

# Chapter 1

## General Information

**1.1 Title of the Academic Program:** B.Sc. (Honors) in Microbiology

**1.2 Name of the University:** Gono Bishwabidyalay

### **1.3 Vision of the Gono Bishwabidyalay**

Gono Bishwabidyalay (GB), a university with a difference, has been established with a vision to create a new consciousness and commitment in the field of education, particularly to foster social development and human welfare.

### **1.4 Mission of the Gono Bishwabidyalay**

A very special mission of **Gono Bishwabidyalay** is to help the female members of the society, students from the low-income families, children of martyrs and ethnic minorities through teaching and related activities. **Gono Bishwabidyalay** aims at achieving the following goals:

- i. To bring cohesion between scientific ideas and people's aspiration as well as to ensure equal opportunity for men and women.
- ii. To foster consciousness about scientific queries and welfare of mankind.
- iii. In building a bridge between modern science and experience of traditional socio-economic concepts.
- iv. Generating the feeling for the backward population and wish for their welfare, active participation in program to eradicate poverty.
- v. To work toward sustaining and modernizing indigenous art and crafts.
- vi. To work for effective solutions for the problems of the people by applying local experiences.
- vii. To learn lessons from the struggles of the people for establishing their rights as well as from the history of the wars of liberation of Bangladesh and other countries of the world.
- viii. To learn in depth about the country, the people, the village life, and to take steps for improvement of the country and of its people.

# Chapter 2

## The Department of Microbiology

### 2.1 Name of the program

Bachelor of Science (B.Sc. Honors) in Microbiology under the faculty of Health Sciences.

### 2.2 Vision of the Department

The vision of the department is going towards international excellence to be recognized as preeminence department with quality education, innovative research, and service emphases.

### 2.3 Mission of the Department

The mission of the Department of Microbiology is to provide a conducive learning environment and a student-friendly atmosphere that allows students to achieve academic excellence in all aspects of Microbiology. The Department also considers its mission as to produce personnel with expertise of the highest standard in the field of Microbiology to cater the increasing demand in the country for microbiologist.

### 2.4 Objective of the Department

Gono Bishwabidyalay opened the B.Sc. program (Honors) course in Microbiology 1998 under the faculty of Health and Medical Science. The goals of the department are to provide and continue to develop a rich environment of interdisciplinary activity and academic freedom for faculty and students. The specific objectives of the department are-

- ✓ To enrich students' knowledge and skill in the different courses of Microbiology
- ✓ To introduce the concepts of application and research in Microbiology
- ✓ To inculcate sense of scientific responsibilities and social and environment awareness
- ✓ To help student's build-up a progressive and successful career
- ✓ To produce highly qualified and competent microbiologist who will be able to contribute in the different fields of Microbiology.

**2.5 Name of the Degree:** B.Sc. Honors in Microbiology.

### 2.6 Description of the Program

#### Overview:

Gono Bishwabidyalay is the pioneer for the establishment of department of Microbiology in private sector. In this century Microbiology is a vital subject. Microbiology is immensely involved with fermentation technology, genetic engineering, food technology, diagnostic technology and many other subjects. Microbiology is the study of microorganisms including their habitat, nature, function, effects and exploitation for the benefit of human beings and the environment. Bacteria, Viruses, Actinomycetes, Cyanobacteria, Mycoplasmas, Rickettsia, Chlamydia, Spirochetes, Fungi, Algae and Protozoa are subjected to study in this science. The department of Microbiology prepare students for highly demandable positions in academia, top national research laboratories and industry like icddr,b, CHRF, Pharmaceuticals, BCSIR, NIB, Food Safety Authority, WASA etc.

## 2.7 Graduate attributes

**In-Depth Knowledge:** Has a broad integrated knowledge of Microbiology, including the disciplines of genetics and immunology.

**Global Perspective:** An awareness of current and emerging worldwide Microbiological technologies, issues, and perspectives.

**Interdisciplinary Perspective:** Demonstrate a multi-disciplinary perspective on Microbiology, an awareness of core concepts from genetics and immunology, and an ability to integrate knowledge from these core areas.

**Lifelong Learning:** An awareness of the dynamic nature and limits of current Microbiological knowledge, limits of own knowledge and a commitment to life-long learning.

**Communication:** Able to accurately and effectively communicate information on Microbiology using written, visual and oral reporting formats.

**Critical Thinking:** An understanding of the need for independent critical data evaluation and formation of evidence-based opinions.

Ability to apply the scientific process, including ability to acquire, assimilates, synthesize, analyze and critique Microbiological information.

**Ethics:** An awareness of the ethical implications of Microbiology, immunology, biotechnology and scientific research into the same.

**Environmental Literacy:** An awareness of environmental implications of biotechnology and Microbiological research.

**Self-Motivation:** Has self-discipline, planning, organizational and time management skills and the ability to work independently.

**Teamwork:** Ability to work effectively as both a member and leader within a team.

## 2.8 Program Education Objectives

### Program Educational Objectives (PEO)

**PEO-1:** We will ensure a strong and applied core curriculum through which students can acquire a basic knowledge of Microbiology.

**PEO-2:** Program will provide a learning environment that excites and informs undergraduates about Microbiology and the many ways that it is relevant to everyday life.

**PEO-3:** Graduates will be able to create an awareness of the current Microbiological knowledge, limits of own knowledge and a commitment to life-long learning.

**PEO-4:** Graduates will achieve the knowledge on applications of Microbiology in health sector, food and pharmaceutical sector, research and sustainable national development.

**PEO-5:** Our graduates will be able to develop skills through innovative, non-conventional coursework that stresses inquiry-based learning to apply the subject knowledge for human welfare.

**PEO-6:** We want to produce qualified and competent Microbiologist in the field of education and research.

## 2.9 Program Learning Outcome

### Program Learning Outcomes (PLO)

Department of Microbiology offers B.Sc. (Honors) degree in Microbiology. Upon graduation, students of Microbiology will be able to:

**PLO-1:** Demonstrate knowledge and have a solid foundation in different types of microorganisms with their structure, habitat, and chemical nature, their disease causing ability and the isolation or identification of these microbes from various samples.

**PLO-2:** Build their knowledge in anatomy, physiology, inorganic and organic chemistry, biochemistry, Bangla, English, environmental science, society and culture.

**PLO-3:** Build their knowledge and understanding the microbial growth, biochemical analysis, application of antibiotics and antimicrobial drugs, physical chemistry and various biomolecules.

**PLO-4:** Demonstrate knowledge and understanding the interactions of microbial populations in host, Microbiological analysis of water, concept of metabolism, math, and introduction to biostatistics and computer data analysis.

**PLO-5:** Build their knowledge and understanding on structure, chemical composition and replication of virus, importance and application of microbial genetics, morphology and reproduction of fungi, beneficial and harmful aspects of microorganisms in food.

**PLO-6:** Ability to understand and acquire knowledge regarding the roles of virus-causing disease and the importance of microbes in fermentation, agriculture, genetics, food and pharmaceutical industries.

**PLO-7:** Build their basic and advance knowledge on the reactions of pathogen with host immune system, mechanisms and the role of enzymes in industry.

**PLO-8:** Ability to acquire brief knowledge of bioinformatics, biotechnology and their implementation in the field of genetic engineering and reducing environmental pollution.

**PLO-9:** Build their knowledge on quality control and quality assurance of food and pharmaceutical industries and be well trained in analytical Microbiology including advanced diagnostic laboratory techniques.

**PLO-10:** Maintain a safe workspace, adhere to lab safety regulations and display responsibility to conduct advanced research and higher study.

## 2.10 Mapping mission of the University with PEOs

PEOs	M1	M2	M3	M4	M5	M6	M7	M8
PEO 1		m	m			m		m
PEO 2	m	m	m			m		m
PEO 3	m	m	m		m	m		
PEO 4		m	m		m			m
PEO 5	m	m	m	m				m
PEO 6		m						

(Note: "m" =matched)

## 2.11 Mapping PLOs with the PEOs

PLOs	PEO-1	PEO-2	PEO-3	PEO-4	PEO-5	PEO-6
PLO-1	m	m				m
PLO-2		m			m	
PLO-3		m	m	m		m
PLO-4		m	m	m	m	
PLO-5	m		m	m	m	m
PLO-6		m		m	m	m
PLO-7	m			m		m
PLO-8		m	m	m		m
PLO-9			m	m		m
PLO-10	m		m	m	m	m

(Note:" m" = matched)

## 2.12 Mapping courses with the PLOs

Curriculum of the Department of Microbiology is aligned with courses and program learning outcome through proper skill mapping.

Courses	Courses Name	Program Learning Outcomes (PLOs)									
		PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
MIC-1101	Introduction to Microbiology and Microbial Diversity	m				m					
MIC-1102	Basic Techniques in Microbiology	m									m
MIC-1104	Practical	m									m
MIC-Chem-1101E	General Chemistry-I	m	m	m							
MIC-Beng-1102E	Bangla		m								
MIC-ENG-1103E	English-I		m								m
MIC-Env-1104E	Environmental Science		m		m				m		
MIC-MBBS-1105E	Human Anatomy		m								
MIC-1105	Viva- voce	m	m						m		m
MIC-1201	General Microbiology-II	m		m							m
MIC-1202	Microbial Chemistry	m	m	m	m						
MIC-1204	Practical	m		m	m						m
MIC-Chem-1201E	General Chemistry-II	m	m	m							
MIC-ENG-1202E	English-II		m								m
MIC-Soc-1203E	Social Studies		m								
MIC-MBBS-1204E	Human physiology		m					m			
MIC-1205	Viva- voce	m	m	m	m						
MIC-2301	Microbial Ecology	m	m		m						
MIC-2302	Environmental Microbiology	m	m	m	m		m		m		
MIC-2303	Microbial Metabolism-I	m	m	m	m						
MIC-2304	Clinical Pathology	m		m	m			m		m	m
MIC-2305	Practical	m	m	m	m						m
MIC-Bus-2301E	Mathematics and Statistics				m						m
MIC-Pharm-2302E	General Chemistry Laboratory		m	m							m
MIC-BMB-2303E	Biochemistry-I	m	m	m							m
MIC-2306	Viva- voce	m	m	m	m						m
MIC-2401	Virology-I	m			m	m	m				
MIC-2402	Basic Microbial Genetics					m	m		m		m
MIC-2403	Microbial Metabolism-II		m	m	m	m					m
MIC-2404	Mycology	m		m		m	m		m		
MIC-2405	Food Microbiology- I					m	m			m	

MIC-2406	Practical	m		m		m	m				m
MIC-BUS-2401E	Biostatistics				m						m
MIC-BMB-2402E	Biochemistry-II	m	m	m	m						m
MIC-2407	Viva- voce	m		m		m	m				m
MIC-3501	Virology-II	m				m	m	m		m	m
MIC-3502	Molecular Genetics					m	m		m		m
MIC-3503	Agricultural Microbiology		m			m	m		m		
MIC-3504	Fermentation Technology			m	m		m	m	m		
MIC-3505	Food Microbiology- II	m				m	m			m	m
MIC-3506	Practical	m				m	m			m	m
MIC-3507	Viva-voce	m				m	m			m	
MIC-CSE-3501E	Computer Data Analysis				m					m	m
MIC-3601	Immunology-I		m					m		m	m
MIC-3602	Medical Microbiology-I	m			m			m		m	m
MIC-3603	Industrial Microbiology			m	m	m	m		m	m	m
MIC-3604	Enzymology		m	m				m	m		m
MIC-3605	Pharmaceutical Microbiology			m			m			m	m
MIC-3606	Practical	m		m		m	m			m	m
MIC-3607	Viva-voce	m		m		m	m			m	m
MIC-4701	Immunology-II		m					m		m	m
MIC-4702	Medical Microbiology-II	m			m			m		m	m
MIC-4703	Environmental Biotechnology	m	m	m	m		m		m		m
MIC-4704	Genetic Engineering					m	m		m	m	m
MIC-4705*	Practical / Research project	m	m	m	m		m		m	m	m
MIC-4706	Viva-voce	m	m	m	m		m		m	m	m
MIC-4801	Microbial Biotechnology				m	m	m	m	m	m	m
MIC-4802	Diagnostic Microbiology	m		m						m	m
MIC-4803	Analytical Microbiology				m					m	m
MIC-4804	Quality Control of Food and Pharmaceuticals					m	m	m		m	m
MIC-4805	Molecular Biology and Bioinformatics					m	m	m	m	m	m
MIC-4806*	Practical / Research project	m	m	m	m	m	m	m	m	m	m
MIC-4807	Viva-voce	m	m	m	m	m	m	m	m	m	m

**(Note: "m" = matched)**

# Chapter 3

## Structure of the Curriculum

**3.1 Duration of the program:**      **Years: 4**                      **Semesters: 8**

**3.2 Admission Requirements:** University follows the rules and regulation of Bangladesh University Grand Commission for students' admission. Minimum qualification for application is GPA 2.5 in both SSC and HSC examinations. Candidates are selected for admission on the basis of results in the admission test and the GPA obtained in the public examinations. Students who have completed the three years diploma course from any approved institute with the biological science or three years experienced health workers are eligible to apply in B. Sc. (Honors) in Microbiology.

**3.3 Total Minimum credit requirement to complete the program:** When a student enrolls in the Microbiology Department for the degree of B.Sc. in Microbiology he/she has to earn **132** academic credits. In case of theoretical course, one lecture per week per semester (18 weeks) is equivalent to one credit i.e. for a 2-credit course, there are two lectures per week and for 3-credit course; there are three lectures per week. In case of practical course one practical class consist of two hours.

