice (2nd ed.), Taylor & Francis
8. NIIR. (2003). Food Packaging Technology Handbook, National Institute of Industrial Research Board, Asia Pacific Business Press Inc.

Food Packaging Engineering Lab (BMI201A)

CO1: Measure physical properties of packaging materials, including thickness, water absorption, and bursting strength.
CO2: Determine mechanical properties such as static and dynamic tensile strength of packaging papers.
CO3: Evaluate barrier properties of packaging materials, including water vapor and gas transmission rates.
CO4: Assess coating levels and surface characteristics of packaging materials like tin plates.
CO5: Apply standard testing methods to analyze packaging materials for food safety and suitability.

1) To measure the thickness of a paper and paper boards used in packaging

2) To measure water absorption capacity of packaging paper

3) To measure the bursting strength of a packaging paper

4) To determine the static and dynamic tensile strength of a packaging paper

5) Determination of water vapour permeability (WVTR) of packaging material.

6) To find the amount of coating in a tin plate.

7) Determination of a gas transmission rate of packaging material.

8) To determine the grease resistance of packaging paper.

9) To determine the tensile tear strength of packaging film or laminate.

10) To determine the moisture content of packaging paper or board.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

Course Outcome	Program Outcome						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	2	2	2	1	2	1	2
CO2	3	3	2	2	2	2	2
CO3	2	2	3	1	2	2	2
CO4	3	3	2	2	2	1	2
CO5	2	2	1	2	1	1	1

3 = Highly Related; 2 = Medium; 1 = Low

Course code	Course Title	L	P	Contact Hr	Contact Hr	Total Credit
BMI202A	Food safety and public health	3	1	3	2	4

Course outcome (CO)

On completion of the course, students are able to:

CO1- Evalute the different sensory methods used for the quality determination of various foods.
CO2- Perform various tests to detect the presence of adulterants in foods.
CO3- Understand the various food laws and standards.
CO4- Understand the various lab practices in food quality
CO5- Understand the importance of Quality Control and Quality Assurance.

Unit I

Bacterial : Food Poisoning by *Staphylococcus, Clostridium perfringens, Clostridium botulinum,. Salmonella, Brucella, E. coli, Shigella, Bacillus cereus, Yersinia enterocolitica, Vibrio cholerae, Listeria monocytogenes* - Fungi – Mycotoxins – *Aflatoxin, ochratoxin, trichothecenes, Roquefortine.*

Unit II

Sensory evaluation - definition and importance of sensory evaluation in relation to consumer acceptability and factors affecting food acceptance-terminology related to sensory evaluation - scoring procedures: types of tests -panel selection-screening, sampling procedures-factors affecting sensory measurements. Chemical methods used in quality evaluation-Moisture, PR, HM, TVBN, Peroxide value, Acidity/ acid value detection of adulterants

Unit III

Food laws and standards - Food regulations, grades and standards - Food safety objectives - National food legislation/ authorities and their role - product certifications: ISI mark of BIS, AGMARK, FPO, MFPO, international organization and agreements-food and agricultural organization (FAO), Concept of Codex Alimentarius/HACCP /USDA/ISO 9000 series

Unit IV

Introduction, principles of sanitation, sanitation chemicals, disinfectants, sanitation methodology, sanitation procedures, CIP and COP- evaluating the effectiveness of sanitation programmes – Good Manufacturing Practices (GMP) and Good Laboratory Practices (GLP) in pharmaceutical industry - Regulatory aspects of quality control - ISO, WHO and US certification

Unit V

Importance and functions of quality control - Methods for quality assessment - Sterilization control and sterility testing (heat sterilization, D value, z value, survival curve, Radiation, gaseous and filter sterilization) - Sampling and specification of raw materials and finished products - Statistical quality control – A comparison of Quality Control and Quality Assurance - Use of microbiology methods in a Quality-Control system - Use of microbiology methods in a Quality Assurance system

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

Course Outcome	Program Outcome						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	2	2	2	1	2	1	2
CO2	1	1	1	2	1	2	1
CO3	2	2	3	1	2	1	2
CO4	1	1	1	2	1	1	2
CO5	2	2	3	1	1	1	1

3 = Highly Related; 2 = Medium; 1 = Low

Suggested Readings:

1. Read G. and Nogodwanithana (1991), Yeast Technology, 2nd Edition, AVI Book, Van Nostrant, Reinhold, New York.
2. Lee B.H. (1996), Fundamental of Food Biotechnology, VCH Publishers.
3. Goldberg I. and Williams R. (1991), Biotechnology and Food Ingredients, Van Nostrant., Reinhold, New York.
4. Joshi V.K. and Pandey A. (1999), Biotechnology: Food Fermentation Vol. 1 & 2, Education Publisher and Distributer, New Delhi.
5. Marwaha S.S. and Arora, J.K. (2000), Food Processing: Biotechnological applications, Asia tech Publishers Inc., New Delhi.
6. Frazier W. C. and Westhoff D.C. (1995). Food Microbiology. Fourth Edition. Tata McGraw Hill Publishing Company Limited, New Delhi
7. Adams M.R. and M.O. MOSS (2005). Food Microbiology. 1st edition. Reprinted, Published by New Age International (P) Limited. Publishers - New Delhi

Food safety and public health Lab (BMI203A)

CO1: Estimate the ash, crude protein, and crude fiber content in different food samples.
CO2: Assess the nutritional composition of food samples using standard analytical methods.
CO3: Evaluate the sensory quality of food products using preference and descriptive rating tests.
CO4: Determine the microbial load of food samples through total plate count technique.
CO5: Identify and study gut microbiota from food samples using selective and differential media.

1) To find out the ash in the given food sample
2) To find out the amount of crude protein in a given food sample
3) To find out the amount of crude fiber in a given food sample
4) Sensory Evaluation of a food product by Preference Test-Hedonic Rating Scale
5) Sensory Evaluation of a food product by Descriptive Rating Test- Star Diagrams
6) To examine total plate count of given food sample.
7) To identify the gut micro biota in given food sample through specific medium

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

Course Outcome	Program Outcome						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	2	2	2	3	2	2	2
CO2	3	3	3	2	2	2	2
CO3	2	2	3	2	2	2	2

CO4	3	1	1	2	2	2	2
CO5	2	2	3	2	2	2	2

3 = Highly Related; 2 = Medium; 1 = Low

Course code	Course Title	L	P	Contact Hr	Contact Hr	Total Credit
BMI204A	Applied Dairy Microbiology	3	1	3	2	4

Course outcome (CO)

On completion of the course, students are able to:

CO1-Understand the pathogenic microorganisms transmitted through raw milk.
CO2-Understand the preservation technique of milk
CO3-Analyze the composition of starter cultures and their use in dairy products
CO4-Analyze the various type of disease transmitted by raw milk.
CO5-Analyze the culture dependent and culture independent techniques for quantification of microorganisms from dairy products.

Unit I

Composition of milk of different animals – classes of milk - Microorganisms of concern in milk - Factors influencing microbial growth in milk - antibacterial properties of milk - Scope of dairy microbiology

Unit II

Preservation techniques in milk and milk based products – Asepsis, removal of microorganisms, anaerobic conditions, high and low temperatures, drying, irradiation, Chemical and bio preservatives and food additives

Unit III

Products from milk: market milk – condensed and dry milk products –frozen desserts Fermented Dairy Products: Starter cultures: their isolation, production, maintenance, biochemical characters - Products: Cheese, yogurt, butter

Unit IV

Human pathogens transmitted through raw milk and other dairy products: *Bacillus cereus, Campylobacter jejuni, Escherichia coli, Listeria monocytogenes, Salmonella spp., Yersinia enterocolitica.* Diseases transmitted through milk: brucellosis, tuberculosis, Q fever

Unit V

Quality analysis of milk: platform tests in milk - SPC, MBRT, alkaline phosphatase test, Resazurin test, clot on boiling test, titratable acidity, butter fat content test - FSSAI standards of milk - PMO – MMPO

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

Course Outcome	Program Outcome						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	2	1	1	3	3	1	2
CO2	3	2	2	1	1	2	1
CO3	2	1	3	3	2	1	2
CO4	3	2	3	2	1	2	2
CO5	2	2	1	2	2	1	1

3 = Highly Related; 2 = Medium; 1 = Low

Suggested Readings:

1. Frazier W. C. and Westhoff D.C. (1995). Food Microbiology. Fourth Edition. Tata McGraw Hill Publishing Company Limited, New Delhi
2. Adams M.R. and M.O. MOSS (2005). Food Microbiology. 1st edition. Reprinted, Published by New Age International (P) Limited. Publishers – New Delhi
3. Robinson R.K. (2002) Dairy Microbiology: Milk and Milk Products,3rd Edn.Wiley Publishers.
4. Banwart JM. (1987). Basic Food Microbiology. 1st edition. CBS Publishers and Distributors, Delhi, India
5. Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. 2nd edition, Elsevier Science Ltd
6. Betty C. Hobbs, Food Microbiology, Arnold-Heinemann Publishing Private Ltd
7. Hammer B. W. and Babal, Dairy Bacteriology, Prentice Hall Incorporated
8. Jay J.M., Modern Food Microbiology, CBS Publishers and Distributors, New Delhi. India

Applied Dairy Microbiology Lab (BMI205A)

CO1: Analyze the milk quality using microbial count and reduction tests.
CO2: Analyze to detect adulteration, spoilage, and pasteurization efficiency in milk.
CO3: Apply Isolate and identify lactic acid bacteria and coliforms from milk products.
CO4: Understand the Prepare fermented dairy products and study the effect of temperature and pH on fermentation.
CO5: Evaluate microbiological quality and safety of milk for public health assurance.

1. Determination of Total Bacterial Count (Standard Plate Count) in milk.
2. Direct Microscopic Count (DMC) of milk under microscope for bacterial load.
3. Methylene Blue Reduction Test (MBRT) – determination of milk quality based on microbial activity.
4. Resazurin Reduction Test – rapid assessment of milk quality.
5. Clot-on-Boiling (COB) Test – test for acidity and spoilage.
6. Phosphatase Test – to check efficiency of milk pasteurization.
7. Detection of Adulteration in Milk – qualitative and quantitative tests for water, starch, urea, etc.

8. Isolation of Lactic Acid Bacteria (LAB) from raw milk and curd.
9. Enumeration of Coliforms in Milk (Most Probable Number / MPN method).
10. Preparation of Curd / Yogurt / Dahi using starter cultures.
11. Effect of Temperature and pH on Lactic Fermentation.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

Course Outcome	Program Outcome						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	2	3	3	2	2
CO2	3	2	2	1	1	2	1
CO3	3	1	3	3	2	1	1
CO4	3	1	3	2	2	2	2
CO5	2	2	2	2	2	2	2

3 = Highly Related; 2 = Medium; 1 = Low

Course code	Course Title	L	P	Contact Hr	Contact Hr	Total Credit
BMI206A	Food safety Law and Standards	3	1	3	2	4

Course outcome (CO)

On completion of the course, students are able to:

CO1Understand the information relating to food laws and regulations.
CO2 Understand the law making process as it applies to food and food technology.
CO3 Understanding and interpreting information on food labels.
CO4 Analyze the major food law legislation and its importance to current regulations.
CO5Analyze the the role of regulatory agencies in enforcing current food laws.

Unit I

Introduction to food laws, prevention of food adulteration Act (PFA-1954). The preamble of act, definition, primary food, kinds of adulteration in the act, adulterated food, article held as court, misbranded food, functional responsibilities of various authority, central food laboratories, role of inspectors

Unit II

Food safety and quality requirements. Voluntary requirement, legal requirement, mandatory provision prescribed under PFA Act 1954 and rule 1955.Enforcement of prevention of food adulteration act (PFA-

1954) by state government, ministries, departments responsible for ensuring food safety and quality in India

Unit III

Food safety and standards act 2006 (FSSA 2006) rules and regulations 2011, existing food law in India, salient features of FSSA 2016, important provision of FSSA, essential commodities act.

Unit IV

Codex alimentarius commission(CAC) , Statutes of Codex alimentarius commission, need for harmonizing ntional standards with codex. WTO implication, SPS agreement, TBT agreement, relation between the codex and WTO.

Unit V

Customs act and import control regulation, and other law related to food products, legal Metrology, provisions of weight and measures act 1976, the insecticides act 1968, Consumer Protection Act 1986, Customs Act 1962.

Suggested Readings:

1. Kiron Prabhakar(2016) A Practical Guide to Food Laws and Regulations.Bloomsbury india
2. Rajan Nijhawan (2016) Food Safety and Standards Act, 2006, Rules & Regulations-- ILBCO 22nd edition.
3. Virag gupta (2019) The food safety and standard act,2006 along with rules and regulations as amended upto 15 APRIL, 2019; 12th edition commercial law publishers, (India) Pvt. Ltd.
4. Adams M.R. and M.O. MOSS (2005). Food Microbiology. 1st edition. Reprinted, Published by New Age International (P) Limited. Publishers - New Delhi
5. Srilakshmi,B.,2005, Food Science., New Age International (P) Limited., New Delhi.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

Course Outcome	Program Outcome						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	2	1	1	3	3	1	2
CO2	3	2	2	1	1	2	1
CO3	3	1	3	3	2	1	2
CO4	3	1	3	2	1	2	2
CO5	2	2	1	2	2	1	1

3 = Highly Related; 2 = Medium; 1 = Low

Food law and Standards Lab(BMI207A)

CO1: Identify common adulterants present in various food samples.
CO2: Examine and evaluate food labels for compliance with FSSAI standards.
CO3: Understand the functioning of food inspectors and food testing laboratories.
CO4: Compare national food safety standards with Codex Alimentarius and related WTO agreements.
CO5: Study real-life cases of food adulteration and the role of legal authorities in ensuring food safety.

1. Perform qualitative detection of common adulterants in food samples i.e. starch in milk, metanil yellow in turmeric, artificial color in spices, chalk powder in flour, etc.
2. Examine and interpret food labels as per FSSAI labeling requirements, ingredients list, nutrition facts, batch number, FSSAI license, allergen statement, expiry date.
3. Observe working of food inspectors, sampling methods, and testing procedures for adulteration and safety parameters.
4. Review Codex Alimentarius standards for dairy, cereals, or processed foods.
5. Analyze a real-life case (from FSSAI website or media) related to food adulteration, import violation, or labeling fraud.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

Course Outcome	Program Outcome						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	2	2	2	2	2
CO2	2	2	2	2	2	3	2
CO3	3	2	2	1	3	2	2
CO4	2	2	2	2	2	2	2
CO5	3	3	2	2	1	2	2

3 = Highly Related; 2 = Medium; 1 = Low

Course code	Course Title	L	P	Contact Hr	Contact Hr	Total Credit
BMI208A	Microbial Toxins in food systems	3	1	2	2	4

Course outcome (CO)

On completion of the course, students are able to:

CO1Understand the origin, types, and mechanisms of microbial toxins in foods.
CO2 Analyze toxin-producing microorganisms, their ecology, and toxin detection methods.
CO3 Understand the impact of foodborne toxins on human health and preventive measures.
CO4 Understand regulatory limits and food safety management related to microbial toxins.
CO5 Analyze the food rapid test kit in various food

Unit I

Microbial toxins (endotoxin and exotoxin) and toxoids, source and chemistry of microbial toxins in contamination of food grains and food products.Role of bacteria, fungi, and algae in toxin production. Factors influencing toxin production (temperature, pH, water activity, etc.). Overview of foodborne intoxication vs. infection.

Unit II

Enterotoxins and Neurotoxins: *Staphylococcus aureus*, *Clostridium botulinum*, *C. perfringens*. Endotoxins and Exotoxins: Structure, mode of action, and detection. Heat stability and inactivation of bacterial toxins. Case studies of bacterial toxin outbreaks in foods.

Unit III

Mycotoxins and Their Significance: Classification and properties of major mycotoxins:Aflatoxins, Ochratoxins, Fumonisins, Zearalenone, Trichothecenes, Patulin. Producing fungi (*Aspergillus*, *Penicillium*, *Fusarium*). Effects on human and animal health. Detection and quantification techniques (ELISA, HPLC, LC-MS). Prevention and control measures in food and feed.

Unit IV

Bacterial secondary metabolites: *Bacillus cereus*, *Vibrio* spp. toxins. Algal and Marine Toxins: Saxitoxin, Tetrodotoxin, Ciguatoxin, Domoic acid. Viral and Protozoal toxins: Overview of indirect toxin-mediated effects. Emerging foodborne toxins and risk assessment approaches.

Unit V

Food safety standards related to microbial toxins: FSSAI, WHO, FAO, Codex Alimentarius. Regulatory limits and monitoring programs. HACCP principles for toxin prevention. Rapid toxin detection kits and biosensor technologies.Risk communication and consumer awareness.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

Course Outcome	Program Outcome						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	1	2	1	2	1
CO2	2	2	1	1	2	1	1
CO3	3	1	2	1	1	2	1
CO4	2	2	1	2	1	1	2
CO5	3	3	2	1	1	2	1

3 = Highly Related; 2 = Medium; 1 = Low

Suggested Readings:

1. Jay, J. M., Loessner, M. J., & Golden, D. A. (2005). *Modern Food Microbiology*, 7th Ed., Springer.
2. Forsythe, S. J. (2020). *The Microbiology of Safe Food*, 3rd Ed., Wiley-Blackwell.
3. Fratamico, P. M., et al. (2015). *Foodborne Pathogens: Microbiology and Molecular Biology*, Caister Academic Press.
4. Marriott, N. G., & Gravani, R. B. (2006). *Principles of Food Sanitation*, Springer.
5. ICMSF (2011). *Microorganisms in Foods 8: Use of Data for Assessing Process Control and Product Acceptance*, Springer.
6. WHO & FAO Reports on *Mycotoxin Control in Food* and *Foodborne Disease Surveillance*.
7. FSSAI (2021). *Manual of Methods of Analysis of Food – Mycotoxins and Microbial Toxins*.

Microbial Toxins in food systems Lab (BMI209A)

1. Introduction to Microbial Toxins
2. Detection of Bacterial Toxins in Food Samples
3. Demonstration of *Clostridium botulinum* Toxin
4. Isolation and Identification of Mycotoxin-Producing Fungi
5. Screening of Food Samples for Aflatoxin Production.
6. Detection of Patulin or Ochratoxin in Fruit Juices/Stored Cereals
7. Study of Factors Affecting Toxin Production.
8. Analysis of Foodborne Toxin Outbreak Case Studies
9. Comparison of National and International Mycotoxin Standards
10. Demonstration of Rapid Toxin Detection Kits and Biosensors

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

Course Outcome	Program Outcome						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	2	2	1	2	2
CO2	2	2	1	2	2	1	2
CO3	3	1	2	2	1	2	1
CO4	2	2	1	2	2	2	2
CO5	3	3	2	2	2	2	1

3 = Highly Related; 2 = Medium; 1 = Low

Major DSE 2 Medical Microbiology

Course code	Course Title	L	P	Contact Hr	Contact Hr	Total Credit
BMI210A	Medical Bacteriology	3	0	3	0	3

Course Outcomes (COs)

By the end of this course, students will be able to:

CO1 Explain the morphology, physiology, and pathogenic mechanisms of medically important bacteria.

CO2 Demonstrate knowledge of laboratory diagnosis and identification techniques for bacterial pathogens.

CO3 Analyze host–pathogen interactions and understand immune responses to bacterial infections.

CO4 Evaluate the epidemiology, prevention, and control strategies for bacterial diseases of clinical relevance.

CO5 Apply knowledge of medical bacteriology in clinical, diagnostic, and public health microbiology settings.