**3.4 Total Class week in a semester:** The duration of a semester is as follows;

Classes (lectures, tutorial and practical)	18 weeks
Mid-term examinations	01 week
Semester break and revision classes before semester final	02 weeks
Semester final examinations including practical and oral test	03 weeks
Vacation	02 weeks
Total	26 weeks

**3.5 Minimum CGPA requirements for post-graduation:** CGPA 2.5

**3.6 Maximum academic years of completion:** 6 years/12 semesters



### 3.7 Category of courses:

#### i) General Education Courses:

SL	Course Code	Course Title	Credit
1	MIC-Chem-1101E	General Chemistry-I	2.0
2	MIC-Beng-1102E	Bangla	2.0
3	MIC-ENG-1103E	English-I	2.0
4	MIC-Env-1104E	Environmental Science	3.0
5	MIC-MBBS-1105E	Human Anatomy	2.0
6	MIC-Chem-1201E	General Chemistry-II	2.0
7	MIC-ENG-1202E	English-II	2.0
8	MIC-Soc-1203E	Social Studies	2.0
9	MIC-MBBS-1204E	Human physiology	3.0
10	MIC-BUS-2301E	Mathematics and Statistics	2.0
11	MIC- Pharm-2302E	General Chemistry Laboratory	2.0
12	MIC-BMB-2303E	Biochemistry-I	2.0
13	MIC-BUS-2401E	Biostatistics	2.0
14	MIC-MBM- 2402E	Biochemistry-II	2.0
15	MIC-CSE- 3501E	Computer Data Analysis	2.0

#### ii. Core Courses:

SL	Course Code	Course Title	Credit
1	MIC-1101	Introduction to Microbiology and Microbial Diversity	2.0
2	MIC- 1102	Basic Techniques in Microbiology	2.0
3	MIC- 1104	Practical	2.0
4	MIC- 1105	Viva- voce	1.0
5	MIC- 1201	General Microbiology	2.0
6	MIC- 1202	Microbial Chemistry	2.0
7	MIC- 1204	Practical	2.0
8	MIC- 1205	Viva- voce	1.0
9	MIC- 2301	Microbial Ecology	2.0
10	MIC- 2302	Environmental Microbiology	2.0
11	MIC- 2303	Microbial Metabolism-I	2.0
12	MIC- 2304	Clinical Pathology	2.0
13	MIC- 2305	Practical	2.0
14	MIC- 2306	Viva- voce	1.0
15	MIC- 2401	Virology-I	2.0
16	MIC- 2402	Basic Microbial Genetics	2.0
17	MIC- 2403	Microbial Metabolism-II	2.0
18	MIC- 2404	Mycology	2.0

19	MIC- 2405	Food Microbiology- I	2.0
20	MIC- 2406	Practical	2.0
21	MIC- 2407	Viva- voce	1.0
22	MIC- 3501	Virology-II	3.0
23	MIC- 3502	Molecular Genetics	3.0
24	MIC- 3503	Agricultural Microbiology	2.0
25	MIC- 3504	Fermentation Technology	2.0
26	MIC- 3505	Food Microbiology- II	2.0
27	MIC- 3506	Practical	2.0
28	MIC- 3507	Viva-voce	1.0
29	MIC- 3601	Immunology-I	2.0
30	MIC- 3602	Medical Microbiology-I	2.0
31	MIC- 3603	Industrial Microbiology	3.0
32	MIC- 3604	Enzymology	2.0
33	MIC- 3605	Pharmaceutical Microbiology	2.0
34	MIC- 3606	Practical	2.0
35	MIC- 3607	Viva-voce	1.0
36	MIC- 4701	Immunology-II	2.0
37	MIC- 4702	Medical Microbiology-II	3.0
38	MIC- 4703	Environmental Biotechnology	3.0
39	MIC- 4704	Genetic Engineering	2.0
40	MIC- 4705	Practical/ Research project	4.0
41	MIC- 4706	Viva-voce	1.0
42	MIC- 4801	Microbial Biotechnology	3.0
43	MIC- 4802	Diagnostic Microbiology	2.0
44	MIC- 4803	Analytical Microbiology	2.0
45	MIC- 4804	Quality Control of Food and Pharmaceuticals	2.0
46	MIC- 4805	Molecular Biology and Bioinformatics	3.0
47	MIC-4806	Practical/ Research project/ Internship	
48	MIC- 4807	Viva-voce	2.0

**iii. Elective course: N/A**

**iv. Capstone course/ thesis/ projects/ internship:** Students have to complete an Internship course of 2 Credit in 8<sup>th</sup> semester which is part of Course MIC-4806.

### 3.8 Year/Level/Semester/Term wise distribution of courses

#### First Year (First Semester)

Course No.	Course Name	Credits	Marks
<b>Departmental Courses</b>			
MIC-1101	Introduction to Microbiology and Microbial Diversity	2.0	50
MIC-1102	Basic Techniques in Microbiology	2.0	50
MIC-1104	Practical	2.0	50
MIC-1104	Viva-voce	1.0	25
<b>Extra-Departmental Courses</b>			
MIC-Chem-1101E	General Chemistry-I	2.0	50
MIC-Beng-1102E	Bangla	2.0	50
MIC-ENG-1103E	English-I	2.0	50
MIC-Env-1104E	Environmental Science	3.0	100
MIC-MBBS-1105E	Human Anatomy	2.0	50

#### First Year (Second Semester)

Course No.	Course Name	Credits	Marks
<b>Departmental Courses</b>			
MIC-1201	General Microbiology	2.0	50
MIC-1202	Microbial Chemistry	2.0	50
MIC- 1204	Practical	2.0	50
MIC- 1205	Viva-voce	1.0	25
<b>Extra-Departmental Courses</b>			
MIC-Chem-1201E	General Chemistry-II	2.0	50
MIC-ENG-1202E	English-II	2.0	50
MIC-Soc-1203E	Social Studies	2.0	50
MIC-MBBS-1204E	Human physiology	3.0	100

### Second Year (Third Semester)

Course No.	Course Name	Credits	Marks
<b>Departmental Courses</b>			
MIC- 2301	Microbial Ecology	2.0	50
MIC- 2302	Environmental Microbiology	2.0	50
MIC- 2303	Microbial Metabolism-I	2.0	50
MIC- 2304	Clinical Pathology	2.0	50
MIC- 2305	Practical	2.0	50
MIC- 2306	Viva-voce	1.0	25
<b>Extra-Departmental Courses</b>			
MIC-BUS-2301E	Mathematics and Statistics	2.0	50
MIC-Chem-2302E	General Chemistry Laboratory	2.0	50
MIC-BMB-2303E	Biochemistry-I	2.0	50

### Second Year (Fourth Semester)

Course No.	Course Name	Credits	Marks
<b>Departmental Courses</b>			
MIC- 2401	Virology-I	2.0	50
MIC- 2402	Basic Microbial Genetics	2.0	50
MIC- 2403	Microbial Metabolism-II	2.0	50
MIC- 2404	Mycology	2.0	50
MIC- 2405	Food Microbiology- I	2.0	50
MIC- 2406	Practical	2.0	50
MIC- 2407	Viva-voce	1.0	25
<b>Extra-Departmental Courses</b>			
MIC-BUS-2401E	Biostatistics	2.0	50
MIC-BMB-2402E	Biochemistry-II	2.0	50

### Third Year (Fifth Semester)

Course No.	Course Name	Credits	Marks
<b>Departmental Courses</b>			
MIC- 3501	Virology-II	3.0	100
MIC- 3502	Molecular Genetics	3.0	100
MIC- 3503	Agricultural Microbiology	2.0	50
MIC- 3504	Fermentation Technology	2.0	50
MIC- 3505	Food Microbiology- II	2.0	50
MIC- 3506	Practical	2.0	50
MIC- 3507	Viva-voce	1.0	25
<b>Extra-Departmental Courses</b>			
MIC-CSE-3501E	Computer Data Analysis	2.0	50

### Third Year (Sixth Semester)

Course No.	Course Name	Credits	Marks
<b>Departmental Courses</b>			
MIC- 3601	Immunology-I	2.0	50
MIC- 3602	Medical Microbiology-I	2.0	50
MIC- 3603	Industrial Microbiology	3.0	100
MIC- 3604	Enzymology	2.0	50
MIC- 3605	Pharmaceutical Microbiology	2.0	50
MIC- 3606	Practical	2.0	50
MIC- 3607	Viva-voce	1.0	25

### Fourth (Seventh Semester)

Course No.	Course Name	Credits	Marks
<b>Departmental Courses</b>			
MIC- 4701	Immunology-II	2.0	50
MIC- 4702	Medical Microbiology-II	3.0	100
MIC- 4703	Environmental Biotechnology	3.0	100
MIC- 4704	Genetic Engineering	2.0	50
MIC- 4705*	Practical / Research project	4.0	100
MIC- 4706	Viva-voce	1.0	25

\*The same research project will be continued from the course # 4705 to course # 4806

### Fourth (Eighth Semester)

Course No.	Course Name	Credits	Marks
<b>Departmental Courses</b>			
MIC- 4801	Microbial Biotechnology	3.0	100
MIC- 4802	Diagnostic Microbiology	2.0	50
MIC- 4803	Analytical Microbiology	2.0	50
MIC- 4804	Quality Control of Food and Pharmaceuticals	2.0	50
MIC- 4805	Molecular Biology and Bioinformatics	3.0	100
MIC- 4806*	Practical / Research project	4.0	100
MIC- 4807	Viva-voce	2.0	50

\*The same research project will be continued from the course # 4705 to course # 4806

# Chapter 4

## Description of all courses of the program

### YEAR-1, SEMESTER-1, COURSE-01

Course Code: MIC-1101 Course Title: Introduction to Microbiology and Microbial Diversity Credits: 2.0
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#### Rationale of the course:

The intended course is designed as a building block for students who have a desire to establish their career in Microbiology.

#### Course Objectives:

The principle aim of the course is to introduce students with fundamentals of Microbiology, so that its subsequent disciplines e.g. virology, immunology, mycology etc. can be understood in the subsequent courses.

#### Course content:

1. **Introduction:** Definitions and units of measurement in Microbiology; Significance of small forms of life; Economic importance of microorganisms; Scope of Microbiology: major branches of Microbiology.
2. **History of Development of Microbiology:** Development of Microbiology as a discipline, Spontaneous generation vs. biogenesis. Contributions of Anton von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming Role of microorganisms in fermentation, Germ theory of disease, Development of various Microbiological techniques and golden era of Microbiology, Development of the field of soil Microbiology: Contributions of Martinus W. Beijerinck, Sergei N. Winogradsky, Selman A.Waksman Establishment of fields of medical Microbiology and immunology through the work of Paul Ehrlich, Elie Metchnikoff, Edward Jenner.
3. **Importance and exploitation of Microbiology:** In food and dairy, human welfare, agriculture, industry health and sanitation, environment and pollution control.
4. **Microbial life form:** Prokaryotic and eukaryotic microbes, their morphology, subcellular structures, distinct features.
5. **General characteristics of different groups of microorganisms:** Cellular microorganisms (Bacteria, Algae, Fungi and Protozoa) with emphasis on distribution and occurrence, morphology, mode of reproduction and economic importance; acellular microorganisms (Viruses, Viroids, Prions).

#### Course Learning Outcome (CLOs):

**CLO1:** To define Microbiology and its subjects

**CLO2:** To describe brief history of Microbiology

**CLO3:** To explain applications of Microbiology in different fields

**CLO4:** To describe prokaryotes, its morphology and importance e.g., bacteria

**CLO5:** To describe major features of different forms of prokaryotes e.g. actinomycet cyanobacteria, archaea, fungi, algae, protozoa and viruses.

**Mapping Course Learning Outcomes (CLOs) with the PLOs**

<b>CLOs</b>	<b>PLO1</b>	<b>PLO2</b>	<b>PLO3</b>	<b>PLO4</b>	<b>PLO5</b>	<b>PLO6</b>	<b>PLO7</b>	<b>PLO8</b>	<b>PLO9</b>	<b>PLO10</b>
CLO1	m									
CLO2	m									
CLO3	m									
CLO4	m									
CLO5	m	m	m							

**Mapping course learning Outcomes (CLOs) with the Teaching-Learning and Assessment strategy**

<b>CLOs</b>	<b>Teaching-Learning Strategy</b>	<b>Assessment Strategy</b>
CLO1	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO2	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO3	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO4	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO 5	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation

## YEAR-1, SEMESTER-1, COURSE-02

Course Code: MIC-1102	Course Title: Basic Techniques in Microbiology	Credits: 2.0
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### Rationale of the course:

This lab-based course will help students better understand and apply concept while gaining practical skills for job application.

### Course Objective:

The aim of the course is to take an approach by integrating advances in isolation, identification, preservation and control of microbes in order to introduce students to the main principles of science and technology and their implementation in microbial industry. The course covers the basic principles and practices of the major techniques used in microbial diagnosis and preservation along with critical issue.

### Course content:

- 1. Microscopy and Staining:** Principles, Function, Application and Care of various microscopes; Preparation for light microscopy; Types of staining (Simple, Differential and Special staining).
- 2. Basic Microbiology techniques:** Basic procedures to examine and characterize microbes - the five "I's: Inoculation, Incubation, Isolation, Inspection (observation), and Identification.
- 3. Microorganism identification and characterization:** Based on morphological, cultural and biochemical properties; Phenotypic and phylogenetic classification of microorganisms.
- 4. Control of microbial growth:** Physical methods: high or low temperature, desiccation, osmotic pressure, radiation, and filtration; Chemical methods: high or low temperature, desiccation, osmotic pressure, radiation, and filtration; Concepts of Sterilization, Pasteurization, Disinfection, antisepsis, sanitization, and *microbiostatic* and *microbiocidal* agents.
- 5. Preservation and Maintenance of Microbial Cultures:** Short term (Periodic transfer, refrigeration and paraffin method) and long term (Cryopreservation and lyophilization or freeze-drying) preservation.
- 6. Methods for Measuring Bacterial Growth: Direct Methods** – Colonies counting, filtration, microscopic count, electronic (coulter counter); Indirect Methods – Turbidity, metabolic activity, nitrogen content, specific chemical changes and biomass (dry and wet).
- 7. Requirements for Microbial Growth:** Physical requirements - Temperature, pH, light, osmotic pressure and hydrostatic pressure; Chemical requirements: Carbon, nitrogen, oxygen, sulfur, phosphorus and other micronutrient and trace elements and; Culture Media - broth and solid media, chemically defined and complex media, anaerobic growth media, non- selective, selective and differential; Concept of enrichment, pure culture and special culture techniques: Categorization of bacteria on the basis of physical and chemical requirements.



### Course Learning Outcome (CLOs)

**CLO1:** To identify the different microorganisms by observing their morphological, cultural and biochemical properties.

**CLO2:** To inoculate, incubate, isolate, inspect and identify organisms and also obtain pure culture.

**CLO3:** To evaluate and apply the proper methods of microbial control necessary in sample scenarios or case studies

**CLO4:** To preserve microorganisms for further assay.

### Mapping Course Learning Outcomes (CLOs) with the PLOs:

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1	m		m						m	
CLO2	m		m						m	
CLO3			m						m	
CLO4	m								m	m

(Note: m= matched)

### Mapping course learning Outcomes (CLOs) with the Teaching-Learning and Assessment strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO2	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO3	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO4	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation

## YEAR-1, SEMESTER-1, COURSE-04

Course Code: MIC-1104

Course Title: Practical

Credits: 02

### Rationale of the course:

The intended course is designed to correlate theoretical studies with practical tasks.