Unit I

Introduction to Medical Bacteriology – Scope and importance of medical bacteriology, Normal human microbiota, Bacterial virulence factors, Host–pathogen interactions, Basic concepts of immunity.

Unit II

Gram-Positive Pathogenic Bacteria – *Staphylococcus*, *Streptococcus*, *Corynebacterium diphtheriae*, *Bacillus anthracis*, *Clostridium* spp.

Unit III

Gram-Negative Pathogenic Bacteria – *Neisseria* spp., Enterobacteriaceae (*Escherichia coli*, *Salmonella*, *Shigella*, *Klebsiella*, *Proteus*), *Vibrio cholerae*, *Pseudomonas aeruginosa*, Zoonotic bacteria (*Yersinia pestis*, *Brucella*, *Francisella*).

Unit IV

Mycobacteria and Other Bacterial Pathogens – *Mycobacterium tuberculosis*, *Mycobacterium leprae*, Spirochetes (*Treponema pallidum*, *Borrelia*, *Leptospira*), Rickettsiae, Chlamydiae, *Helicobacter pylori*.

Unit V

Laboratory Diagnosis, Treatment and Control – Specimen collection and processing, Staining techniques, Culture methods, Biochemical identification, Antibiotic susceptibility testing, Antimicrobial resistance, Vaccines, Chemoprophylaxis, Molecular diagnostics (PCR, sequencing, rapid tests).

Reference Books:

1. Pelczar, M.J., Chan, E.C.S., & Krieg, N.R. (2016). *Microbiology* (7th Edition). McGraw-Hill Education.
2. Madigan, M.T., Martinko, J.M., Bender, K., Buckley, D., & Stahl, D. (2021). *Brock Biology of Microorganisms* (16th Edition). Pearson.
3. Tortora, G.J., Funke, B.R., & Case, C.L. (2020). *Microbiology: An Introduction* (13th Edition). Pearson.
4. Cowan, S.T., & Steel, K.J. (2013). *Cowan and Steel's Manual for the Identification of Medical Bacteria* (3rd Edition). Cambridge University Press.
5. Murray, P.R., Rosenthal, K.S., & Pfaller, M.A. (2020). *Medical Microbiology* (9th Edition). Elsevier.

6. Ravikrishnan, K. (2017). *Textbook of Medical Microbiology for B.Sc. Students*. Jaypee Brothers Medical Publishers.
7. Cruickshank, R. (1975). *Medical Microbiology: A Guide to Microbial Infections*. Churchill Livingstone.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	1	1	1	1	1
CO2	3	2	2	1	1	1	1
CO3	2	1	2	1	2	1	1
CO4	2	1	1	2	2	1	2
CO5	3	2	3	2	3	2	3

3 = Highly Related; 2 = Medium; 1 = Low

Medical Bacteriology Lab (BMI211A)

CO1: Perform and demonstrate basic staining techniques, including Gram, acid-fast, and capsule staining.

CO2: Isolate, culture, and identify medically important bacteria from clinical and environmental samples.

CO3: Conduct motility tests, biochemical tests, and antibiotic susceptibility testing to characterize bacterial isolates.

CO4: Practice proper specimen collection, handling, and aseptic techniques in clinical microbiology.

CO5: Apply laboratory knowledge to interpret results and understand their clinical and diagnostic significance.

Practical List

1. Study of normal human microbiota (skin, oral cavity, nasal cavity)
2. Gram staining of bacteria
3. Acid-fast staining (Ziehl–Neelsen)
4. Capsule staining
5. Motility test (hanging drop method)
6. Isolation and identification of *Staphylococcus* and *Streptococcus*
7. Isolation and identification of Enterobacteriaceae (*E. coli*, *Salmonella*, *Shigella*)
8. Isolation and identification of *Pseudomonas aeruginosa*
9. Antibiotic susceptibility testing (Kirby–Bauer method)
10. Specimen collection and processing (blood, urine, throat swab)

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	1	1	1	1	1

CO2	3	2	2	1	1	1	1
CO3	3	2	2	1	2	1	1
CO4	2	1	1	2	2	1	2
CO5	3	2	3	2	3	2	3

3 = Highly Related; 2 = Medium; 1 = Low

Course code	Course Title	L	P	Contact Hr	Contact Hr	Total Credit
BMI212A	Immunology	3	0	3	0	3

Course Outcomes (COs)

By the end of this course, students will be able to:

CO1. Explain the components, structure, and functions of the immune system.
CO2. Demonstrate knowledge of innate and adaptive immune responses.
CO3. Analyze mechanisms of antigen recognition, antibody formation, and immune regulation.
CO4. Evaluate immunological basis of diseases, vaccines, and therapeutic interventions.
CO5. Apply immunological principles in clinical, diagnostic, and research settings.

Unit I

Scope and importance of immunology, Cells and organs of the immune system, Innate vs. adaptive immunity, Basic concepts of antigens and haptens

Unit II

Structure and function of antibodies, B-cell development and activation, T-cell subsets and functions, Major Histocompatibility Complex (MHC)

Unit III

Antigen processing and presentation, Cytokines and chemokines, Complement system and immune effector mechanisms, Hypersensitivity reactions (Types I–IV)

Unit IV

Autoimmunity and immunodeficiency, Transplantation immunology, Tumor immunology, Allergies and chronic inflammatory conditions

Unit V

Vaccines and immunization strategies, Monoclonal antibodies and immunotherapy, Laboratory immunodiagnostic techniques (ELISA, Western blot, flow cytometry, rapid tests), Emerging trends in immunology

Reference Books:

1. Abbas, A.K., Lichtman, A.H., & Pillai, S. (2023). *Basic Immunology: Functions and Disorders of the Immune System* (6th Edition). Elsevier.
2. Roitt, I., Brostoff, J., & Male, D. (2022). *Immunology* (14th Edition). Elsevier.
3. Kuby, J. (2019). *Immunology* (8th Edition). W.H. Freeman & Co.
4. Parham, P. (2020). *The Immune System* (5th Edition). Garland Science.
5. Goldsby, R.A., Kindt, T.J., Osborne, B.A., & Kuby, J. (2019). *Kuby Immunology* (8th Edition). W.H. Freeman.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	1	1	1	1	1
CO2	3	2	2	1	1	1	1
CO3	2	1	2	1	2	1	1
CO4	2	1	1	2	2	1	2
CO5	3	2	3	2	3	2	3

3 = Highly Related; 2 = Medium; 1 = Low

Immunology Lab (BMI213A)

CO1: Perform basic immunological techniques including agglutination and precipitation tests.
CO2: Conduct immunoassays such as ELISA and rapid diagnostic tests.
CO3: Demonstrate methods for antibody titration and complement fixation..
CO4: Practice aseptic and proper laboratory handling techniques in immunology experiments.
CO5: Apply laboratory findings to interpret immune responses and clinical relevance.

Practical Exercises:

1. Blood group determination (ABO and Rh typing)
2. Widal test for Salmonella antibodies
3. Rapid diagnostic tests for viral/bacterial antigens
4. ELISA – detection of antibodies or antigens
5. Ouchterlony double diffusion (precipitation reaction)
6. Agglutination tests (direct and indirect)
7. Complement fixation test (basic demonstration)
8. Antibody titer determination
9. Isolation of lymphocytes from blood (demonstration)
10. Immunofluorescence staining (demonstration)

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	1	1	1	1	1
CO2	3	2	2	1	1	1	1
CO3	3	2	2	1	2	1	1
CO4	2	1	1	2	2	1	2
CO5	3	2	3	2	3	2	3

3 = Highly Related; 2 = Medium; 1 = Low

Course code	Course Title	L	P	Contact Hr	Contact Hr	Total Credit
BMI214A	General pathology	3	0	3	0	3

Course Outcomes (COs)

By the end of this course, students will be able to:

CO1: Explain the basic principles of pathology, including the mechanisms of disease and tissue responses to injury.

CO2: Describe the cellular and molecular basis of inflammation, repair, and hemodynamic disorders.

CO3: Analyze the pathogenesis of neoplasia, immune-mediated diseases, and infectious conditions.

CO4: Interpret gross and microscopic features of pathological lesions.

CO5: Apply knowledge of general pathology in clinical and diagnostic settings

Unit I

Introduction to pathology laboratory, specimen collection and handling, safety and aseptic techniques, preparation of histological slides, fixation and staining methods.

Unit II

Study of cell injury, necrosis, and apoptosis using microscopic slides; demonstration of cellular adaptations such as hypertrophy, hyperplasia, atrophy, and metaplasia.

Unit III

Inflammation and tissue repair: examination of acute and chronic inflammation, granuloma formation, fibrosis, and wound healing through prepared slides and models.

Unit IV

Hemodynamic disorders and thrombosis: identification of edema, hemorrhage, thrombosis, embolism, and infarction in gross specimens and histopathology slides.

Unit V

Neoplasia and laboratory techniques: study of benign and malignant tumors, tumor grading and staging, demonstration of cytology smears, immunohistochemistry basics, and interpretation of pathological findings in a clinical context.

Reference Books

1. Robbins, S.L., Kumar, V., & Cotran, R.S. (2021). *Robbins and Cotran Pathologic Basis of Disease* (10th Edition). Elsevier.
2. McPherson, R.A., & Pincus, M.R. (2022). *Henry's Clinical Diagnosis and Management by Laboratory Methods* (24th Edition). Elsevier.
3. Kumar, V., Abbas, A.K., & Aster, J.C. (2021). *Basic Pathology* (10th Edition). Elsevier.
4. Cotran, R.S., Kumar, V., & Collins, T. (2015). *Robbins Basic Pathology* (9th Edition). Elsevier.
5. Rosai, J. (2015). *Rosai and Ackerman's Surgical Pathology* (11th Edition). Elsevier.
6. Warrell, D.A., Cox, T.M., Firth, J.D., & Benz, E.J. (2018). *Oxford Textbook of Medicine* (6th Edition). Oxford University Press.
7. Strayer, D.S., & Rubin, E. (2020). *Rubin's Pathology: Clinicopathologic Foundations of Medicine* (7th Edition). Wolters Kluwer.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	1	1	1	2	1
CO2	3	2	2	1	2	2	1
CO3	2	1	2	2	2	1	1
CO4	2	1	1	2	3	1	2
CO5	3	2	3	2	3	2	3

3 = Highly Related; 2 = Medium; 1 = Low

General Pathology Lab (BMI215A)

CO1: Practice proper specimen collection, handling, and slide preparation techniques in the pathology lab.
CO2: Identify and demonstrate cell injury, necrosis, apoptosis, and cellular adaptations microscopically.
CO3: Examine inflammation, tissue repair, and hemodynamic disorders using gross specimens and slides.
CO4: Analyze neoplastic lesions and interpret histopathology and cytology findings.
CO5: Apply laboratory knowledge to understand pathological processes in clinical and diagnostic settings.