### Course Objective:

The main objective of the course is to educate students in lab tasks such as microscopic, staining and cultivation techniques.

### Course Content

1. **Introduction to safety;** Regulations and hygiene practice on working in Microbiology laboratory.
2. **Microscopy;** Use and function of microscopes, Use and function of microscopes
3. **Micrometry;** Measurement of size of different microbial cells. Measurement of size of different microbial cells.
4. **Bacterial staining;** simple staining and negative staining, Gram staining, Acid fast staining, Spore staining.
5. **Cultivation techniques;** Media preparation and Sterilization techniques. Sterility testing, Techniques for isolation of pure cultures.

### Course Learning Outcomes (CLOs)

**CLO1:** To describe the precautions taken during working in Microbiology laboratory.

**CLO2:** To use variety of microscopes for diagnostic purpose.

**CLO3:** To measure size of microbial cells.

**CLO4:** To estimate shape and arrangement of microbial cells through staining.

**CLO5:** To prepare culture media for cultivation and isolation of Microorganisms.

### Mapping Course Learning Outcomes (CLOs) with the PLOs:

(CLOs)	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1	m		m						m	m
CLO2	m		m						m	m
CLO3	m		m						m	m
CLO4	m		m						m	m
CLO5	m		m							m

(Note: "m" =matched)

### Mapping course learning Outcomes (CLOs) with the Teaching-Learning and Assessment strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CL01	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CL02	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CL03	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CL04	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CL05	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation

### YEAR-1, SEMESTER-1, COURSE-05

<b>Course Code: MIC-Chem-1101E</b>	<b>Course Title: General Chemistry-I</b>	<b>Credits: 02</b>
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#### Rationale of the course:

The intended course is designed to impart courses on basic/fundamental, analytical and physical chemistry for incumbents of Microbiology.

#### Course Objective

The main objective of the course is to equip students with the knowledge of fundamentals of chemistry.

#### Course content:

- Inorganic Chemistry** Introduction, atomic structure, atomic weight, atomic number, Atomic mass number, Rutherford theory, Bohr theory, arrangement of the electron in an atom, Atomic orbital, Pauli exclusion principle.
- Chemical bonds** Electrovalent bond, covalent bond, Coordinate covalent bond, hydrogen bond
- Metallic bond, modern periodic law, Usefulness and limitation of periodic table.
- Organic chemistry Introduction**, carbon-carbon bond, carbon-nitrogen bond, tetrahedral carbon atom, carbon-nitrogen bond, tetrahedral carbon atom
- Preparation and properties** of alkanes, alkenes, alcohols and aldehydes and ketones
- Introduction to stereochemistry**

### Course Learning Outcome (CLOs):

**CLO1:** To describe fundamentals of chemistry.

**CLO2:** To describe the importance of the application of chemistry (inorganic and organic) in the field of Microbiology.

**CLO3:** To describe the importance of the application of chemistry (analytical and physical) in the field of Microbiology.

### Mapping Course Learning Outcomes (CLOs) with the PLOs:

(CLOs)	PL01	PL02	PL03	PL04	PL05	PL06	PL07	PL08	PL09	PL010
CLO1		m	m							
CLO2		m	m							
CLO3		m	m							

(Note: "m" =matched)

### Mapping course learning Outcomes (CLOs) with the Teaching-Learning and Assessment strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO2	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO3	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation

## YEAR-1, SEMESTER-1, COURSE-06

<b>Course Code: MIC-Beng-1102E</b>	<b>Course Title: Bangla</b>	<b>Credits: 02</b>
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### Rationale of the course:

এই কোর্সটির মাধ্যমে শিক্ষার্থীরা উচ্চ শিক্ষায় রাষ্ট্রভাষা বাংলার গঠনমূলক প্রয়োজনীয়তা আরও ভালোভাবে অনুধাবন করতে পারবে।

### Course Objective

বাংলাকে উচ্চশিক্ষার এজি মধ্যম হিসেবে ব্যবহার করে বাংলা ভাষাভাষী শিক্ষার্থীদের জন্য পাঠ্য বিষয়কে আরও সহজ করে তোলা, বাংলা শব্দভাণ্ডার উন্নত করা, বাংলা ভাষার শৈল্পিক, ব্যাকরণিক এবং লিখিত রূপের সহজবোধ্যতা আনয়ন ও বাংলা সাহিত্যের স্বরূপ উন্মোচন করা।

### Course Content:

১. ব্যাকরণ: কোর্স ও বিষয় পরিচিতি, ব্যাকরণের সংজ্ঞা, পরিধি, বিষয়বস্তু এবং প্রয়োজনীয়তা।
২. ভাষা: ভাষার সংজ্ঞা, বৈশিষ্ট্য, উৎপত্তি, ক্রমবিকাশ, বিবর্তন, সাধুরীতি, চলিতরীতি, আঞ্চলিক ও প্রমিত রীতি।
৩. ধ্বনি, বর্ণ, অক্ষর: সংজ্ঞা, বৈশিষ্ট্য, পার্থক্য নির্ণয়, ধ্বনির উচ্চারণ স্থান ও ধ্বনি গঠনে বাক্যবস্তুর ভূমিকা
৪. শব্দ: শব্দের সংজ্ঞা, শ্রেণীবিভাগ, শব্দের গঠন, বাংলা ভাষার শব্দ ভাণ্ডার।

৫. বাক্য: সংজ্ঞা, সার্থক বাক্যের বৈশিষ্ট্য, শ্রেণীবিভাগ, বাক্য বিশ্লেষণ ও বাক্য শুদ্ধিকরণ।
৬. ন-ত্ব বিধান ও ঘ-ত্ব বিধান: সংজ্ঞা ও প্রয়োগবিধি।
৭. বিরামচিহ্ন: বিরামচিহ্নের পরিচিতি ও ব্যবহারবিধি।
৮. বাংলা বানান ও উচ্চারণ: প্রমিত উচ্চারণের নীতিমালা, বাংলা বানান সংস্কারের ইতিহাস ও বাংলা একাডেমী প্রমিত বাংলা বানানের নিয়ম।
৯. প্রতিবেদন ও আবেদনপত্র: প্রতিবেদনের সংজ্ঞা, বৈশিষ্ট্য, প্রকারভেদ, প্রতিবেদন ও আবেদন তৈরী ও প্রণয়ন।
১০. সাহিত্য, কবিতা, নাটক, উপন্যাস, ছোটগল্প: সংজ্ঞা, বৈশিষ্ট্য, শ্রেণীবিভাগ এবং সাহিত্যের যুগবিভাগ।
১১. বাংলা সাহিত্যের ধারায় কাজী নজরুল ইসলাম এবং বাংলা সাহিত্যে সৈয়দ ওয়ালী উল্লাহর অবদান।
১২. রবীন্দ্রনাথ ও বাঁশি কবিতা: জীবন ও কাব্যভাবনা এবং বাঁশি কবিতার বিষয়বস্তু ও শিল্পরূপ।
১৩. রবীন্দ্রনাথ ও সমাপ্তি গল্প: ছোটগল্পে রবীন্দ্রনাথের অবদান ও সমাপ্তি গল্পের বিষয়বস্তু সম্পর্কে আলোচনা।
১৪. কাজী নজরুল ইসলাম ও মানুষ কবিতা: মানবতাবাদী কবি নজরুল ও মানুষ কবিতার বিষয়বস্তু।
১৫. সৈয়দ ওয়ালীউল্লাহ ও গল্প- একটি তুলসী গাছের কাহিনী: দেশভাগের প্রেক্ষাপট ও উদ্ভাস্ত মানুষের জীবনচিত্র।
১৬. বেগম রোকেয়া ও অবরোধবাসিনী: বেগম রোকেয়ার জীবন ও সাহিত্যকর্ম, অবরোধবাসিনী গ্রন্থের বিষয়বস্তু ও তত্ত্ব বিশ্লেষণ এবং অসহায় নারীর জীবনচিত্র।
১৭. মুনীর চৌধুরী ও কবর নাটক: জীবন ও সাহিত্য, নাটকের ঘটনা ও চরিত্র বিশ্লেষণ এবং ভাষা আন্দোলনের প্রতিবাদী নাটক ও নাটকের প্রেক্ষাপট।
১৮. উপসংহার: সমগ্র কোর্সের বিষয়ে সংক্ষিপ্ত পুনরালোচনা।

### Course Learning Outcomes (CLOs)

- CLO1:** সমগ্র কোর্স তথা ব্যাকরণ, ভাষা এবং ভাষার প্রায়োগিক রূপ সম্পর্কে ধারণা প্রদান।
- CLO2:** বাংলা বানান ও উচ্চারণের ক্ষেত্রে ব্যাকরণগত সঠিক নিয়মনীতি ও রীতি পদ্ধতি সম্পর্কে ধারণা প্রদান।
- CLO3:** অভিধান ব্যবহারের পদ্ধতি, আবেদনপত্র ও প্রতিবেদন লেখার সঠিক প্রক্রিয়া সম্পর্কে জ্ঞান লাভ।
- CLO4:** সাহিত্যের রূপ ও রীতি, সাহিত্যতত্ত্ব এবং বাংলা সাহিত্যের বিশিষ্ট সাহিত্যিক ও তাঁদের সাহিত্যকর্ম সম্পর্কে জ্ঞান লাভ।
- CLO5:** নির্বাচিত সাহিত্যের বিষয়বস্তু ও শৈলী সম্পর্কে ধারণা লাভ।

### Mapping Course Learning Outcomes (CLOs) with the PLOs

(CLOs)	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1		m								
CLO2		m								
CLO3		m								
CLO4		m								
CLO5		m								

(Note: "m" = matched)

## Mapping course learning Outcomes (CLOs) with the Teaching-Learning and Assessment strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	লেখকচারণ, ডিশকারণ ও হ্যান্ডনোট	মৌখিক, টিউটোরিয়াল, কুইজ, মিডটার্ম এসাইনমেন্ট, প্রেজেন্টেশন
CLO2	লেখকচারণ, ডিশকারণ ও হ্যান্ডনোট	মৌখিক, টিউটোরিয়াল, কুইজ, মিডটার্ম এসাইনমেন্ট, প্রেজেন্টেশন
CLO3	লেখকচারণ, ডিশকারণ ও হ্যান্ডনোট	মৌখিক, টিউটোরিয়াল, কুইজ, মিডটার্ম এসাইনমেন্ট, প্রেজেন্টেশন
CLO4	লেখকচারণ, ডিশকারণ ও হ্যান্ডনোট	মৌখিক, টিউটোরিয়াল, কুইজ, মিডটার্ম এসাইনমেন্ট, প্রেজেন্টেশন
CLO5	লেখকচারণ, ডিশকারণ ও হ্যান্ডনোট	মৌখিক, টিউটোরিয়াল, কুইজ, মিডটার্ম এসাইনমেন্ট, প্রেজেন্টেশন

### YEAR-1, SEMESTER-1, COURSE-07

Course Code: MIC-1103E

Course Title: English-I

Credits: 02

#### Rationale of the course:

The intension of the course is to increase fluency in spoken English, reading and writing.

#### Course Objective

This course is aimed to emphasize on students primary skill of English language and make them able to develop it.

#### Course content:

- Foundation Review;** English tense system, Basic pattern of sentences, changing sentences into interrogative, negative, exclamatory etc. Present, past and pas participles forms of verbs-based on students' need.
- Writing skill;** Application to VC, Dean and Chairman, Application to Editor of a newspaper, Paragraph writing-comparing and contrasting.
- Reading skill;** Reading small passages for specific answers, Reading short stories for overall idea.
- Speaking skill;** Basic pronunciation skill-Recognizing places of Articulation, Basic pronunciation skill-recognizing phonetic symbols.

#### Course Learning Outcomes (CLOs)

**CLO1:** To describe the basic concept of English grammar

**CLO2:** To describes the basic concept of spoken.

**CLO3:** To describes the importance of learning English in our daily life.

**CLO4:** To describes the basic concept of writing formal and informal letters.

**CLO5:** To present topics on selected articles or journals.

**CLO6:** To speak in English in seminars and meetings.

**Mapping Course Learning Outcomes (CLOs) with the PLOs:**

<b>(CLOs)</b>	<b>PLO1</b>	<b>PLO2</b>	<b>PLO3</b>	<b>PLO4</b>	<b>PLO5</b>	<b>PLO6</b>	<b>PLO7</b>	<b>PLO8</b>	<b>PLO9</b>	<b>PLO10</b>
CLO1		m								
CLO2		m								
CLO3		m								
CLO4		m								
CLO5		m								
CLO6		m								

**Mapping course learning Outcomes (CLOs) with the Teaching-Learning and Assessment strategy**

<b>CLOs</b>	<b>Teaching-Learning Strategy</b>	<b>Assessment Strategy</b>
CLO1	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO2	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO3	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO4	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO5	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO6	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation

## YEAR-1, SEMESTER-1, COURSE-08

**Course Code: MIC-Env-1104E Course Title: Environmental Science Credits: 03**

### Rationale of the course:

Basic understanding of natural environment is essential for survival and sustainable development for an individual.

### Course Objective

The main objective of the course is to provide students with basic understanding of natural environment as our life support system through lectures and practical lessons

### Course content:

1. **Concept and components of environment:** Matter and energy
2. **Environment as system Ecosystem:** Structure and function; interrelation.
3. **Environment and natural resource:** economic development and environment  
Environmental degradation and pollution; atmosphere and climate; local and global impact  
Climate; local and global impact.
4. **Water, land and air pollution and degradation:** impacts on Water, land and air
5. **Human environment:** indoor air pollution, Water, land and air
6. Occupational hazard, gender and environment: urban and rural Environment and health
7. Education and awareness, Environment and health individual, state and global efforts: media and civil society
8. **Environment laws,** conventions and government's efforts CBD, CCC, CCD, MDGs and SDGs: how Bangladesh adopting Participatory approach, Community based efforts.

### Course Learning Outcomes (CLOs)

- CLO1.** To describe about their natural environment as a system  
**CLO2.** To describe ecosystem approach for sustainable environment.  
**CLO3.** To describe how components of environment work and interrelated.  
**CLO4.** To describe how matter and energy interplay.  
**CLO5.** To describe how the environment has been used as natural resource base.  
**CLO6.** To describe how human degraded and polluted.  
**CLO7** To describe what impacts environmental degradation and pollution Emphasis on Bangladesh

### Mapping Course Learning Outcomes (CLOs) with the PLOs

(CLOs)	PL01	PL02	PL03	PL04	PL05	PL06	PL07	PL08	PL09	PL010
CLO1		m						m		
CLO2		m						m		
CLO3		m						m		
CLO4		m						m		



CLO5		m						m		
CLO6		m						m		
CLO7		m						m		

**Mapping course learning Outcomes (CLOs) with the Teaching-Learning and Assessment strategy**

<b>CLOs</b>	<b>Teaching-Learning Strategy</b>	<b>Assessment Strategy</b>
CLO1	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO2	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO3	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO4	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO5	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO6	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO7	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation

**YEAR-1, SEMESTER-1, COURSE-08**

<b>Course Code: MIC-MBBS-1105E</b>	<b>Course Title: Human Anatomy</b>	<b>Credits: 02</b>
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**Rationale of the course:**

The intended course is designed to delineate anatomy of the human body.

**Course Objective:**

The aim of the course is to introduce students with the knowledge of structure of different systems such as circulatory system, respiratory system, urinary system, digestive system and nervous system of the human body.

**Course Content:**

1. **Structural Organization of the Human Body:** Levels of organization - Cells and tissues, organs, organ system; Different types of cells and their functions in the human body.
2. **Human Skeleton System: Structure** - axial skeleton and appendicular skeleton; Function of skeleton system; skeletal disorders - arthritis and osteoporosis.
3. **Structure and Function of the Respiratory System:** Upper respiratory tract - nasal cavity, pharynx and larynx; Lower respiratory tract – trachea, bronchi and bronchioles and alveoli and lungs; External and internal respiration in the lungs; gas exchange between atmosphere and alveoli; Lung volumes and capacities.
4. **Human Circulatory System:** Cardiovascular System and Lymphatic System; Components and Functions of the Circulatory System; Pulmonary Circulation and Systemic Circulation - The Routes and Function of Blood Flow and Blood Flow Velocity; Heartbeat and Pulse; Cardiac Cycle – Systole and Diastole and blood pressure (BP).
5. **Human Excretory System:** Components and the functions of the excretory system; Excretion through the excretory organs – Lungs, sweat glands, liver and kidneys, Structural components urinary system; Functional unit of kidneys – filtration and concentration in the nephrons; Kidney dialysis.
6. **Human Digestive System:** Major Structural Regions of Digestive System and their functions – Oral cavity, esophagus, stomach, small intestine, large intestine and anal region; Accessory organs and their function - salivary glands, pancreas, liver, gallbladder, teeth and tongue. Mechanical and chemical digestion processes; Common acid-related diseases - Peptic ulcers and Heartburn.
7. **Nervous system Central nervous system**-peripheral nervous system, autonomic nervous system, Nervous system Central nervous system- Cerebrospinal fluid (composition).
8. **Special senses of the body**- Sight, hearing, smell, taste, touch, Endocrine system. Brief discussion on Chromosomes (structure and karyotype), Special senses of the body-genes, (dominant and recessive genes) autosome and sex chromosome, autosomal and sex-linked disorders, genotype, phenotype.
9. **Male & female reproductive system** External genitalia, internal-testes and ducts, Male reproductive system epididymides, ejaculatory ducts, prostate gland Female reproductive system External genitalia, Female reproductive system internal- ovaries, uterine/fallopian tubes, uterus, cervix, vagina.

**Course Learning Outcome (CLOs):**

**CLO1:** To describe structural organization of human body.

**CLO2:** To describe structural organization of human body.

**CLO3** To describe the structure and function of the Respiratory, digestive, circulatory, excretory, nerves & reproductive system of human body.

**CLO4:** To explain the human skeleton system.

**Mapping Course Learning Outcomes (CLOs) with the PLOs:**

(CLOs)	PL01	PL02	PL03	PL04	PL05	PL06	PL07	PL08	PL09	PL010
CLO1		m								
CLO2		m								
CLO3		m								
CLO4		m								

(Note: "m" =matched)

**Mapping course learning Outcomes (CLOs) with the Teaching-Learning and Assessment strategy**

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO2	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO3	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO4	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation

**YEAR-1, SEMESTER-1, COURSE-09**

<b>Course Code: MIC-1105</b>	<b>Course Title: Viva- voce</b>	<b>Credits: 01</b>
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**Rationale of the course:** N/A

**Course Objective:**

The objective of the course is to enable students to demonstrate a firm understanding of all the courses of this semester, so that the examiners can have an opportunity to assess the students.

**Course content:** Topics of all the theoretical and practical courses of 1<sup>st</sup> semester and other relevant matters will be included.

**Course Learning Outcomes:** N/A

**Mapping Course Learning Outcomes (CLOs) with the PLOs:** N/A

**Mapping course learning Outcomes (CLOs) with the Teaching-Learning and Assessment strategy:** N/A

## YEAR-1, SEMESTER-2, COURSE-10

<b>Course Code: MIC-1201</b>	<b>Course Title: General Microbiology</b>	<b>Credits: 02</b>
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### Rationale of the course:

Microbes as we know are capable of both good and bad as far as human life is concerned. We will list both the harmful and beneficial microbes and draw a conclusion as to how Microbiology has helped to control the bad microbes and make maximum use of good microbes.

### Course Objective

To provide modern knowledge and skills of general Microbiology with regard to general characteristics of microorganisms and their requirements of growth.

### Course Content:

- 1. Nutrition of microorganisms:** Influence of various mineral elements and growth factors on microbial growth.
- 2. Nutritional Classification of Microorganisms:** Classification on the basis of energy source, carbon source, electron source and gaseous nutrients; Autotrophic bacteria - photoautotrophs (purple sulphur and green sulphur bacteria) and chemoautotrophs (sulphur, hydrogen, iron, methane and nitrifying bacteria); Heterotrophic bacteria - photoheterotrophs (purple non-sulphur bacteria) and chemoheterotrophs (saprophytic, parasitic and symbiotic bacteria).
- 3. Bacterial Taxonomy:** Early and modern classification schemes; Bacterial Taxonomy – Identification, nomenclature and classification; Biological systematics; Phenetic system of classification; Phylogenetic system - Phylogenetic tree and the Three Domains.
- 4. Culture media:** Types, composition, preparation, use and dispersion.
- 5. Growth of microbes:** Detailed study of bacterial growth curve, mathematics of growth, synchronous growth influence of various factors on microbial growth.
- 6. Atypical Bacteria:** (General characteristics and their important Species): Archaeobacteria, Mycoplasma, Rickettsia, Chlamydia, Spirochaete.
- 7. Representative genera of important Gram positive and gram negative bacteria:** *Escherichia, Rhizobium, Salmonella, Shigella, Vibrio, Bacillus, Streptococcus and Staphylococcus.*

### Course Learning Outcomes (CLOs)

- CLO1:** To developed knowledge and a comprehensive understanding of the methods used to determine microorganisms from different samples.
- CLO2:** To discuss and justify the placement of bacteria in living world and their modern classification.
- CLO3:** To developed skills to prepare different types media to inoculate the initiation of microbial growth.

**CLO4:** To know the requirements of nutrition and physical factors for bacterial

**CLO5:** To critically characterize the different genera of important bacteria.

**Mapping Course Learning Outcomes (CLOs) with the PLOs**

<b>(CLO)</b>	<b>PLO1</b>	<b>PLO2</b>	<b>PLO3</b>	<b>PLO4</b>	<b>PLO5</b>	<b>PLO6</b>	<b>PLO7</b>	<b>PLO8</b>	<b>PLO9</b>	<b>PLO10</b>
CLO1	m									
CLO2	m									
CLO3	m									m
CLO4	m									
CLO5	m									

(Note: "m" =matched)

**Mapping course learning Outcomes (CLOs) with the Teaching-Learning and Assessment strategy**

<b>CLOs</b>	<b>Teaching-Learning Strategy</b>	<b>Assessment Strategy</b>
CLO1	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO2	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO3	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO4	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO5	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation

## YEAR-1, SEMESTER-2, COURSE-11

Course Code: MIC-1202	Course Title: Microbial Chemistry	Credits: 02
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### Rationale of the course:

The intended course is designed to assist students in learning basics of microbial chemistry.

### Course Objective:

The main objective of the course is to equip students with the knowledge of structural and functional features macromolecules, mode of actions of antibiotics and disinfectants.

### Course Content:

- Structure, Chemical composition and function of organelles;** Capsule, Flagella, Pilli, Cell-wall, Cytoplasmic membrane, Pigments, Ribosome, Cytoplasmic inclusions and endospore.
- Antimicrobial agents;** Type, Chemistry & Mode of action, Mode of action, Efficiency, Antimicrobial resistance.
- Structure, Function, of action antibiotics;** Penicillin, Ampicillin, Streptomycin, Tetracycline, Chloramphenicol, Nystatin and Gryseofulvin.
- Effectiveness of disinfectants;** commonly used in laboratories, Hospitals and household purposes.
- Properties and functions; The major and minor essential elements;** Water and their role in microorganisms, pH and their role in microorganisms, Osmosis and Diffusion
- Bio-molecules and biopolymers;** Carbohydrates, Lipids & Nucleic acids, Proteins.

### Course Learning Outcomes (CLOs)

**CLO1:** To describe cellular organelles and their functions.

**CLO2:** To explain the application and mechanism of antibiotics.

**CLO3:** To describe antifungal drugs.

**CLO4:** To explain the basic of antibiotic resistance.

**CLO5:** To discuss the function of antimicrobial agents.

**CLO6:** To discuss the structure, function & classification of macromolecules

**CLO7:** To describe properties of different biomolecules

### Mapping Course Learning Outcomes (CLOs) with the PLOs

(CLOs)	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1	m		m							
CLO2			m							
CLO3			m							
CLO4			m							
CLO5			m							
CLO6			m							
CLO7			m							

(Note: "m" =matched)

### Mapping course learning Outcomes (CLOs) with the Teaching-Learning and Assessment strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CL01	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CL02	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CL03	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CL04	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CL05	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CL06	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CL07	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation

### YEAR-1, SEMESTER-2, COURSE-13

<b>Course Code: MIC-1204</b>	<b>Course Title: Practical</b>	<b>Credits: 02</b>
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#### Rationale of the course:

The intended course is designed to correlate theoretical studies with practical tasks.

#### Course Objective

The main objective of the course is to educate students in lab tasks such as pure culture isolation, biochemical test for identification of microbes and preservation of microbes.

#### Course Content:

- 1. Pure culture characteristics;** Characteristics of various media, Characteristics of bacteria, Characteristics of Yeast

2. **Preparation and Observation of stained microbial preparations;** Bacteria, Preparation and Observation of Yeast and mycelial fungal cells, Preparation and Observation of stained microbial preparations Protozoa, Algae, Actinomycetes cell
3. **Biochemical tests for identification of microorganisms;** Catalase test, Coagulase test, Oxidase test, Nitrate reduction test, Litmus milk reaction test, MIU, KIA test., Lipid, Casein test, Hydrolysis of gelatin test, Carbohydrate fermentation tests (Glucose, Fructose, Lactose, Maltose, Sucrose, Starch, IMVIC test.
4. **Preservation techniques;** Technique for preservation, Techniques for preservation and maintenance of pure cultures.
5. **Observation of permanent slides;** Different microbial group.

### Course Learning Outcomes (CLOs)

**CLO1:** To identify microorganisms via biochemical tests.

**CLO2:** To preserve and maintain pure culture.

**CLO3:** To describe cultural characteristics of bacteria on various media.

**CLO4:** To describe structural difference between different microbial groups through observation of stained microbial preparations.

### Mapping Course Learning Outcomes (CLOs) with the PLOs

(CLOs)	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1	m									
CLO2			m						m	
CLO3	m		m						m	
CLO4			m						m	

(Note: "m" =matched)

### Mapping course learning Outcomes (CLOs) with the Teaching-Learning and Assessment strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO2	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO3	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO4	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation



## YEAR-1, SEMESTER-2, COURSE-14

**Course Code: MIC-Chem-1201E Course Title: General Chemistry-II Credits: 02**

### Rationale of the course:

The intended course is designed to impart courses on basic/fundamental, analytical and physical chemistry for incumbents of Microbiology

### Course Objective

The main objective of the course is to equip students with the knowledge of fundamentals of chemistry.

### Course Content:

1. Physical Chemistry: Kinetic theory of gases, Law of thermodynamic (only physical interpretation) Types of solution (their colligative properties), Vapor pressure, Surface tension, Viscosity, Elevation of boiling point,
2. Elevation of boiling point, freezing point, Osmotic pressure, Law of mass action, Chemical equilibrium, Chemical kinetics (first and second order reaction only).
3. Electro- chemistry Preparation and properties: Of carboxylic acids and their derivatives, Aromatic compounds Heterocyclic compounds, Introduction to stereochemistry

### Course Learning Outcomes (CLOs)

**CLO1:** To describe fundamentals of chemistry.

**CLO2:** To describe the importance of the application of chemistry (inorganic and organic) in the field of Microbiology.

**CLO3:** To describe the importance of the application of chemistry (analytical and physical) in the field of Microbiology.

### Mapping Course Learning Outcomes (CLOs) with the PLOs

(CLOs)	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1		m	m							
CLO2		m	m							
CLO3		m	m							

(Note: "m" =matched)

### Mapping course learning Outcomes (CLOs) with the Teaching-Learning and Assessment strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO2	Lecture, Interactive discussion,	Class Test, Mid Term, Final Exam,

	Multimedia presentation, Brain storming, Feedback, Assignment	Class attendance, Assignment, Presentation
CLO3	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation

### YEAR-1, SEMESTER-2, COURSE-15

<b>Course Code: MIC-ENG-1202E</b>	<b>Course Title: English-II</b>	<b>Credits: 02</b>
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#### Rationale of the course:

This is continuation of the course named English-I with the same purpose of improving fluency, writing, reading and listening in English

#### Course Objective:

The major objective of the course is to educate students with complete English language skill.