Practical Exercises:

1. Demonstration of proper collection, labeling, and transport of pathological specimens.
2. Preparation of tissue sections, fixation methods, and common stains (H&E, special stains).
3. Microscopic observation of necrosis, apoptosis, and cellular adaptations (hypertrophy, hyperplasia, atrophy, metaplasia).
4. Examination of acute and chronic inflammation using histological slides.
5. Study of granulomatous inflammation, fibrosis, and wound healing in slides/models.
6. Identification of edema, hemorrhage, thrombosis, embolism, and infarction in gross specimens.
7. Study of morphological changes in shock using models or prepared slides.
8. Microscopic examination of tumor types, grading, and staging.
9. Preparation and interpretation of cytology slides (e.g., Pap smear, FNAC).
10. Demonstration of antibody staining techniques for tumor or tissue markers.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	1	1	1	3	1
CO2	3	2	2	1	2	3	1
CO3	2	1	2	2	2	2	1

CO4	2	1	1	2	3	2	2
CO5	3	2	3	2	3	2	3

3 = Highly Related; 2 = Medium; 1 = Low

Course code	Course Title	L	P	Contact Hr	Contact Hr	Total Credit
BMI216A	**Medical Mycology and Parasitology**	**3**	**0**	**3**	**0**	**3**

Course Outcomes (COs)

By the end of this course, students will be able to:

CO1: Explain the morphology, life cycles, and pathogenic mechanisms of medically important fungi and parasites.

CO2: Demonstrate knowledge of laboratory techniques for diagnosis of fungal and parasitic infections.

CO3: Analyze host–pathogen interactions and immune responses in fungal and parasitic diseases.

CO4: Evaluate epidemiology, prevention, and control strategies for mycotic and parasitic infections.

CO5: Apply knowledge of medical mycology and parasitology in clinical, diagnostic, and public health settings.

Unit I:

Scope and importance of medical mycology and parasitology, normal fungal and parasitic flora, overview of fungal and parasitic diseases, host–pathogen interactions, and basic concepts of immunity against fungi and parasites.

Unit II:

Medically important fungi: morphology, physiology, classification, and pathogenic mechanisms of Candida, Aspergillus, Cryptococcus, dermatophytes, and other clinically relevant fungi. Laboratory diagnosis, specimen collection, and culture methods.

Unit III:

Protozoan parasites: morphology, life cycles, pathogenicity, and clinical manifestations of Plasmodium, Entamoeba, Giardia, Leishmania, and Trypanosoma. Laboratory techniques for diagnosis including wet mounts, staining, and serological tests.

Unit IV:

Helminths and ectoparasites: classification, life cycles, morphology, pathogenicity, and clinical features of nematodes (Ascaris, Trichuris), cestodes (Taenia), trematodes (Schistosoma), and ectoparasites (lice, mites). Laboratory diagnosis using stool, blood, and skin samples.

Unit V:

Epidemiology, prevention, and control strategies of mycotic and parasitic infections, antifungal and antiparasitic therapy, emerging pathogens, molecular diagnostics, and interpretation of laboratory results for clinical and public health applications.

Suggested Reference Books

1. Garcia, L.S. (2022). *Diagnostic Medical Parasitology* (7th Edition). ASM Press.

2. Larone, D.H. (2020). *Medically Important Fungi: A Guide to Identification* (6th Edition). ASM Press.
3. McPherson, R.A., & Pincus, M.R. (2022). *Henry's Clinical Diagnosis and Management by Laboratory Methods* (24th Edition). Elsevier.
4. Kauffman, C.A. (2021). *Medical Mycology* (3rd Edition). Elsevier.
5. Garcia, L.S., & Bruckner, D.A. (2019). *Clinical Microbiology Procedures Handbook* (4th Edition). ASM Press.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	1	1	1	1	1
CO2	3	2	2	1	1	1	1
CO3	2	1	2	1	2	1	1
CO4	2	1	1	2	2	1	2
CO5	3	2	3	2	3	2	3

3 = Highly Related; 2 = Medium; 1 = Low

Medical Mycology and Parasitology Lab (BMI217A)

CO1: Practice proper collection, handling, and processing of clinical specimens for mycological and parasitological analysis.
CO2: Perform direct microscopy and staining techniques for the identification of fungi and parasites.
CO3: Isolate and culture medically important fungi and identify them microscopically.
CO4: Identify protozoan, helminthic, and ectoparasitic infections using appropriate laboratory techniques.
CO5: Apply laboratory findings to interpret clinical significance and support diagnosis of mycotic and parasitic infections

Practical Exercises:

1. Specimen collection and handling – proper collection, labeling, and transport of clinical specimens for fungal and parasitic analysis.
2. Direct microscopy of fungi – KOH mounts.
3. Fungal culture and identification – isolation and identification of Candida.
4. Staining and identification of blood protozoa – wet mounts.
5. Stool examination for protozoa – identification of Entamoeba.
6. Helminth identification in stool – detection and identification of nematodes.
7. Ectoparasite identification – microscopic examination of lice.
8. Serological tests – detection of fungal and parasitic antigens or antibodies using ELISA.
9. Antifungal and antiparasitic susceptibility testing – determination of susceptibility patterns for clinically relevant isolates.
10. Interpretation and reporting of laboratory findings – correlation of microscopic, culture, and serological results with clinical features.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	1	1	1	3	1
CO2	3	2	2	1	2	3	1
CO3	3	2	2	1	2	3	1
CO4	2	1	2	2	2	2	1
CO5	3	2	3	2	3	2	3

3 = Highly Related; 2 = Medium; 1 = Low

Course code	Course Title	L	P	Contact Hr	Contact Hr	Total Credit
BMI218A	**Diagnostic Microbiology and Laboratory Techniques**	**3**	**0**	**3**	**0**	**3**

Course Outcomes (COs)

By the end of this course, students will be able to:

CO1: Explain the principles and scope of diagnostic microbiology and laboratory techniques.
CO2: Demonstrate knowledge of specimen collection, transport, and processing for microbial diagnosis.
CO3: Identify bacterial, viral, fungal, and parasitic pathogens using conventional and molecular methods.
CO4: Evaluate antimicrobial susceptibility patterns and interpret results for clinical diagnosis.
CO5: Apply quality control, biosafety, and automation principles in diagnostic microbiology laboratories.

Unit I

Scope and significance of diagnostic microbiology, organization of a clinical microbiology laboratory, biosafety levels, sterilization and disinfection, specimen collection, labeling, transport, and processing for clinical samples (blood, urine, stool, sputum, throat, wound swab).

Unit II

Preparation of smears and staining methods – simple, differential (Gram, acid-fast), and special stains. Culture media – types, preparation, and uses; aerobic and anaerobic culture techniques; selective and differential media; isolation and identification of bacterial pathogens.

Unit III

Biochemical tests for bacterial identification – IMViC, catalase, oxidase, coagulase, urease, TSI, citrate utilization, and nitrate reduction tests. Serological techniques – agglutination, precipitation, complement fixation, ELISA, and immunochromatographic rapid tests.

Unit IV

Principles and applications of molecular diagnostics – PCR, RT-PCR, nucleic acid hybridization, gene sequencing, and microarrays. Automation in microbiology – automated culture systems, MALDI-TOF, biosensors, and AI-assisted microbial identification.

Unit V

Methods of antimicrobial susceptibility testing – Kirby–Bauer disk diffusion, MIC determination, E-test, and automated systems. Detection of antimicrobial resistance mechanisms (β-lactamase, MRSA, ESBL). Laboratory quality control, record keeping, accreditation standards (NABL, ISO), and waste management in microbiology laboratories.

Suggested Readings:

1. Bailey & Scott (2020). *Diagnostic Microbiology* (15th Edition). Elsevier.
2. Mackie & McCartney (2013). *Practical Medical Microbiology* (14th Edition). Churchill Livingstone.
3. Collee, J.G., Fraser, A.G., Marmion, B.P., & Simmons, A. (2012). *Mackie & McCartney's Practical Medical Microbiology*. Elsevier.
4. Forbes, B.A., Sahm, D.F., & Weissfeld, A.S. (2016). *Bailey & Scott's Diagnostic Microbiology* (14th Edition). Elsevier.
5. Koneman, E.W., Allen, S.D., Janda, W.M., Schreckenberger, P.C., & Winn, W.C. (2017). *Color Atlas and Textbook of Diagnostic Microbiology* (7th Edition). Lippincott Williams & Wilkins.
6. Patel, R. (2021). *Clinical Microbiology Made Ridiculously Simple* (8th Edition). MedMaster.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	1	1	1	1	1
CO2	3	2	2	1	1	1	1
CO3	2	1	2	1	2	1	1
CO4	2	1	1	2	2	1	2
CO5	3	2	3	2	3	2	3

3 = Highly Related; 2 = Medium; 1 = Low

Diagnostic Microbiology and Laboratory Techniques Lab (BMI219A)

CO1: Perform collection, labeling, and processing of various clinical specimens for microbial diagnosis.
CO2: Demonstrate staining, culture, and isolation techniques for medically important microorganisms.
CO3: Conduct biochemical, serological, and antimicrobial susceptibility tests for pathogen identification.
CO4: Follow biosafety and quality control practices in diagnostic laboratory procedures.
CO5: Apply molecular and rapid diagnostic tools for clinical interpretation of results.