#### Course Content:

- 1. Communicative Grammar practice;** Conception of Quantity (Count, Non- count), Comparison of Adjectives and Adverbs, Making Requests and Apologies, Conditional sentences, Relative clauses.
- 2. Writing Skill;** Writing about an incident, Describing people, writing- process and narrative, Writing letters of requests and protests, Letters of reply, Letters of information and advice, Paragraph writing Different kinds of paragraph, Academic Essay and report writing- process and narrative, Diction: Words mean denotation and connotation, Euphemism, three qualities of good diction, Imagery, Simile, Metaphor, Analogy, Personification, Allusion, Vagueness, Jargon.
- 3. Reading Skill;** Reading scientific English, Reading English Extensively: English short stories, English poems.
- 4. Speaking Skill;** Taking interview, Debating, Giving speech, listening for specific information, listening for an overall idea.

#### Course Learning Outcomes (CLOs)

**CLO1:** To describe the usage & important grammar items..

**CLO2:** To learn freehand writing techniques & develop their writing skill.

**CLO3:** To read journals, newspapers, articles for specific purposes.

**CLO4:** To speak in different situations effectively.

**CLO5:** To listen and understand English in different seminars and meetings

### Mapping Course Learning Outcomes (CLOs) with the PLOs

(CLOs)	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1		m								
CLO2		m								
CLO3		m								
CLO4		m								
CLO5		m								

(Note: "m" =matched)

### Mapping course learning Outcomes (CLOs) with the Teaching-Learning and Assessment strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO2	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO3	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO4	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO5	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation

## YEAR-1, SEMESTER-2, COURSE-16

**Course Code: MIC-Soc-1203E**

**Course Title: Social Studies**

**Credits: 02**

### Rationale of the course:

The intended course is designed to give a student the realization of the significance of the society in educational transactions and organizing him/her both intrinsically & extrinsically.

### Course Objective

The principle objective of the course is to equip students with the knowledge of society, Culture, socialization, its importance's, implications and development

### Course Content:

1. Introducing Class, Define Sociology.
2. Relationship between sociology and Microbiology.

3. The basic concept of social studies or sociology.
4. Concept of medical sociology and its importance.
5. Define Culture, Elements of culture, Types of culture, and Basic elements of Bangladesh culture.
6. Define socialization, Agents of socialization, Theory of socialization, Define Social structure,
7. Elements of social structure, Define Organizations, Types and activities of organizations, Organization (World Bank, SAARC, & MNC).
8. Define development, Dependency theory of development.
9. Social System & Change, Capitalism, Socialism, Globalization, Global inequality.

### Course Learning Outcomes (CLOs)

- CLO1:** To learn about the society, associate, Norms-values, social systems, sociology and yourself.
- CLO2:** To learn intellectual, technical skills and knowledge to cope up with medical sociology.
- CLO3:** To apply statistical & field research knowledge on social mobility, classes & organization.
- CLO4:** To learn about the social systems, pattern of social relationship.
- CLO5:** To identify various types of culture, elements of culture and their appropriate application to the personal life.
- CLO6:** To socialize through family, religion and various educational institution & activities.
- CLO7:** To learn about the society, associate, Norms-values, social systems, sociology and yourself.

### Mapping Course Learning Outcomes (CLOs) with the PLOs

(CLOs)	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1		m								
CLO2		m								
CLO3		m								
CLO4		m								
CLO5		m								
CLO6		m								
CLO7		m								

(Note: "m" =matched)

**Mapping course learning Outcomes (CLOs) with the Teaching-Learning and Assessment strategy**

<b>CLOs</b>	<b>Teaching-Learning Strategy</b>	<b>Assessment Strategy</b>
CL01	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CL02	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CL03	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CL04	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CL05	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CL06	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CL07	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation

**YEAR-1, SEMESTER-2, COURSE-16**

<b>Course Code: MIC-MBBS-1204E</b>	<b>Course Title: Human Physiology</b>	<b>Credits: 03</b>
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**Rationale of the course:**

To explain pathogenesis of microbes affecting human's body parts, fundamentals about human body and its components is need to know.

**Course Objective:**

The main objective of the course is to introduce students with the knowledge of human body, its components with their functions

**Course Content:**

- 1. General physiology:** An introduction.
- 2. Blood and circulatory system:** composition, formation, destruction and function, blood coagulation, blood groups, tissue fluid, lymphatic system and lymph.

3. **Functions:** Respiratory system and respiratory stimulants, cardiovascular system, urinary system.
4. **Endocrinology:** Endocrine System and Glands of the Human Body; Structure, function and hormones of hypothalamus, pituitary gland, thyroid gland, Parathyroid Gland, Adrenal Glands, Pancreatic Islets, Pineal Gland, Thymus Gland, male and female Gonads; Diseases and Disorders of Endocrine System
5. **Reproductive system:** Structure and function of testis, Ovary, Uterus and Placenta.
6. **Body fluid:** Water and Electrolytes balance.
7. **Digestion and digestive system :** Mechanisms and control of the secretion and composition
8. **Digestive juices:** Digestion and absorption of food-stuffs.
9. **Nervous system:** Special sense. Central Nervous System - Brain and Spinal Cord; Peripheral Nervous System - Somatic neural system (SNS) and Autonomic neural system (ANS); Neuron and nerves.

**Course Learning Outcomes (CLOs)**

**CLO1:** To describe about human physiology.

**CLO2:** To explain blood cells, types and their functions.

**CLO3:** To discuss the roles of systems such as respiratory, digestive, cardiovascular system of human body.

**Mapping Course Learning Outcomes (CLOs) with the PLOs**

(CLOs)	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1	m		m							
CLO2			m							
CLO3			m							

(Note: "m" =matched)

**Mapping course learning Outcomes (CLOs) with the Teaching-Learning and Assessment strategy**

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO2	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO3	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation

## YEAR-1, SEMESTER-2, COURSE-17

**Course Code: MIC-1205**

**Course Title: Viva- voce**

**Credits: 01**

**Rationale of the course:** N/A

**Course Objective:**

The objective of the course is to enable students to demonstrate a firm understanding of all the courses of this semester, so that the examiners can have an opportunity to assess the students.

**Course content:** Topics of all the theoretical and practical courses of 2<sup>nd</sup> semester and other relevant matters will be included.

**Course Learning Outcomes:** N/A

**Mapping Course Learning Outcomes (CLOs) with the PLOs:** N/A

**Mapping course learning Outcomes (CLOs) with the Teaching-Learning and Assessment strategy:** N/A

## YEAR-2, SEMESTER-3, COURSE-18

**Course Code: MIC-2301**

**Course Title: Microbial Ecology**

**Credits: 2.0**

**Rationale of the course:**

To identify the roles of microbes in environment, it is fundamental to know how they survive in the environment or they interact with other microbes.

**Course Objective:**

The main objective of the course is to provide a framework for understanding the relationship between microorganisms and their habitats such as soil, water and air.

**Course Content:**

1. **Microbial ecology and ecosystems:** Fundamentals and importance of microbial ecology and Ecosystem.
2. **Microbial habitats and Niches:** Brief introduction to microorganisms in soil, water and air.
3. **Factors affecting microorganisms in nature:** Biotic and abiotic factors.
4. **Effect of abiotic factors on microorganisms:** Abiotic limitations to microbial growth, Leibig's Law of minimum, Shelford's low of tolerance.
5. **Effect of environmental determinants on microorganisms:** Temperature, Radiation, Pressure, Salinity, Water activity, air movement, pH, Redox potential, inorganic compounds.
6. **Interactions among populations:** Types, among microbial populations, microbial populations with plants and animal population.

**Course Learning Outcomes (CLOs):**

- CLO1:** To discuss brief history of microbial ecology.
- CLO2:** To explain the abiotic factors influencing microbial growth.
- CLO3:** To describe the factors, regulate interactions between microbes and the importance of these interactions in structuring microbial communities
- CLO4:** To discuss the environmental properties of soils, oceans.
- CLO5:** To explain the distribution and role of microorganisms in habitats such as air, water and soil.
- CLO6:** To describe the general principles of microbial ecology to role of microbes in disease.

**Mapping Course Learning Outcomes (CLOs) with the PLOs:**

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1			m	m						
CLO2			m							
CLO3			m	m						
CLO4				m						
CLO5				m						
CLO6	m			m						

(Note: m= matched)

**Mapping Course Learning Outcome (CLOs) with the Teaching-Learning Strategy & Assessment Strategy:**

CLOs	Teaching Learning Strategy	Assessment Strategy
CLO1	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO2	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO3	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO4	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO5	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO6	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation



## YEAR-2, SEMESTER-3, COURSE-19

<b>Course Code: MIC-2302 Course Title: Environmental Microbiology Credits: 2.0</b>
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### Rationale of the course:

A survey of modern microorganisms and their environmentally and geochemically significant activities is an important foundation for the course. The student's will also learn how metabolic processes catalyzed by microorganisms are related to major elemental cycles, biogeochemical processes, and organic contaminant degradation.

### Course Objective:

The principle objective of the course is to introduce students with the knowledge of interactions between microbes in an environment, isolation of environmentally important bacteria and involvement of microbes in the treatment of sewage.

### Course Content:

- 1. Biological Interactions:** Microbial Interaction - Interaction within a Single Microbial Population, Positive and Negative Interactions, Interaction among Diverse Microbial Populations; Types of Interactions - Neutralism, Commensalism, Synergism, Mutualism, Competition, Ammensalism, Parasitism and Predation; Microbe-Plant Interactions; Microbe-Animal Interactions.
- 2. Techniques for the Studying Environmental Microbes:** Sample Collection; Sample Processing; Detection of Microbial Populations; Determination of Microbial Number and Biomass; Measurement of Microbial Metabolism.
- 3. Microbiology of Potable Water:** Introduction to Indicator Organisms; Water-borne Pathogens; Isolation and Identification of Indicator Bacteria; Water-borne Pathogens.
- 4. Sanitation and Public Health Microbiology:** Water Supply; Safe Water; Potable Water; Concept of Sanitation and Hygiene; Disposal of Human Excreta and Refuse.
- 5. Novel Pollution Problem:** Xenobiotics and Recalcitrant Substances - Recalcitrant Halocarbons, Polychlorinated Biphenyls (PCBS), Alkyl Benzyl Sulfonates and Synthetic polymer; Persistence and Biomagnification of Xenobiotics; Biostimulation; Bioaugmentation.
- 6. Waste-Water:** Primary, secondary and tertiary treatment of waste water, biological treatment of anaerobic and aerobic; biochemistry and Microbiology of aerobic and anaerobic treatment, use of genetically engineered organisms. Emerging biotechnological processes in waste - water treatment, Bioremediation of contaminated ground water; Membrane technology in waste water treatment, Bioreactors for waste water treatment, treatment of typical industrial effluents: dairy, distillery, dye, and pharmaceutical industries
- 7. Effluent Treatment:** Solid waste treatment, characteristics of municipal, industrial and biomedical wastes; Aerobic and anaerobic methods, Physical and chemical treatment of solid waste, Composting and vermin-composting. Use of bacteria, fungi, plants, enzymes, an GE organism; Bioremediation of contaminated soils and waste land. Phytoremediation of

soil metals; Treatment for waste water from dairy, distillery, tannery, sugar and antibiotic industries.

**Course Learning Outcomes (CLOs):**

- CLO1:** To describe biological interactions between microorganisms and host.
- CLO2:** To list environmentally important microbes.
- CLO3:** To explain the treatment of water for human consumption and use.
- CLO4:** To describe the sewage disposal in the environment and roles of microorganisms in the treatment of sewage.
- CLO5:** To characterize diseases transmitted by polluted waters
- CLO6:** To conduct qualitative and quantitative analysis of water
- CLO7:** To discuss about xenobiotics, it's metabolism and biomagnification

**Mapping Course Learning Outcomes (CLOs) with the PLOs:**

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1			m							
CLO2	m									
CLO3				m						
CLO4				m						
CLO5				m						
CLO6				m						
CLO7		m	m					m		

(Note: m= matched)

**Mapping Course Learning Outcome (CLOs) with the Teaching-Learning Strategy & Assessment Strategy:**

CLOs	Teaching Learning Strategy	Assessment Strategy
CLO1	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO2	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO3	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation

CLO4	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO5	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO6	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO7	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation

### YEAR-2, SEMESTER-3, COURSE-20

<b>Course Code: MIC-2303 Course Title: Microbial Metabolism-I Credits: 2.0</b>
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#### Rationale of the course:

It is fundamental to know about metabolic reactions occurred inside the organisms, to prove the role of microbes in different anabolic or catabolic mechanisms.

#### Course Objective:

The main objective of the course is to provide a framework for understanding the concepts of microbial metabolism.

#### Course Content:

- 1. Concept of metabolism:** Catabolism and anabolism, important difference and relationships between these mechanisms.
- 2. Cell bioenergetics:** Free energy, energy production, energy coupling
- 3. Carbohydrate metabolism:** Different catabolic pathways, Embden-Meyerhof pathway, Hexose monophosphate shunt, Entner-Doudoroff pathway, TCA-cycle, glyoxalate cycle, methyl-glyoxal bypass, interlinkages of pathways.
- 4. Anapleurotic reactions:** Electron transport chain, oxidation reduction reaction, oxidative phosphorylation.
- 5. Pathways for utilization of sugars other than glucose:** Starch, galactose, maltose, sucrose, lactose, sorbitol, mannitol and aromatic compounds.
- 6. Catabolic activities of aerobic heterotrophs:** Degradation of polymers by exoenzymes.
- 7. Growth of microbes with organic acids:** Amino acid, aliphatic hydrocarbons, aromatic compounds, and chlorine compounds.

### Course Learning Outcomes (CLOs):

- CLO1:** To define metabolism and fundamental differences between anabolism and catabolism.
- CLO2:** To Describe major types of anabolism and their relationship to catabolism.
- CLO3:** To compare between aerobic and anaerobic respiration.
- CLO4:** To categorize organisms according to carbon source and mechanisms of carbohydrate catabolism and ATP generation.
- CLO5:** To describe glycolysis, Krebs cycle and their importance
- CLO6:** To describe catabolic activities of aerobic heterotrophs
- CLO7:** To explain growth of microbes with organic acids

### Mapping Course Learning Outcomes (CLOs) with the PLOs:

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1				m						
CLO2			m	m						
CLO3			m	m						
CLO4	m		m	m						
CLO5		m		m						
CLO6				m						
CLO7		m	m							

(Note: m= matched)

### Mapping Course Learning Outcome (CLOs) with the Teaching-Learning Strategy & Assessment Strategy:

CLOs	Teaching Learning Strategy	Assessment Strategy
CLO1	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO2	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO3	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO4	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO5	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback,	Class Test, Mid Term, Final Exam, Class attendance, Assignment,

	Assignment	Presentation
CL06	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CL07	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation

## YEAR- 2, SEMESTER-3, COURSE-21

<b>Course Code: MIC-2304</b>	<b>Course Title: Clinical Pathology</b>	<b>Credits: 2.0</b>
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### Rationale of the course:

The intended course is designed to correlate theoretical studies with practical tasks.

### Course Objective:

The main objective of the course is to educate students in lab tasks such as blood group determination, bleeding and clotting time determination, diagnosis of tuberculosis.

### Course Content:

1. **Theoretical aspects of different tests:** Blood for TC, DC, HB, ESR, BT, CT.
2. **Common tests in diagnostic Microbiology:** (a) Blood group and Rh factor, RBC fragility test. (b) Routine and culture sensitivity examination for urine (c) Routine examination and culture sensitivity of stool. (d) Acid- fast stains of sputum and other specimens. (e) Culture and sensitivity for pus, body fluid, eye and ear swabs samples. (f) Serological tests for diagnosis of infection (Widal, VDRL ASO titre) (g) Estimation of blood glucose, urea, creatinine, serum cholesterol.

### Course Learning Outcomes (CLOs):

**CLO1:** To determine blood group and Complete Blood Count of individuals.

**CLO2:** To determine hemoglobin content, bleeding time and clotting time.

**CLO3:** To conduct Microbiological examination of urine and stool samples.

**CLO4:** To diagnose tuberculosis (TB) via acid-fast staining.

**CLO5:** To diagnose typhoid, syphilis and streptococcal infection and diabetes.

**CLO6:** To determine lipid profile and kidney function.

### Mapping Course Learning Outcomes (CLOs) with the PLOs:

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CL01	m								m	m
CL02									m	m
CL03							m		m	m
CL04			m			m			m	m
CL05							m		m	m
CL06		m							m	m

(Note: m= matched)

## Mapping Course Learning Outcome (CLOs) with the Teaching-Learning Strategy & Assessment Strategy:

CLOs	Teaching Learning Strategy	Assessment Strategy
CL01	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CL02	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CL03	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CL04	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CL05	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CL06	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation

### YEAR-2, SEMESTER-3, COURSE-22

<b>Course Code: MIC-2305</b>	<b>Course Title: Practical</b>	<b>Credits: 2.0</b>
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#### Rationale of the course:

The intended course is designed to correlate theoretical studies with practical tasks.

#### Course Objective:

The main objective of the course is to educate students in lab tasks such as enumeration of microorganisms, effect of temperature, pH, O<sub>2</sub> on growth and control of microbial growth by physical and chemical agents.

#### Course Content:

- 1. Techniques of enumeration of microorganisms:** Direct and Indirect Techniques.
- 2. Nutritional and physical requirements:** Growth of microorganisms using differentials and selective media, effect of temperature, pH and oxygen on microbial growth.
- 3. Cultivation of aerobic bacteria:** Bacterial growth curve determination by viable counts and OD method.
- 4. Control of microbial growth by physical and chemical agents:** Heat (moist and dry), osmotic pressure, radiation.
- 5. Antimicrobial sensitivity test:** Qualitative, Kirby-Bauer antimicrobial sensitivity test, drug synergism, phenol co-efficient, macro-dilution broth procedure and agar dilution procedure.

**Course Learning Outcomes (CLOs):****CLO1:** To enumerate microorganisms by direct and indirect techniques.**CLO2:** To determine nutritional and physical requirements of growth.**CLO3:** To determine bacterial growth curve by viable count and od.**CLO4:** To describe the techniques employed to control microbial growth.**CLO5:** To determine antimicrobial sensitivity through disk diffusion method.**Mapping Course Learning Outcomes (CLOs) with the PLOs:**

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1	m								m	m
CLO2			m						m	m
CLO3			m						m	m
CLO4			m						m	m
CLO5			m						m	m

**(Note: m= matched)****Mapping Course Learning Outcome (CLOs) with the Teaching-Learning Strategy & Assessment Strategy:**

CLOs	Teaching Learning Strategy	Assessment Strategy
CLO1	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO2	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO3	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO4	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO5	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation

## YEAR-2, SEMESTER-3, COURSE-23

**Course Code: MIC-BUS-2301E Course Title: Mathematics and Statistics Credits: 2.0**

### Rationale of the course:

The course is designed to introduce statistical concepts associated with producing, presenting and interpreting data, develop skills in critical analysis and synthesis of statistical information and provide the opportunity to demonstrate student's statistical literacy skills.

### Course Objective:

The main objective of the course is to introduce students with the knowledge of extracting information from the data in order to better understand the situations that these data portray.

### Course Content:

#### Mathematics:

1. **Graphs and Gradients:** Rectangular Co-ordinates, curve fitting using first degree equation in both variables. Determination of slope, Intercept and points of intersection. Equation of first degree in both X and Y (circle), Ellipse, Rectangular hyperbola etc.
2. **Exponential and logarithmic** curves, graphical solution equation, graphical solution of simultaneous equation.
3. **Arithmetic progression**, geometric progression, Permutation, Combination the binomial theorem and exponential theorem.

#### Basic Statistics:

1. Introduction, Significant of digit and rounding of number, data collection, Sampling, Random and non- Random sampling, Sample size, Representative sample, Tabulation and graphical presentation of data, Measures of central tendency, Measures of dispersion, Standard deviation and standard error of mean, Coefficient of variation, Confidence limit, Probability and events, the normal, Binomial and poisson distribution, Kurtosis and skewness, Hypothesis testing.

### Course Learning Outcomes (CLOs):

- CLO1:** To Describe a concise and clear description of a statistical problem.
- CLO2:** To describe a method used for analysis, including a discussion of advantages, disadvantages, and necessary assumptions.
- CLO3:** To discuss and interpret the results a statistical analysis.
- CLO4:** To describe a derivation for mathematical statistics problems.

### Mapping Course Learning Outcomes (CLOs) with the PLOs:

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1				m						
CLO2				m						
CLO3				m						
CLO4				m						

(Note: m= matched)



## Mapping Course Learning Outcome (CLOs) with the Teaching-Learning Strategy & Assessment Strategy:

CLOs	Teaching Learning Strategy	Assessment Strategy
CL01	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CL02	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CL03	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CL04	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation

### YEAR-2, SEMESTER-3, COURSE-24

**Course Code: MIC-Pharm-2302E Course Title: General Chemistry Laboratory Credits: 2.0**

#### Rationale of the course:

To know the fundamental of chemistry and its reaction, it is necessary to conduct the experiments in laboratory to correlate with theoretical studies.

#### Course Objective:

The main objective of the course is to get familiar with experimental procedures conducted in a chemical laboratory.

#### Course Content:

- 1. Different experiments frequently practiced in chemical laboratory.**
- 2. Preparation of acid and bases:** Standardization of acids and bases using indicator and pH meter. Preparation of buffer solution of different pH and determination of  $pK_a$  and  $pK_b$  values. Determination of titration curves of acids and bases.
- 3. Qualitative and detection of organic compounds:** a) element test, b) functional group test, c) melting point determination.

#### Course Learning Outcomes (CLOs):

**CL01:** To describe the chemical reactions and strategies to balance them.

**CL02:** To measure the relative quantities of reactants and products.

**CL03:** To describe the fundamentals of acid base chemistry including pH calculation, buffer behavior and acid/base titration.

**CL04:** To explain Laboratory safety procedures.

**Mapping Course Learning Outcomes (CLOs) with the PLOs:**

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1	m	m								m
CLO2	m	m								m
CLO3	m	m								m
CLO4	m	m								m

(Note: m= matched)

**Mapping Course Learning Outcome (CLOs) with the Teaching-Learning Strategy & Assessment Strategy:**

CLOs	Teaching Learning Strategy	Assessment Strategy
CLO1	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO2	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO3	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO4	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation

**YEAR-2, SEMESTER-3, COURSE-25**

<b>Course Code: MIC-BMB-2303E</b>	<b>Course Title: Biochemistry-I</b>	<b>Credits: 2.0</b>
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**Rationale of the course:**

To understand the biosynthesis or degradation of biomolecules, fundamentals of biochemistry needs to know

**Objective:**

The main of objective of the course is to educate students a good understanding of the basic principles of biochemistry at the molecular and cellular levels.

**Course Content:**

- Brief introduction to biomolecules:** Carbohydrates, proteins, lipids.
- Carbohydrate metabolism:** Glycolysis, TCA cycle, gluconeogenesis, glycogenesis and glycogenolysis, uronic acid and sorbitol pathway, importance of pentose phosphate pathway, regulation of carbohydrate metabolism.

3. **Metabolism of Nitrogenous compound:** Nitrogen balance, biosynthesis of amino acids, catabolism of amino acids, conversion of amino acids to specialized products, assimilation of ammonia, urea cycle, metabolic disorder of amino acids-PKU, Parkinson's disease, Alkaptonuria.
4. **Lipids:** The chemistry of oxidation of fatty acids and energetic, biosynthesis of ketone bodies and their utilization, biosynthesis of saturated and unsaturated fatty acids, phospholipids and sphingolipids, control of lipid metabolism, essential fatty acids and eicosanoids (prostaglandin, thromboxane).

### Course Learning Outcomes (CLOs):

- CLO1:** To understand the major types of biochemical molecules found in the cells.  
**CLO2:** To mention the characteristics that makes these molecules indispensable for life.  
**CLO3:** To explain the importance of biochemistry in everyday life.  
**CLO4:** To describe the energy metabolism of cells.  
**CLO5:** To describe the metabolism of nitrogenous compounds and lipids.

### Mapping Course Learning Outcomes (CLOs) with the PLOs:

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1	m	m	m							
CLO2		m	m							
CLO3		m	m		m					
CLO4				m						
CLO5		m	m	m						

(Note: m= matched)

### Mapping Course Learning Outcome (CLOs) with the Teaching-Learning Strategy & Assessment Strategy:

CLOs	Teaching Learning Strategy	Assessment Strategy
CLO1	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO2	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO3	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO4	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback,	Class Test, Mid Term, Final Exam, Class attendance, Assignment,

	Assignment	Presentation
CL05	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation

### YEAR-2, SEMESTER-3, COURSE-26

<b>Course Code: MIC-2306</b>	<b>Course Title: Viva-Voce</b>	<b>Credits: 1.0</b>
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**Rationale of the course:** N/A

**Course Objective:**

The objective of the course is to enable students to demonstrate a firm understanding of all the courses of this semester, so that the examiners can have an opportunity to assess the students

**Course Content:**

Topics of all the theoretical and practical courses of 3<sup>rd</sup> semester and other relevant matters will be included.

**Course Learning Outcomes (CLOs):** N/A

**Mapping Course Learning Outcomes (CLOs) with the PLOs:** N/A

**Mapping Course Learning Outcome (CLOs) with the Teaching-Learning Strategy & Assessment Strategy:** N/A

### YEAR-2, SEMESTER-4, COURSE-27

<b>Course Code: MIC- 2401</b>	<b>Course Title: Virology-I</b>	<b>Credits: 2.0</b>
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**Rationale of the course:**

To prevent contracting viral diseases of human, animal and plant, it is prerequisite to know the structural and functional properties of the viral agent.

**Course Objective:**

The intended course is designed to educate students with the knowledge of virus, its classification, and cultivation, disease causing mechanism as well as treatment and prevention of these diseases.

**Course Content:**

- 1. Brief history and importance of Virology.**
- 2. Characteristics of Viruses:** Novel Properties of Viruses; Virophages and Their Interactions with Giant Viruses; Host Range and Cell or Tissue Tropism; Viral Transmission.

3. **Important terminology:** Phage, viroids, and prions.
4. **Basic Architecture of Virions:** Size range of viruses; General morphological types of capsids and virion structure; Viral nucleic acids and viral enzymes.
5. **Nomenclature and classification:** Bacteriophages, animal and plant viruses.
6. **Cultivation and quantification:** Bacteriophages, animal and plant viruses.
7. **Bacteriophages:** Genome organization and relocation of DNA and RNA bacteriophages, temperate and transposable phages
8. **Virus replication:** Replication and gene expression of DNA and RNA viruses
9. **Common viral diseases:** Plants, animals and humans
10. **Prevention and treatment of viral disease:** Immunity to viral diseases, interferon induction and action, antiviral agents and viral vaccines.

**Course Learning Outcomes (CLOs):**

- CLO1:** To describe history and importance of virology.  
**CLO2:** To describe morphological structure and chemical composition of virus.  
**CLO3:** To explain common methods used for cultivation of virus.  
**CLO4:** To discuss replication of DNA and RNA virus.  
**CLO5:** To explain viral diseases of plants, animal and human.  
**CLO6:** To describe prevention and treatment of viral diseases.

**Mapping Course Learning Outcomes (CLOs) with the PLOs:**

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1					m					
CLO2	m				m					
CLO3					m	m			m	m
CLO4				m						
CLO5				m	m	m	m			
CLO6					m	m				

(Note: m= matched)

**Mapping Course Learning Outcome (CLOs) with the Teaching-Learning Strategy & Assessment Strategy:**

CLOs	Teaching Learning Strategy	Assessment Strategy
CLO1	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO2	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO3	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation

CL04	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CL05	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CL06	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation

## YEAR-2, SEMESTER-4, COURSE-28

<b>Course Code: MIC- 2402    Course Title: Basic Microbial Genetics    Credits: 2.0</b>
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### Rationale of the Course:

The intended course is designed with the purpose of paving the way to make researchers in the field of molecular biology

### Course Objective:

The major objective of the course is to help students learning the basic concepts in genetics and apply this knowledge in practical field.