Practical Exercises:

1. Collection and processing of clinical specimens (blood, urine, sputum, swabs).
2. Preparation of smears and Gram, acid-fast, and special staining techniques.
3. Preparation and use of culture media; isolation of bacterial pathogens.

4. Performance of biochemical identification tests (IMViC, oxidase, catalase, urease, coagulase).
5. Serological testing – agglutination, precipitation, and Widal test.
6. ELISA and immunochromatographic rapid tests for diagnosis.
7. Antibiotic susceptibility testing (Kirby–Bauer method) and MIC determination.
8. Detection of β-lactamase and MRSA (demonstration).
9. PCR-based demonstration for pathogen identification.
10. Laboratory biosafety, record keeping, and waste disposal practices.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	1	1	1	1	1
CO2	3	2	2	1	1	1	1
CO3	3	2	2	1	2	1	1
CO4	2	1	1	2	2	1	2
CO5	3	2	3	2	3	2	3

3 = Highly Related; 2 = Medium; 1 = Low

Course code	Course Title	L	P	Contact Hr	Contact Hr	Total Credit
BMI220A	Antimicrobial resistance	3	0	3	0	3

Course Outcomes (COs)

By the end of this course, students will be able to:

CO1: Explain the mechanisms of action and resistance associated with various antimicrobial agents.
CO2: Illustrate the molecular and biochemical basis of antimicrobial resistance in microorganisms.
CO3: Analyze the impact of antimicrobial resistance on public health and clinical treatment strategies.
CO4: Evaluate current approaches and emerging technologies for combating antimicrobial resistance.
CO5: Develop an understanding of antimicrobial stewardship and resistance surveillance programs.

Unit I

Definition, history, and development of antimicrobial resistance (AMR); overview of antimicrobial agents; classification and mechanisms of antimicrobial action; types of antimicrobial resistance – intrinsic and acquired; global and national scenario of AMR.

Unit II

Genetic and biochemical mechanisms of resistance: mutation, efflux pumps, enzymatic degradation (β-lactamases), target modification, and biofilm formation; horizontal gene transfer mechanisms – transformation, transduction, and conjugation; mobile genetic elements and resistance genes.

Unit III

Phenotypic and genotypic methods for detection of antimicrobial resistance; antimicrobial susceptibility testing (AST) – disk diffusion, MIC determination, and E-test; molecular diagnostics in AMR detection; surveillance programs and databases (WHONET, GLASS).

Unit IV

Public health implications of AMR; resistant pathogens of clinical importance (ESKAPE pathogens, MRSA, VRE, MDR-TB); infection control strategies; antimicrobial stewardship programs; policies and regulations on antibiotic use in healthcare and agriculture.

Unit V

Novel approaches to overcome AMR – bacteriophage therapy, antimicrobial peptides, CRISPR-Cas systems, probiotics, and nanotechnology-based interventions; research advancements and global initiatives for AMR containment.

Suggested Readings:

1. Walsh, C. (2003). *Antibiotics: Actions, Origins, Resistance.* ASM Press.
2. Levy, S. B., & Marshall, B. (2004). *Antibacterial resistance worldwide: causes, challenges, and responses. Nature Medicine,* 10(Suppl).
3. Davies, J., & Davies, D. (2010). *Origins and evolution of antibiotic resistance. Microbiology and Molecular Biology Reviews.*
4. Greenwood, D., Slack, R., & Peutherer, J. (2012). *Medical Microbiology.* Churchill Livingstone.
5. WHO (2021). *Global Action Plan on Antimicrobial Resistance.*
6. CDC (2020). *Antibiotic Resistance Threats in the United States.*

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	1	2	3	1	1
CO2	3	2	2	3	2	1	1
CO3	2	1	2	2	1	1	1
CO4	2	1	1	2	2	1	2
CO5	3	2	3	2	3	2	3

3 = Highly Related; 2 = Medium; 1 = Low

Antimicrobial resistance Lab (BMI221A)

CO1: Demonstrate aseptic handling and culture of pathogenic bacteria for antimicrobial testing.
CO2: Perform antimicrobial susceptibility testing using standard protocols (disk diffusion, MIC).
CO3: Identify resistant bacterial isolates and interpret resistance patterns.
CO4: Apply molecular techniques for detection of resistance genes.
CO5: Analyze and report antimicrobial resistance data following standard guidelines.

Practical Exercises:

1. Introduction to biosafety and aseptic techniques in AMR research.
2. Preparation of antibiotic stock solutions and serial dilutions.

3. Determination of antibiotic sensitivity using the Kirby-Bauer disk diffusion method.
4. Determination of Minimum Inhibitory Concentration (MIC) by broth dilution method.
5. Detection of β-lactamase-producing bacteria.
6. Detection of ESBL, MRSA, and VRE isolates from clinical or environmental samples.
7. Plasmid extraction and detection of resistance genes by PCR.
8. Interpretation of antibiograms and preparation of AMR reports as per CLSI guidelines.
9. Demonstration of efflux pump activity and biofilm-associated resistance.
10. Visit/report on antimicrobial surveillance or hospital infection control unit.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	2	2	3	3	1
CO2	3	2	3	1	3	1	1
CO3	3	2	2	2	2	2	1
CO4	2	1	1	2	2	2	2
CO5	3	2	3	2	3	2	3

3 = Highly Related; 2 = Medium; 1 = Low

Course code	Course Title	L	P	Contact Hr	Contact Hr	Total Credit
BMI222A	Epidemiology and Public Health Microbiology	3	0	3	0	3

Course Outcomes (COs)

By the end of this course, students will be able to:

CO1: Explain the fundamental concepts and principles of epidemiology and their applications in public health.

CO2: Describe modes of transmission, reservoirs, and determinants of infectious diseases.

CO3: Interpret epidemiological data for disease surveillance, prevention, and control.

CO4: Analyze the role of public health microbiology in outbreak investigation and policy formulation.

CO5: Evaluate global health challenges and strategies for emerging and re-emerging infectious diseases

Unit I

Definition, scope, and importance of epidemiology; history and development; key concepts – epidemic, endemic, pandemic, sporadic diseases; measures of disease frequency – incidence, prevalence, morbidity, mortality, DALY; determinants and distribution of disease.

Unit II

Sources and reservoirs of infection; modes of transmission (direct and indirect); host, agent, and environment triad; chain of infection; herd immunity and vaccination; epidemiological triad and web of causation; zoonoses and vector-borne diseases.

Unit III

Descriptive, analytical, and experimental epidemiology; study designs – case-control, cohort, and cross-sectional studies; data collection, analysis, and interpretation; outbreak investigation steps; national and international disease surveillance systems (IDSP, WHO, CDC, ECDC).

Unit IV

Role of microorganisms in community health; waterborne, foodborne, and air-borne infections; microbiological quality control of food and water; sanitation and hygiene; microbiological standards for drinking water and food; public health laboratories and biosafety.

Unit V

Epidemiology of major infectious diseases – cholera, tuberculosis, malaria, influenza, HIV/AIDS, COVID-19; emerging zoonoses – Nipah, Ebola, Avian influenza; antimicrobial resistance and its epidemiological impact; global health initiatives and One Health approach.

Suggested Readings:

1. Park, K. (2023). *Park's Textbook of Preventive and Social Medicine.* Banarsidas Bhanot Publishers.
2. Jawetz, E., Melnick, J. L., & Adelberg, E. A. (2022). *Medical Microbiology.* McGraw Hill.
3. Ryan, K. J., & Ray, C. G. (2021). *Sherris Medical Microbiology.* McGraw Hill.
4. Last, J. M. (2007). *A Dictionary of Epidemiology.* Oxford University Press.
5. WHO (2024). *Epidemiology: Principles and Practice.*
6. CDC (2023). *Principles of Epidemiology in Public Health Practice.*

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	2	2	1	2	3	1	2
CO2	3	2	2	3	2	2	1
CO3	2	3	2	2	2	3	2
CO4	2	1	1	2	2	1	2
CO5	3	2	3	2	1	2	3

3 = Highly Related; 2 = Medium; 1 = Low

Epidemiology and Public Health Microbiology Lab (BMI223A)

CO1: Apply aseptic and biosafety practices in the handling of infectious samples.
CO2: Perform microbiological analysis of water, food, and air for public health monitoring.
CO3: Conduct serological and immunological tests for disease diagnosis.
CO4: Demonstrate epidemiological investigation techniques including data recording and interpretation.

CO5: Correlate laboratory findings with epidemiological data for public health decision-making.

Practical Exercises:

1. Introduction to epidemiological tools, data recording, and biosafety practices.
2. Enumeration of total bacterial count in drinking water using pour plate and membrane filtration methods.
3. Detection of coliforms in water samples using the Most Probable Number (MPN) technique.
4. Isolation and identification of foodborne pathogens (e.g., *Salmonella*, *E. coli*) from food samples.
5. Air sampling and microbial load determination in indoor environments.
6. Determination of microbial contamination in milk and dairy products.
7. Serological tests for diagnosis of infectious diseases (Widal, VDRL, ELISA demonstration).
8. Epidemiological data analysis: calculation of incidence, prevalence, and attack rates.
9. Case study: outbreak investigation and source tracing.
10. Visit/report to a public health or water testing laboratory.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	2	2	3	3	3
CO2	3	2	3	1	3	1	3
CO3	3	2	3	3	3	2	2
CO4	2	1	1	2	2	2	2
CO5	3	2	3	2	3	2	3

3 = Highly Related; 2 = Medium; 1 = Low

Major DSE 3 Environmental & Agricultural Microbiology

Course code	Course Title	L	P	Contact Hr	Contact Hr	Total Credit
BMI224A	Soil Microbiology	3	0	3	0	3

Course Outcomes (COs)

CO1: Explain the origin, composition, and structure of soil, soil-forming processes, and the ecological importance of soil microorganisms in maintaining soil health and fertility.

CO2: Describe the diversity, distribution, and physiological characteristics of soil microorganisms, including bacteria, fungi, actinomycetes, protozoa, and algae.

CO3: Analyze the microbial transformations of major nutrients (carbon, nitrogen, phosphorus, sulfur) and their significance in biogeochemical cycles and soil fertility management.

CO4: Evaluate the role of soil microorganisms in plant–microbe interactions, including rhizosphere, mycorrhizae, biofertilizers, and biocontrol agents in sustainable agriculture.

CO5: Interpret applied aspects of soil microbiology such as composting, biodegradation, bioremediation, and recent molecular and metagenomic approaches for studying soil microbial communities.

Unit I

Definition, scope, and history of soil microbiology, Soil as a microbial habitat: soil composition, structure, and types, Major groups of soil microorganisms: bacteria, fungi, actinomycetes, protozoa, and algae, Methods of studying soil microorganisms: culture-dependent and culture-independent (molecular) techniques

Unit II

Rhizosphere and phyllosphere microflora: significance and factors influencing microbial growth, Microbial interactions: mutualism, commensalism, competition, predation, parasitism, and antagonism

Unit III

Microbial role in carbon, nitrogen, phosphorus, and sulfur cycles, Nitrogen fixation: symbiotic (Rhizobium) and non-symbiotic (Azotobacter, Clostridium) microorganisms, Ammonification, nitrification, denitrification

Unit IV

Biofertilizers: types, production, and application (Rhizobium, Azotobacter, Azospirillum, Cyanobacteria, Mycorrhizae), Biopesticides and plant growth-promoting rhizobacteria (PGPR).

Unit V

Metagenomics and environmental genomics for uncultured microbial diversity, Microbial nanotechnology and biosensors for soil health monitoring, Engineered microbialconsortia and synthetic ecology.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	2	3	1	1	2
CO2	3	2	2	3	1	1	2
CO3	3	2	2	3	1	1	2
CO4	3	2	2	3	1	1	2
CO5	3	2	2	3	1	1	2

3 = Highly Related; 2 = Medium; 1 = Low

Suggested Readings

1. Atlas, R. M., & Bartha, R. (1998). *Microbial Ecology: Fundamentals and Applications* (4th ed.). Benjamin/Cummings Publishing, California.
2. Subba Rao, N. S. (2018). *Soil Microbiology* (4th ed.). Medtech Science Press, New Delhi.
3. Paul, E. A. (2019). *Soil Microbiology, Ecology, and Biochemistry* (5th ed.). Academic Press, London.
4. Sylvia, D. M., Fuhrmann, J. J., Hartel, P. G., & Zuberer, D. A. (2020). *Principles and Applications of Soil Microbiology* (3rd ed.). Pearson Education, USA.

5. Dhanasekaran, D., & Thajuddin, N. (2021). *Recent Trends in Soil Microbiology*. Springer Nature, Singapore.

Soil Microbiology Lab (BMI225A)

Course Outcomes (COs)

CO1: Explain the scope of microbial ecology and the principles of microbial diversity, evolution, and community organization.

CO2: Describe various types of microbial interactions, community dynamics, and their influence on ecosystem stability and productivity.

CO3: Analyze the role of microorganisms in natural ecosystems including soil, water, air, and extreme environments.

CO4: Evaluate modern techniques for assessing microbial diversity, including culture-independent molecular and metagenomic approaches.

CO5: Interpret the ecological and biotechnological applications of microbial diversity in biogeochemical cycling, bioremediation, and sustainable development.

1. Isolation of soil microorganisms using serial dilution and spread plate technique.
2. Enumeration of total bacterial count in soil by plate count method.
3. Estimation of microbial biomass carbon in soil samples.
4. Isolation and identification of nitrogen-fixing bacteria from rhizosphere soil.
5. Demonstration of phosphate-solubilizing microorganisms from agricultural soil.
6. Study of microbial succession during composting process.
7. Detection of coliform bacteria in water using MPN (Most Probable Number) method.
8. Observation of air microflora using settle plate technique.
9. Examination of biofilm formation by soil bacteria on glass slides.
10. Study of the effect of pH and temperature on microbial growth in soil extract medium.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	2	3	1	1	2
CO2	2	2	3	3	2	2	2
CO3	2	2	2	3	2	3	3
CO4	2	1	3	2	2	2	2
CO5	3	2	2	2	2	2	3

3 = Highly Related; 2 = Medium; 1 = Low

Course code	Course Title	L	P	Contact Hr	Contact Hr	Total Credit
BMI226A	Microbial Ecology and Diversity	3	0	3	0	3

Course Outcomes (COs):

CO1: Explain the scope of microbial ecology and the principles of microbial diversity, evolution, and community organization.

CO2: Describe various types of microbial interactions, community dynamics, and their influence on ecosystem stability and productivity.

CO3: Analyze the role of microorganisms in natural ecosystems including soil, water, air, and extreme environments.

CO4: Evaluate modern techniques for assessing microbial diversity, including culture-independent molecular and metagenomic approaches.

CO5: Interpret the ecological and biotechnological applications of microbial diversity in biogeochemical cycling, bioremediation, and sustainable development.

Unit I

Definition, scope, and significance of microbial ecology. Methods in microbial ecology: culture-dependent vs. culture-independent techniques. Microscopic, biochemical, and molecular tools for studying microbial communities.

Unit II

Definition and types of microbial diversity: genetic, species, and ecosystem diversity.. Extremophiles and their ecological significance. Microbial endemism and biogeography.

Unit III

Microbe–microbe and microbe–host interactions: mutualism, commensalism, competition, predation, parasitism. Rhizosphere, phyllosphere, and endophytic microorganisms.

Unit IV

Soil microorganisms and their ecological functions. Aquatic microbial communities: freshwater and marine ecosystems. Aeromicrobiology and bioaerosols. Microbes in extreme environments: thermophiles, psychrophiles, acidophiles, halophiles, and barophiles. Role of microorganisms in biogeochemical cycles: carbon, nitrogen, sulfur, and phosphorus.

Unit V

Bioremediation, biodegradation, and biotransformation. Biofertilizers and biopesticides in ecosystem management. Metagenomics, metatranscriptomics, and metaproteomics in microbial diversity studies.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	2	3	1	1	2
CO2	2	3	2	2	3	1	1
CO3	3	3	3	2	2	1	2
CO4	2	3	3	3	2	2	2
CO5	3	3	3	2	2	2	1

3 = Highly Related; 2 = Medium; 1 = Low

Suggested Readings

1. Atlas, R. M., & Bartha, R. (1998). *Microbial Ecology: Fundamentals and Applications* (4th ed.). Benjamin/Cummings Publishing, California.
2. Madigan, M. T., Bender, K. S., Buckley, D. H., & Sattley, W. M. (2021). *Brock Biology of Microorganisms* (16th ed.). Pearson Education, USA.
3. Paul, E. A. (2019). *Soil Microbiology, Ecology, and Biochemistry* (5th ed.). Academic Press, London.
4. Singh, A., & Parmar, N. (2020). *Microbial Ecology and Biotechnology*. Springer Nature, Singapore.
5. Dhanasekaran, D., & Thajuddin, N. (2021). *Recent Trends in Microbial Ecology*. Springer Nature, Singapore.

Microbial Ecology and Diversity Lab (BMI227A)

Course Outcomes (COs)

CO1: Explain and apply fundamental techniques for the isolation, enumeration, and identification of microorganisms from soil, water, and air environments.
CO2: Analyze the physiological and ecological characteristics of beneficial microbes such as phosphate-solubilizing, nitrogen-fixing, and biofilm-forming organisms.
CO3: Demonstrate microbial interactions such as antagonism and symbiosis, and interpret their ecological significance in natural habitats.
CO4: Evaluate microbial biomass and diversity in different environmental samples using qualitative and quantitative methods.
CO5: Assess the occurrence and adaptations of extremophilic microorganisms and their potential ecological and biotechnological applications.

1. Isolation of soil microorganisms by serial dilution and plating method.
2. Enumeration of total viable microbial count in soil or water.
3. Isolation and identification of phosphate-solubilizing microorganisms.
4. Study of microbial interactions (antagonism) using the cross-streak method.
5. Isolation of nitrogen-fixing bacteria from root nodules (Rhizobium).
6. Observation of air microflora using settle plate technique.

7. Isolation of fungi and actinomycetes from soil samples.
8. Determination of microbial biomass carbon in soil.
9. Demonstration of biofilm formation using glass slide method.
10. Isolation of extremophiles (halophiles or thermophiles) from environmental samples.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	2	2	2	3	1	1	2
CO2	3	3	2	2	3	1	1
CO3	2	2	2	2	1	1	2
CO4	2	3	3	3	2	2	2
CO5	1	2	2	2	3	2	1

3 = Highly Related; 2 = Medium; 1 = Low

Course code	Course Title	L	P	Contact Hr	Contact Hr	Total Credit
BMI228A	**Environmental Biotechnology**	**3**	**0**	**3**	**0**	**3**

Course Outcomes

CO1: Explain the principles and scope of environmental biotechnology.
CO2: Describe the role of microorganisms in pollution control and bioremediation.
CO3: Analyze biological treatment methods for solid, liquid, and gaseous wastes.
CO4: Evaluate biofertilizers, biopesticides, and bioenergy production techniques.
CO5: Discuss recent biotechnological advances for sustainable environment and climate mitigation.

Unit I

Definition, scope, and importance. Major global environmental issues: air, water, and soil pollution. Role of microorganisms in the environment. Concept of sustainable development and green technology.

Unit II

Definition and types: in situ and ex situ bioremediation. Microbial degradation of hydrocarbons, pesticides, and heavy metals. Phytoremediation and mycoremediation. Factors affecting biodegradation efficiency.