### Course Content:

- 1. Introduction to Genetics:** The Importance of Genetics; Divisions of Genetics; A Brief History of Genetics; Basic Concepts in Genetics.
- 2. Basic Principles of Heredity:** Mendel: The Father of Genetics: Mendel's Success; Monohybrid Crosses; Dihybrid Crosses; Applications of Mendel's Principles; Trihybrid Crosses; Genetic Terminology; Test Cross and Its Value.
- 3. Extensions of Mendelism and Modifications of Basic Principles:** Dominance Revisited; Multiple Alleles; Gene Interaction; Interaction Between Sex and Heredity; Interaction Between Genes and Environment.
- 4. Chromosomal Basis of Inheritance:** Chromosome Structure; Sex Chromosomes; Sex Determination; Dosage Compensation of X-linked Genes; Changes in Chromosome Number and Structure; Genetic Disorders associated with Chromosomal Aberrations.
- 5. Bacterial Transformation:** Overview of Transformation; Mechanisms of Transformation; Transformation Analysis; Principle of Estimation of Linkage; Mapping by Transformation.
- 6. Bacterial Conjugation:** Lederberg and Tatum's Experimental Design; Fertility Factor and Bacterial Conjugation; Mapping Genes by Conjugation Analysis; Molecular Mechanism of Bacterial Conjugation; Mechanism of DNA Transfer During Conjugation in Gram-Negative Bacteria; Sexduction in *E. coli*: F' Conjugation.
- 7. Bacterial Transduction:** Transduction Analysis of Gene Transfer in Bacteria; Mapping by Generalized Transduction Analysis; Specialized Transduction.

**8. DNA - The Chemical Nature of the Gene:** Characteristics of Genetic Material; The Molecular Basis of Heredity; The Structure of DNA: Genetic Implications of DNA Structure; Special Structures in DNA and RNA.

**Course Learning Outcomes (CLOs):**

**CLO1:** To describe about genetics, its importance and applications.

**CLO2:** To explain basic concepts on First & Second Law of Mendel.

**CLO3:** To know the extension & exception of Mendel's law.

**CLO4:** To explain the basics of semi conservative replication.

**CLO5:** To discuss the basics of bacterial transformation.

**CLO6:** To discuss the basics of bacterial Conjugation.

**CLO7:** To discuss the basics of bacterial Transduction.

**CLO8:** To have thorough knowledge of chromosome mapping.

**Mapping Course Learning Outcomes (CLOs) with the PLOs:**

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1					m	m	m			
CLO2					m	m		m		
CLO3						m		m		
CLO4					m	m		m		
CLO5					m	m		m		
CLO6					m	m		m		
CLO7										
CLO8					m	m		m		

(Note: m= matched)

**Mapping Course Learning Outcome (CLOs) with the Teaching-Learning Strategy & Assessment Strategy:**

CLOs	Teaching Learning Strategy	Assessment Strategy
CLO1	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO2	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO3	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO4	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation

CLO5	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO6	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO7	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO8	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation

### YEAR-2, SEMESTER-4, COURSE-29

<b>Course Code: MIC-2403   Course Title: Microbial Metabolism-II   Credits: 2.0</b>
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#### Rationale of the course:

The intended course is a continuation of the course named “Metabolism I” with the same purpose of discussing and explaining metabolic reactions inside the cell.

#### Course Objective:

The objective of the course is to provide a framework for understanding the concepts related to microbial metabolism.

#### Course Content:

1. **Membrane transport:** active, passive, facilitative and group translocation.
2. **Nitrogen Metabolism:** Biological nitrogen fixation process and Regulation.
3. **Inorganic Nitrogen Metabolism:** Assimilation of inorganic nitrogen.
4. **General reaction of amino acid:** Decarboxylases, deaminase, transaminases and recemases, the Stickland reaction.
5. **Biosynthesis of purines and pyridins** and their regulation lipid biosynthesis.
6. **Biosynthesis of fatty acids:** role of cofactors in fatty acid biosynthesis.
7. **Pathway to biosynthesis** of mevalonate, squalene and sterols.
8. **Autotrophic CO<sub>2</sub> Fixation:** mechanisms of photosynthesis in green, sulphur and cyanobacteria; physiological groups of aerobic chemolithotroph; hydrogen and CO oxidizers; ammonia, sulphur and ferrous ion oxidizers; facultative obligate chemolithotrophs.

#### Course Learning Outcomes (CLOs):

- CLO1:** To describe the membrane transport systems.  
**CLO2:** To explain nitrogen metabolism.  
**CLO3:** To describe inorganic nitrogen metabolism.  
**CLO4:** To discuss general reaction of amino acid.



- CLO5:** To describe biosynthesis of purines and pyridines.  
**CLO6:** To explain biosynthesis of fatty acid.  
**CLO7:** To write the pathway to biosynthesis of mevalonate, squalene and sterol.  
**CLO8:** To describe photosynthesis of photosynthetic bacteria.

**Mapping Course Learning Outcomes (CLOs) with the PLOs:**

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1			m	m						
CLO2		m		m						
CLO3			m	m						
CLO4		m	m	m						
CLO5		m	m	m						
CLO6		m	m	m						
CLO7		m		m						
CLO8		m		m		m				

(Note: m= matched)

**Mapping Course Learning Outcome (CLOs) with the Teaching-Learning Strategy & Assessment Strategy:**

CLOs	Teaching Learning Strategy	Assessment Strategy
CLO1	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO2	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO3	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO4	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO5	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO6	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO7	Lecture, Interactive discussion,	Class Test, Mid Term, Final Exam,

	Multimedia presentation, Brain storming, Feedback, Assignment	Class attendance, Assignment, Presentation
CLO8	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation

## YEAR-2, SEMESTER-4, COURSE-30

<b>Course Code: MIC- 2404</b>	<b>Course Title: Mycology</b>	<b>Credits: 2.0</b>
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### Rationale of the course:

To keep plants and crops free from fungal growth or contamination, the biology of fungi or its interaction with plants is fundamental to know.

### Course Objective:

The objective of the course is to introduce students with fungi, their morphology, classification, reproduction, metabolism and diseases caused by these fungi including their diagnosis.

### Course Content:

- 1. Introduction to the Fungi:** A brief history of mycology; What are fungi and organisms related to fungi
- 2. Morphological Characteristics of Fungi:** Structure of fungi; Characteristics of fungal organelles and function
- 3. Fungal Taxonomy:** Detailed description of major fungal subdivisions: Mastigomycotina, Zygomycotina, Basidiomycotina, Deuteromycotina, and Ascomycotina.
- 4. Fungal Reproduction:** Fungi genetics; Asexual and sexual reproduction; Growth and development of fungi; Life cycle of fungi.
- 5. Fungal Physiology and Metabolism:** Nutrition in fungi; Aerobic and anaerobic respiration in fungi.
- 6. Laboratory Methods in Mycology:** Collection and transportation of fungal samples; Storage and processing of samples for mycological studies; Media and growth requirements, Methods for microscopic examination; Colonial appearance and microscopic features, and Methods for laboratory identification.
- 7. Fungal Diseases in Man, Animals and Plants:** Medically important species; Fungal diseases in man – hypersensitivity, mycotoxicosis and mycoses; General aspects of fungal immunology and pathology; Antifungal therapeutic agents; Animal and plant pathogens
- 8. General Economic Importance of Fungi to Man and the Environment:** Fungal metabolites; Importance of fungi in agriculture (*e.g.*, mycorrhiza), food industry, medicine (pharmaceuticals), environment, and biotechnology.

**Course Learning Outcomes (CLOs):**

- CLO1:** To state general properties and classify fungi.  
**CLO2:** To describe morphology and reproduction of fungi.  
**CLO3:** To describe physiology and metabolism of fungi.  
**CLO4:** To explain fungal diseases in man, animals and plants.  
**CLO5:** To describe the laboratory methods to diagnose fungal infections.  
**CLO6:** To explain antifungal agents, their classes and modes of action.  
**CLO7:** To describe economic importance of fungi.

**Mapping Course Learning Outcomes (CLOs) with the PLOs:**

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1	m				m					
CLO2	m				m					
CLO3					m					
CLO4				m	m	m				
CLO5					m				m	m
CLO6			m		m					
CLO7			m		m	m	m	m		

(Note: m= matched)

**Mapping Course Learning Outcome (CLOs) with the Teaching-Learning Strategy & Assessment Strategy:**

CLOs	Teaching Learning Strategy	Assessment Strategy
CLO1	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO2	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO3	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO4	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO5	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO6	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback,	Class Test, Mid Term, Final Exam, Class attendance, Assignment,

	Assignment	Presentation
CL07	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation

## YEAR-2, SEMESTER-4, COURSE-31

<b>Course Code: MIC- 2405</b>	<b>Course Title: Food Microbiology-I</b>	<b>Credits: 2.0</b>
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### Rationale of the course:

To prevent food spoilage and preserve food up to a specified time, the interaction between food spoilage microorganism and foods needs to be understood.

### Course Objective:

The principle objective of the course is to equip students with knowledge of microorganisms present in food, their interaction and factors influencing growth as well as mechanisms of food spoilage and preservation.

### Course Content:

1. Introduction: microorganisms in food-historical developments, food fermentation Technology: origin, scope and development of fermented products, primary feed stock, raw materials and conversions, fermented food and microbial starters, commercial potential, food fermentation industries, their magnitude, R&D innovations.
2. **Beneficial and harmful aspects of microbes in food:** desired level and types of microbes in processed foods, undesired microbes interfering preparation, quality and often responsible for food borne disease.
3. **Factors influencing microbial growth in foods:** Temperature, pH,  $a_w$ , oxidation reduction potential, nutrient content, inhibitory substance and their structures, composition of food materials, combined effects of factors.
4. Food spoilage and preservation: general principle of spoilage, microbial toxins (endotoxins and exotoxins), contamination and preservation, factors affecting spoilage. Methods of food preservation (thermal processing, cold preservation, chemical preservatives & food dehydration); Role of radiations in food preservation, characteristics of radiation of interest in food preservation. Principles underlying the destruction of microorganisms by irradiation. Effect of irradiations on food constituents. Legal status of food irradiation.
5. **Biological controls and monitoring of food quality, packaging of food:** Need for packaging, requirements for packaging, containers for packaging (glass, metal, plastics, molded pulp and aluminium foil), dispensing devices..
6. **Determination of microorganisms:** Sampling, laboratory examination- microscopic and cultural.
7. **Preparation of some fermented foods:** Dairy products cheese, yogurt, cabbage, cucumber and other products, oriental fermented foods

**Course Learning Outcomes (CLOs):**

- CLO1:** To describe the interactions between microorganisms and the food environment and the history of food Microbiology.
- CLO2:** To describe the factors influencing microorganism's growth and survival.
- CLO3:** To describe the significance and activities of microorganisms in food.
- CLO4:** To describe the spoilage and preservation of food.
- CLO5:** To isolation of food spoilage microbes.
- CLO6:** To describe the biological control and monitoring of food.
- CLO7:** To prepare various fermented food.

**Mapping Course Learning Outcomes (CLOs) with the PLOs:**

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1	m			m						
CLO2	m			m						
CLO3				m		m				
CLO4				m					m	
CLO5				m	m					
CLO6				m	m					m
CLO7				m	m					

(Note: m= matched)

**Mapping Course Learning Outcome (CLOs) with the Teaching-Learning Strategy & Assessment Strategy:**

CLOs	Teaching Learning Strategy	Assessment Strategy
CLO1	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO2	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO3	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO4	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO5	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO6	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO7	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation

## YEAR-2, SEMESTER-4, COURSE-32

<b>Course Code: MIC- 2406</b>	<b>Course Title: Practical</b>	<b>Credits: 2.0</b>
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### Rationale of the course:

The intended course is designed to correlate theoretical studies with practical tasks.

### Course Objective:

The main objective of the course is to educate students in lab tasks such as quantitative and qualitative analysis of water and food.

### Course Content:

- 1. Microbiology of water:** Standard qualitative analysis of water, most probable number technique (MPN) and quantitative analysis of water by membrane filter method.
- 2. Microbiology of food:** Methylene blue reductase test, Microbiological analysis of milk and dairy products and other foods.
- 3. Fungal study:** Study of different fungal isolates-yeasts and molds, laboratory diagnosis of common fungal infection.
- 4. Analytical techniques:** Determination total carbohydrate by phenol sulphuric acid method, estimation of reducing sugar by Somogyi-Nelson method and dinitrosalicylic acid method, estimation of protein by Lowery method.

### Course Learning Outcomes (CLOs):

- CLO1:** To conduct quantitative and qualitative analysis of water.
- CLO2:** To conduct microbiological analysis of milk and dairy products.
- CLO3:** To enumerate coliform bacteria from food and water.
- CLO4:** To conduct enzymatic test to determine the quality of food sample.
- CLO5:** To describe the principles and commonly used methods to detect carbohydrate and protein from sample.
- CLO6:** To diagnose causative agents of fungal diseases.

### Mapping Course Learning Outcomes (CLOs) with the PLOs:

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1				m						
CLO2				m	m	m				
CLO3				m	m	m				
CLO4				m			m			
CLO5		m		m					m	m
CLO6			m		m				m	
CLO7										

(Note: m= matched)

**Mapping Course Learning Outcome (CLOs) with the Teaching-Learning Strategy & Assessment Strategy:**

<b>CLOs</b>	<b>Teaching Learning Strategy</b>	<b>Assessment Strategy</b>
CLO1	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO2	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO3	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO4	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO5	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO6	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO7	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation

**YEAR-2, SEMESTER-4, COURSE-33**

<b>Course Code: MIC-BUS-2401E</b>	<b>Course Title: Biostatistics</b>	<b>Credits: 2.0</b>
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**Rationale of the course:**

To introduce some statistical concepts associated with producing, presenting and interpreting data, to develop skills in critical analysis and synthesis of statistical information, to provide the opportunity to demonstrate your statistical literacy skills.

**Course Objective:**

The main objective of the course is to introduce students with the knowledge of extracting information from the data in order to better understand the situations that these data portray.

**Course Content:**

1. **Graphical and diagrammatic representation:** graphs and diagrams.
2. **Measures of central tendency:** Arithmetic mean, geometric mean, harmonic mean median and mode.
3. **Measures of dispersion:** range mean deviation, variance, co-efficient of variance, standard deviation. Moments, skew ness and kurtosis.
4. **Probability distribution:** Probability distribution definition and applications; Binominal distribution, Poisson distribution, Normal distribution, logic of statistical standard error estimation testing of hypothesis. Tests of significance: Null hypothesis, alternative hypothesis, type I error, type II error, level of significance, and power of test.
5. **The basic idea and significance test:** simple significance test based on the normal distribution, comparison with a known standard, comparison of means of two large samples.
6. **Regression analysis:** Basic idea of regression, calculation of regression coefficient, standard error and significance test. Partial correlation and multiple regression with two or more than two independent variances.
7. **Correlation and regression analysis:**
8. Tests for mean based on normal distribution, one sample t-test, two-sample t-test, paired-sample t-test, Chi-Squared test, and Tests for variance based on normal distribution – one sample and two-sample problem. One-way and Two-way analysis of variance (ANOVA) techniques. Correlation concept and applications, Spearman’s rank correlation coefficient, regression concept and applications.
9. **Introduction to factorial experiments:** Principle basic ideas, notation in  $2^n$  factorial, scope of more advanced designs.