Unit III

Solid waste: composting, vermicomposting, and landfill microbiology. Liquid waste: sewage treatment (primary, secondary, tertiary treatment). Industrial waste: microbial treatment of effluents (textile, dairy, pharmaceutical).

Unit IV

Biofertilizers: Rhizobium, Azospirillum, Azotobacter, Cyanobacteria, Mycorrhizae. Biopesticides: *Bacillus thuringiensis*, *Trichoderma*, and viral pesticides.

Unit V

Biosensors for detection of pollutants and toxins. Genetically engineered microorganisms (GEMs) in waste treatment. Metagenomics and bioinformatics in environmental monitoring.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	2	2	1	1	3
CO2	2	3	2	2	3	1	2
CO3	3	2	3	3	2	1	2
CO4	2	1	3	2	2	2	3
CO5	3	3	3	2	2	2	2

3 = Highly Related; 2 = Medium; 1 = Low

Suggested Readings

1. **Agarwal, S. K., & Pandey, G. (2018).** *Environmental Biotechnology.* APH Publishing, New Delhi.
2. **Singh, A., & Parmar, N. (2020).** *Applied Environmental Biotechnology.* Springer Nature, Singapore.
3. **Scragg, A. (2019).** *Environmental Biotechnology.* Oxford University Press, UK.
4. **Jogdand, S. N. (2020).** *Environmental Biotechnology.* Himalaya Publishing, Mumbai.
5. **Rittmann, B. E., & McCarty, P. L. (2021).** *Environmental Biotechnology: Principles and Applications.* McGraw-Hill Education, USA.

Environmental Biotechnology Lab (BMI229A)

Course Outcomes

1. **CO1:** Demonstrate basic microbiological techniques to isolate and identify microorganisms from air, water, and soil.
2. **CO2:** Analyze the role of microorganisms in biodegradation and bioremediation of environmental pollutants.
3. **CO3:** Apply knowledge of microbial processes in solid, liquid, and industrial waste treatment.

4. **CO4:** Isolate and characterize biofertilizers and biopesticides for sustainable agriculture.
5. **CO5:** Develop practical skills to evaluate microbial diversity and activity in environmental samples for eco-friendly solutions.

1. Isolation of airborne microorganisms from campus air.
2. Detection of microbial contaminants in water samples.
3. Biodegradation of hydrocarbons by soil microbes.
4. Pesticide degradation by soil microorganisms.
5. Heavy metal tolerance assay of soil bacteria.
6. Composting and microbial analysis of kitchen waste.
7. Vermicomposting and microbial monitoring.
8. Microscopic observation of activated sludge in sewage treatment.
9. Isolation and characterization of Rhizobium from legume nodules.
10. Antagonistic activity of Trichoderma against plant pathogenic fungi.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	2	2	2	2	3	2	3
CO2	2	3	2	2	3	2	3
CO3	2	2	3	3	3	2	2
CO4	3	3	3	2	2	3	2
CO5	2	2	3	2	2	3	2

3 = Highly Related; 2 = Medium; 1 = Low

Course code	Course Title	L	P	Contact Hr	Contact Hr	Total Credit
BMI230A	**Bioremediation and Pollution Control**	**3**	**0**	**3**	**0**	**3**

CO1: Understand the sources, types, and impacts of environmental pollution and the role of microorganisms in ecosystem balance.

CO2: Analyze and apply microbial processes for biodegradation and bioremediation of pollutants in soil, water, and industrial effluents.

CO3: Demonstrate knowledge of solid, liquid, and industrial waste treatment using microbial approaches.

CO4: Isolate, characterize, and utilize biofertilizers and biopesticides for sustainable agriculture.

CO5: Evaluate environmental quality and pollution mitigation using microbial indicators, molecular tools, and emerging biotechnologies.

Unit I

Definition, scope, and importance of environmental microbiology, Major global environmental issues: air, water, and soil pollution, Microorganisms in the environment: beneficial and harmful roles, Concepts of sustainable development and green technology

Unit II

Definition and types: in situ and ex situ bioremediation, Microbial degradation of hydrocarbons, pesticides, and heavy metals, Phytoremediation and mycoremediation, Factors affecting biodegradation efficiency

Unit III

Solid waste: composting, vermicomposting, and landfill microbiology, Liquid waste: sewage treatment (primary, secondary, tertiary), Industrial effluent treatment: textile, dairy, pharmaceutical industries, Microbial role in pollution mitigation

Unit IV

Biofertilizers: Rhizobium, Azospirillum, Azotobacter, Cyanobacteria, Mycorrhizae, Biopesticides: *Bacillus thuringiensis*, Trichoderma, viral pesticides, Mechanisms of microbial action in nutrient cycling and pest control, Application in sustainable agriculture

Unit V

Microbial indicators of pollution and environmental quality assessment, Molecular techniques for monitoring microbial degradation, Emerging biotechnologies for pollution control, Case studies of successful bioremediation projects

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	2	3	2	2	1	2	2
CO2	3	3	2	3	3	2	2
CO3	3	3	3	2	2	2	3
CO4	3	2	3	3	2	3	2
CO5	2	3	2	2	2	2	3

3 = Highly Related; 2 = Medium; 1 = Low

Suggested Readings

1. Agarwal, S. K., & Pandey, G. (2018). *Environmental Biotechnology*. APH Publishing, New Delhi.

2. Reddy, S. R., & Reddy, K. S. (2017). *Bioremediation and Pollution Control*. IK International Publishing, New Delhi.
3. Singh, A., & Ward, O. P. (2004). *Biodegradation and Bioremediation*. Springer, New York.
4. Madigan, M. T., Bender, K. S., Buckley, D. H., Sattley, W. M., & Stahl, D. A. (2018). *Brock Biology of Microorganisms* (15th ed.). Pearson, London.
5. Singh, R., & Kumar, R. (2016). *Microbial Approaches in Environmental Management*. Springer, Singapore.
6. Tyagi, V. K., & Singh, R. (2017). *Advances in Environmental Biotechnology*. CRC Press, Taylor & Francis, USA.

Bioremediation and Pollution Control Lab (BMI231A)

Course Outcomes (COs)

CO1: Explain and demonstrate the isolation and characterization of pollutant-degrading microorganisms from contaminated environments.
CO2: Analyze microbial processes involved in the biodegradation of hydrocarbons, synthetic dyes, and plastics.
CO3: Evaluate water and soil quality through microbiological and biochemical parameters such as MPN, COD, and BOD.
CO4: Assess microbial tolerance and adaptive mechanisms toward heavy metals and environmental stress.
CO5: Interpret the ecological and industrial significance of microbial diversity, biofilm formation, biosurfactant production, and waste management processes.

1. Isolation of hydrocarbon-degrading bacteria from oil-contaminated soil.
2. Study of microbial degradation of synthetic dyes.
3. Detection of coliform bacteria in polluted water using MPN method.
4. Determination of chemical oxygen demand (COD) and biological oxygen demand (BOD).
5. Study of heavy metal tolerance in soil bacteria.
6. Demonstration of biosurfactant production by oil-degrading microbes.
7. Isolation of plastic-degrading microorganisms.
8. Analysis of composting and bio-sludge microbial diversity.
9. Demonstration of biofilm formation on solid surfaces.
10. Visit to industrial wastewater treatment or solid waste management plant.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	2	3	2	3	1	2	3
CO2	1	3	2	2	3	2	3

CO3	2	2	3	3	2	2	2
CO4	2	1	3	3	2	3	2
CO5	2	3	3	2	2	3	2

3 = Highly Related; 2 = Medium; 1 = Low

Course code	Course Title	L	P	Contact Hr	Contact Hr	Total Credit
BMI232A	**Waste Microbiology**	**3**	**0**	**3**	**0**	**3**

CO1: Explain the types and sources of waste and their environmental impact.
CO2: Describe microbial diversity in solid, liquid, and gaseous wastes.
CO3: Analyze microbial processes involved in composting, sewage treatment, and industrial effluent degradation.
CO4: Evaluate modern microbial technologies for waste management and bioenergy production.
CO5: Discuss policies, sustainability, and emerging trends in waste microbiology.

Unit I
Definition, types, and sources of waste: municipal, industrial, agricultural, hospital. Microbial diversity in waste environments. Environmental impact of untreated waste. Role of microbes in natural decomposition and waste transformation.

Unit II
Composting: aerobic and anaerobic processes. Vermicomposting and microbial role in organic matter degradation. Microbial succession during decomposition.

Unit III
Sewage and wastewater composition. Microbial treatment processes: primary, secondary, and tertiary treatment. Activated sludge process, trickling filters, and biofilm reactors.

Unit IV
Microbial treatment of industrial effluents: dairy, textile, pharmaceutical, and chemical industries. Biodegradation of xenobiotics, heavy metals, and plastics. Mycoremediation and phytoremediation approaches.

Unit V
Bioenergy production from waste: biogas, biohydrogen, biodiesel.Microbial fuel cells (MFCs) for energy recovery from wastewater. Metagenomics and microbial community analysis of waste environments.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7

CO1	2	3	2	2	1	1	2
CO2	2	2	2	2	3	1	3
CO3	3	2	3	3	2	1	3
CO4	2	3	3	2	2	2	2
CO5	1	2	3	2	2	2	1

3 = Highly Related; 2 = Medium; 1 = Low

Suggested Readings

1. Rittmann, B. E., & McCarty, P. L. (2021). *Environmental Biotechnology: Principles and Applications.* McGraw-Hill Education, USA.
2. Agarwal, S. K. (2018). *Bioremediation: Techniques and Applications.* APH Publishing, New Delhi.
3. Singh, A., Kuhad, R. C., & Ward, O. P. (2020). *Advances in Applied Bioremediation.* Springer Nature, Singapore.
4. Vijayalakshmi, G., & Kumar, P. (2019). *Environmental Pollution and Control.* Medtech Science Press, New Delhi.
5. Jogdand, S. N. (2020). *Environmental Biotechnology.* Himalaya Publishing, Mumbai.

Waste Microbiology Lab (BMI233A)

Course Outcomes (COs)

CO1: Explain and perform techniques for isolation and characterization of waste-degrading and wastewater microorganisms.
CO2: Analyze microbial succession and metabolic activities during composting and anaerobic digestion processes.
CO3: Evaluate the physico-chemical and microbiological quality of wastewater using parameters such as BOD, COD, and MPN.
CO4: Assess microbial tolerance to heavy metals and biofilm formation in various waste environments.
CO5: Interpret the role of microorganisms in solid and liquid waste management systems for sustainable environmental practices.

1. Isolation of waste-degrading bacteria from compost or soil.
2. Study of microbial succession during composting.
3. Determination of BOD and COD of wastewater.
4. Coliform detection using MPN method in water samples.
5. Biofilm formation studies in solid or liquid waste samples.
6. Microbial analysis of industrial effluent.
7. Biogas production demonstration using anaerobic digesters.
8. Detection of heavy metal tolerance in wastewater microorganisms.
9. Microbial monitoring of landfill leachate.

10. Visit to sewage treatment plant or composting facility.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	2	2	1	3	2
CO2	3	2	2	2	3	2	2
CO3	3	3	3	3	2	2	2
CO4	2	3	3	2	2	3	3
CO5	2	2	3	2	2	3	3

3 = Highly Related; 2 = Medium; 1 = Low

Course code	Course Title	L	P	Contact Hr	Contact Hr	Total Credit
BMI234A	**Bioindicators and Microbial Biomonitoring**	**3**	**0**	**3**	**0**	**3**

CO1: Define and explain the principles of bioindicators and microbial biomonitoring.
CO2: Identify different microbial indicators used for assessing air, water, and soil pollution.
CO3: Analyze microbial responses to environmental stress using biochemical and molecular tools.
CO4: Evaluate biosensors and bioassays for detection of environmental contaminants.
CO5: Interpret global approaches and modern techniques in microbial biomonitoring.

Unit I

Definition, concept, and significance of bioindicators. Characteristics of good bioindicators. Types of bioindicators: microbial, plant, and animal indicators. Advantages and limitations of biological monitoring over chemical methods.

Unit II

Indicators of water pollution: coliforms, *E. coli*, *Enterococcus* spp. Indicators of soil quality: nitrifying and phosphate-solubilizing bacteria, actinomycetes, and mycorrhizae. Air quality indicators: fungi and bacteria as bioaerosols..

Unit III

Conventional methods: plate counts, MPN, and biochemical assays. Enzymatic biomarkers: dehydrogenase, catalase, phosphatase activities. Molecular biomarkers: stress proteins, heat-shock proteins, and genetic markers.

Unit IV

Principles and classification of biosensors. Microbial biosensors for detection of heavy metals, pesticides, and organic pollutants. Enzyme-based and cell-based biosensors.

Unit V

Biomonitoring of water bodies, soil contamination, and air pollution. Microbial indicators in environmental impact assessment (EIA). Case studies: microbial responses to heavy metal and pesticide stress.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	2	2	2	1	2
CO2	2	2	2	2	2	1	2
CO3	2	2	3	3	1	1	3
CO4	3	2	3	2	2	2	3
CO5	1	3	3	2	1	2	2

3 = Highly Related; 2 = Medium; 1 = Low

Suggested Readings

1. Bitton, G. (2019). *Environmental Microbiology: A Laboratory Manual* (3rd ed.). CRC Press, USA.
2. Hagedorn, C., Blanch, A. R., & Harwood, V. J. (2011). *Microbial Source Tracking: Methods, Applications, and Case Studies.* Springer, New York.
3. Pepper, I. L., Gerba, C. P., & Gentry, T. J. (2020). *Environmental Microbiology* (4th ed.). Academic Press, USA.
4. Atlas, R. M., & Bartha, R. (1998). *Microbial Ecology: Fundamentals and Applications* (4th ed.). Benjamin/Cummings Publishing, California.
5. Gupta, P. K. (2020). *Methods in Environmental Analysis: Water, Soil and Air.* Agrobios (India).

Bioindicators and Microbial Biomonitoring Lab (BMI235A)

Course Outcomes (COs)

CO1: Explain and perform microbiological methods for assessing air, water, and soil quality using standard indicator organisms.
CO2: Analyze functional microbial groups such as phosphate-solubilizing bacteria and indicator fungi for their ecological roles in polluted environments.
CO3: Evaluate microbial enzymatic activities and growth responses under environmental stress and heavy metal exposure.
CO4: Demonstrate the use of microbial systems in toxicity testing and biosensor-based environmental monitoring.
CO5: Interpret the significance of microbial indicators and biochemical parameters such as BOD in pollution assessment and control.

1. Determination of microbial load in air by settle plate method.
2. Detection of coliforms in water using MPN technique.
3. Isolation and characterization of phosphate-solubilizing bacteria from soil.
4. Measurement of microbial enzymatic activity (dehydrogenase assay).

5. Study of microbial growth inhibition in presence of heavy metals.
6. Bioassay of toxicity using algal or bacterial test system.
7. Demonstration of biosensor principles using microbial cultures.
8. Estimation of biochemical oxygen demand (BOD) in water samples.
9. Isolation of indicator fungi from polluted air or soil samples.
10. Visit to environmental monitoring or pollution control laboratory.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	2	3	3	2	1	2	3
CO2	3	2	3	2	1	1	2
CO3	3	2	3	3	2	1	2
CO4	3	2	3	2	2	2	3
CO5	2	3	2	2	3	2	3

3 = Highly Related; 2 = Medium; 1 = Low

Course code	Course Title	L	P	Contact Hr	Contact Hr	Total Credit
BMI236A	**Agricultural Microbiology and Crop Protection**	**3**	**0**	**3**	**0**	**3**

Course Outcomes (COs)

After completing this course, students will be able to:

CO1: Explain the importance of microorganisms in soil fertility and nutrient cycling.
CO2: Identify agriculturally important microorganisms and their ecological roles.
CO3: Describe microbial interactions with plants and their use in biofertilizers and biopesticides.
CO4: Evaluate plant–pathogen interactions and strategies for microbial disease management.
CO5: Apply microbial approaches for sustainable agriculture and crop productivity.

Unit I

Definition, scope, and importance of agricultural microbiology. Soil as a habitat for microorganisms rhizosphere, phyllosphere, and rhizoplane. Types of agriculturally important microorganisms: bacteria, fungi, actinomycetes, and cyanobacteria.

Unit II

Microbial role in carbon, nitrogen, phosphorus, and sulfur cycles. Nitrogen fixation: symbiotic (*Rhizobium*, *Frankia*) and non-symbiotic (*Azotobacter*, *Clostridium*).

Unit III

Rhizosphere effect and root exudates. Plant growth-promoting rhizobacteria (PGPR). Endophytes and their role in plant health. Microbial communication: quorum sensing in soil.

Unit IV

Overview of plant pathogens: bacterial, fungal, and viral diseases. Mechanisms of pathogenesis: enzymes, toxins, and phytohormones. Epidemiology and transmission of plant diseases.

Unit V

Biocontrol agents: *Trichoderma*, *Pseudomonas fluorescens*, *Bacillus subtilis*. Mode of action: antibiosis, competition, parasitism, and induced resistance. Biopesticides: bacterial (Bt toxins), fungal, and viral pesticides.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	2	2	2	1	2
CO2	2	2	2	2	2	1	2
CO3	2	2	3	3	1	1	3
CO4	3	2	3	2	2	2	3
CO5	1	3	3	2	1	2	2

3 = Highly Related; 2 = Medium; 1 = Low

Suggested Readings

1. Subba Rao, N. S. (2018). *Soil Microbiology* (4th ed.). Medtech Science Press, New Delhi.
2. Dubey, R. C., & Maheshwari, D. K. (2019). *A Textbook of Microbiology*. S. Chand & Company, New Delhi.
3. Gnanamanickam, S. S. (2017). *Plant-Associated Bacteria*. Springer, Netherlands.
4. Vyas, S. C., & Gulati, A. (2018). *Biofertilizers and Biopesticides*. New India Publishing Agency, New Delhi.
5. Dhanasekaran, D., & Thajuddin, N. (2021). *Recent Trends in Agricultural Microbiology*. Springer Nature, Singapore.

Agricultural Microbiology and Crop Protection (BMI237A)

CO1: Explain and perform isolation, identification, and characterization of agriculturally important microorganisms such as Rhizobium, Azotobacter, and phosphate-solubilizing bacteria.
CO2: Analyze the symbiotic and associative interactions between microorganisms and plants, including mycorrhizae and nitrogen-fixing associations.
CO3: Evaluate the role of biocontrol agents like *Trichoderma* and study their antagonistic effects against phytopathogenic fungi.
CO4: Demonstrate methods for preparation and quality assessment of biofertilizer inoculants and study plant growth-promoting rhizobacteria (PGPR) traits.
CO5: Interpret plant disease symptoms and assess the application of microbial technology in sustainable agriculture and soil health management.

1. Isolation of rhizobial bacteria from root nodules.
1. Isolation of phosphate-solubilizing microorganisms from soil.
2. Demonstration of nitrogen fixation by *Azotobacter*.

3. Observation of mycorrhizal spores under microscope.
4. Isolation of plant pathogenic fungi (*Fusarium*, *Alternaria*).
5. Antagonistic activity of *Trichoderma* against phytopathogenic fungi.
6. Preparation of biofertilizer inoculants (liquid and carrier-based).
7. Detection of plant disease symptoms in local crops.
8. Study of PGPR traits: siderophore, IAA, and phosphate solubilization.
9. Visit to an agricultural microbiology or biofertilizer production center.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	2	2	2	3	2
CO2	2	2	2	2	2	2	3
CO3	3	3	3	3	3	2	2
CO4	2	3	3	2	2	3	3
CO5	3	3	3	2	2	2	3

3 = Highly Related; 2 = Medium; 1 = Low