**Course Learning Outcomes (CLOs):**

- CLO1:** To describe a concise and clear description of a statistical problem.
- CLO2:** To describe a method used for analysis, including a discussion of advantages, disadvantages, and necessary assumptions.
- CLO3:** To discuss and interpret the results a statistical analysis.
- CLO4:** To describe a derivation for mathematical

**Mapping Course Learning Outcomes (CLOs) with the PLOs:**

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1				m					m	
CLO2				m					m	
CLO3				m					m	
CLO4				m					m	

(Note: m= matched)



## Mapping Course Learning Outcome (CLOs) with the Teaching-Learning Strategy & Assessment Strategy:

CLOs	Teaching Learning Strategy	Assessment Strategy
CLO1	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO2	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO3	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO4	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation

### YEAR-2, SEMESTER-4, COURSE-34

<b>Course Code: MIC- 2402E</b> <b>Course Title: Biochemistry-II</b> <b>Credits: 2.0</b>
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#### Rationale of the Course:

The course is designed to understand the basics of Biochemistry through the study of its origin to the future, the chemistry of nucleic acids, fundamental processes, and utilizing various techniques used to perform biological works and producing researchers in the field.

#### Course Objective:

The principal aim of the course is to introduce students to the genetic materials, the central dogma and various techniques used in the field, and their applications to change the future of the biological world.

#### Course Content:

- 1. Fundamentals of molecular biology:** Gene, genome, genotype, phenotype and nucleic acid (DNA, RNA).
- 2. Nitrogenous bases:** Purine biosynthesis, purine nucleotide interconversion, pyrimidine biosynthesis and formation of deoxyriboneucleotides.
- 3. Biosynthesis of nucleic acids:** Brief introduction to the genetic organization of mammalian genome (chromosome packaging), alteration and rearrangements of genetics materials/ chromosomal anomaly.
- 4. Gene Expression:** Central dogma of molecular biology, biosynthesis of DNA and its replication, DNA repair mechanism, transcription.

**5. Genetic code and protein synthesis:** Genetic code, components of protein synthesis and inhibitors of gene expression.

**Course Learning Outcomes (CLOs):**

- CLO1:** To know about gene, genomics and nucleic acids.
- CLO2:** To explain the biosynthesis of nucleic acids and bases.
- CLO3:** To discuss about the organization of genetic material.
- CLO4:** To describe the replication of gene.
- CLO5:** To know the expression of gene.

**Mapping Course Learning Outcomes (CLOs) with the PLOs:**

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1		m	m		m	m				
CLO2			m		m	m				
CLO3					m	m				
CLO4					m	m		m		
CLO4					m			m		

(Note: m= matched)

**Mapping Course Learning Outcome (CLOs) with the Teaching-Learning Strategy & Assessment Strategy:**

CLOs	Teaching Learning Strategy	Assessment Strategy
CLO1	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO2	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO3	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO4	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO5	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation

## YEAR-2, SEMESTER-4, COURSE-35

**Course Code: MIC-2407**

**Course Title: Viva-Voce**

**Credits: 1.0**

**Rationale of the Course:** N/A

**Course Objective:**

The objective of the course is to enable students to demonstrate a firm understanding of all the courses of this semester, so that the examiners can have an opportunity to assess the students

**Course Content:**

Topics of all the theoretical and practical courses of 4<sup>th</sup> semester and other relevant matters will be included.

**Course Learning Outcomes (CLOs):** N/A

**Mapping Course Learning Outcomes (CLOs) with the PLOs:** N/A

**Mapping Course Learning Outcome (CLOs) with the Teaching-Learning Strategy & Assessment Strategy:** N/A

## YEAR-3, SEMESTER-5, COURSE-36

**Course Code: MIC-3501**

**Course Title: Virology-II**

**Credits: 3.0CH**

**Rationale of the course:**

The intended course is a continuation of the course named “virology I” with the purpose of elaborating the pathogenesis of viruses in respiratory, gastrointestinal and nervous system.

**Course Objectives:**

The objective of the intended course is to equip students with the knowledge of detailed information of viral agents including their pathogenesis, virulence factors and evading mechanisms.

**Course content:**

1. **Overview of animal viruses:** different classes of plant, animal and human viruses.
2. **Viral infection of respiratory tract:** Pathogenesis, Epidemiology and transmission of common cold, influenza, measles, mumps, rubella, chicken pox and shingles.
3. **Viral infection of gastrointestinal tract:** Rota virus, Norovirus, Adenovirus, Sapovirus and Aichi virus.
4. **Viral infection of central nervous system (CNS) :** Rabies, Nipa, Madcow disease, Japanese encephalitis
5. **Emerging and specially emphasized Viruses:** Ebola virus, Nipah Virus, Dengue virus, Yellow fever virus, Japanese encephalitis virus, Rabies, Madcow and Zika virus.
6. **Hepatitis Virus:** Types of Hepatitis Virus, Hepatitis B Virus’s structure; genome organization; replication; pathogenesis; epidemiology; transmission; prevention and diagnosis.

7. **Influenza Viruses:** general properties; antigenic shift and drift; pathogenesis; epidemiology.
8. **DNA oncogenic viruses:** EBV-structure and disease production, tumor suppressor gene.
9. **RNA oncogenic viruses:** HTLV-genome structure and replication, T-cell transformation.
10. **Non-oncogenic retrovirus:** HIV-structure, genome organization, transmission and epidemiology, disease pathogenicity, treatment and vaccine approaches.
11. **Uses of retroviruses:** gene therapy and genetic engineering.

**Course Learning Outcome (CLOs):**

- CLO1:** To describe different viral disease of plant, animal and human.
- CLO2:** To explain pathogenesis, mode of transmission and epidemiology of viral diseases.
- CLO3:** To describe viral diseases affecting different system of the body such as respiratory system, digestive system, nervous system etc.
- CLO4:** To discuss newly emerging viral diseases causing recent outbreak.
- CLO5:** Explain pathogenesis, mode of transmission, replication strategy of oncogenic viruses and non- oncogenic viruses.
- CLO6:** Describe uses of retroviruses in different aspects of biomedical sciences.

**Mapping Course Learning Outcomes (CLOs) with the PLOs**

CLOs	PL01	PL02	PL03	PL04	PL05	PL06	PL07	PL08	PL09	PL010
CLO1	m				m					
CLO2					m	m				
CLO3					m	m				
CLO4						m				
CLO5						m	m			
CLO6					m	m				

(Note: "m" = matched)

**Mapping course learning Outcomes (CLOs) with the Teaching-Learning and Assessment strategy**

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO2	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO3	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation

CLO4	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO5	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO6	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation

### YEAR-3, SEMESTER-5, COURSE-37

<b>Course Code: MIC-3502</b>	<b>Course Title: Molecular Genetics</b>	<b>Credits: 3.0</b>
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#### Rationale of the course:

The course is designed as an essential building block for students with a desire to have a complete understanding of cell biology at the molecular level.

#### Course Objectives:

The principle aim of the course is to equip students with a basic knowledge of the structural and functional properties of hereditary materials.

#### Course content:

- 1. Introduction to Molecular Genetics:** Characteristics of Genetic Material; The Importance of Genetics; Divisions of Genetics; The Rise of Modern Genetics; Twentieth-Century Genetics; The Future of Genetics; The Central Dogma of Molecular Biology.
- 2. DNA Replication:** The Central Problem of Replication; Semiconservative Replication; Modes of Replication; Requirements of Replication; Direction of Replication; The Mechanism of Replication of Bacterial DNA; Mechanism of Replication of Eukaryotic DNA; Replication in Archaea.
- 3. RNA Molecules:** The Chemical Nature of RNAs; Classes of RNAs; Structure of mRNA, tRNA and rRNA; Noncoding Intervening Sequences or Introns; Alternative Processing Pathways.
- 4. Transcription and Post-Transcriptional Modification:** Transcription of RNA from DNA; The Process of Bacterial Transcription; The Process of Eukaryotic Transcription; Post-Transcriptional Processing of mRNA, tRNA and rRNA.
- 5. The Process of Translation:** The Genetic Code; Stages of Translation Process; The Overall Process of Protein Synthesis; RNA-RNA Interactions in Translation; Polyribosomes; The Posttranslational Modifications of Proteins; Translation and Antibiotics.
- 6. Control of Gene Expression in Prokaryotes:** General Principles of Gene Regulation; Genes and Regulatory Elements; Gene Regulation in Bacterial Cells; Operon Structure; Negative

and Positive Control; Inducible and Repressible Operons; The Lac Operon of *E. coli*; Catabolite Repression; The Trp Operon of *E. coli*.

7. **Gene Mutations and Repair Mechanisms:** Introduction; Classification of Mutation; Genotypic Effects of Mutations; Phenotypic Effects of Mutations: Mutation Rates; Causes of Mutations; Molecular Mechanisms of Mutations. DNA Repair Mechanisms.

**CL01:** To describe important historical developments in genetics, particularly the contributions of Mendel and Watson & Crick.

**CL02:** To describe structure and functions of different species of RNA molecules.

**CL03:** To discuss transcription of genes and the structural and functional features of the transcripts.

**CL04:** To describe genetic code and the translation of the genetic message.

**CL05:** To explain basic concept of regulation of gene expression in bacteria.

**CL06:** To state mutation, its types and importance.

### Mapping Course Learning Outcomes (CLOs) with the PLOs

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CL01					m	m				
CL02					m	m				
CL03					m	m				
CL04					m		m	m		
CL05					m	m		m		
CL06					m			m		

(Note: "m" = matched)

### Mapping course learning Outcomes (CLOs) with the Teaching-Learning and Assessment strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CL01	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CL02	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CL03	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CL04	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation

CL05	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CL06	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation

### YEAR-3, SEMESTER-5, COURSE-38

<b>Course Code: MIC-3503</b>	<b>Course Title: Agriculture Microbiology</b>	<b>Credits: 2.0</b>
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#### Rationale of the course:

To keep soil fertile for planting crops and prevent plant diseases from contracting, the Microbiology of soil, reactions within the bio-geochemical cycles and relationship between host and plant are fundamental to know.

#### Course Objectives:

The major objective of the study is to equip students with the knowledge of soil microorganism and their interaction within soil, biofertilizers and biopesticides so that environmental pollution or plant diseases can be prevented or lessened.

#### Course content:

- 1. Introduction and Historical Developments in Agricultural Microbiology:** Contributions of Beijerinck, Winogradsky, Fleming and Waksman.
- 2. Distribution and Importance of Soil Microorganisms:** Factors influencing the activities of soil microorganisms.
- 3. Carbon cycle:** Role of soil microorganisms in the decomposition of organic matter; Importance of C: N ratio; Humus formation.
- 4. Nitrogen cycle:** Mineralization; Ammonification; Nitrification and denitrification.
- 5. Biological Nitrogen Fixation:** Symbiotic and non-symbiotic microorganisms
- 6. Microbial Transformation of Phosphorus:** Rhizosphere and its importance; RS ratio.
- 7. Interrelationship between Microorganisms:** Beneficial and harmful relationships; Mycorrhizae; Phosphobacteria.
- 8. Biofertilizers:** *Rhizobium*, *Azospirillum*, *Azotobacter*, *Gluconacetobacter* and *Azorhizobium*, Cyanobacteria, *Azolla* – PGPR; Mass production of biofertilizers and quality control; Bioconversion of agricultural wastes for compost making.
- 9. Important Diseases of Crop Plants and Their Management:** Pest and disease management; Chemical pesticides; microbiological control of plant pathogens.

**Course Learning Outcome (CLOs):****CLO1:** To describe agricultural Microbiology, its importance and development.**CLO2:** State economically important soil microorganism and factors influencing their activities.**CLO3:** To describe biogeochemical cycles and their importance.**CLO4:** To explain biological nitrogen fixation, its mechanism and importance.**CLO5:** To describe microbial transformation of phosphorous by Rhizosphere.**CLO6:** To describe symbiotic relationship between fungi and plants.**CLO7:** To describe bio-fertilizers and bio-pesticides, types and advantages and Disadvantages.**Mapping Course Learning Outcomes (CLOs) with the PLOs**

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1				m		m				
CLO2	m			m		m				
CLO3		m		m						
CLO4		m		m						
CLO5				m		m				
CLO6			m		m					
CLO7		m		m		m				

**(Note: "m" = matched)****Mapping course learning Outcomes (CLOs) with the Teaching-Learning and Assessment strategy**

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO2	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO3	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO4	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO5	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO6	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO7	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation



## YEAR-3, SEMESTER-5, COURSE-39

<b>Course Code: MIC-3504</b> <b>Course Title: Fermentation Technology</b> <b>Credits: 2.0</b>
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### Rationale of the course:

The course is designed to provide an understanding of the fundamentals and basic principles of fermentation technology and industrial Microbiology.

### Course Objectives:

The principle aim of the course is to provide students with an advanced understanding of the concepts and applications of how industrial microorganisms are used to produce valuable products.

### Course content:

- 1. Introduction to Fermentation Processes:** Historical Highlights of Fermentation Processes; Typical Operations of a Fermentation Process; Fermentation Methods; Types of Fermentation Products.
- 2. Industrially Important Microorganisms:** Fermentation Products and Producers; Isolation of Suitable Microorganisms from the Environment; Culture Collections; Industrial Strains and Strain Improvement; Strain Stability.
- 3. The Development of Inocula for Industrial Fermentations:** Choice of Inoculum Culture Medium; Quantity of Inoculum; Inoculum-Development Programme; Criteria for the Transfer of Inoculum; Development of Inocula for Yeast, Bacterial and Mycelial Processes; The Aseptic Inoculation of Plant Fermenters.
- 4. Media for Industrial Fermentations:** Establish the Most Suitable Fermentation Medium; Medium Formulation; Medium Ingredients; Addition of Precursors and Metabolic Regulators to Media; Oxygen Requirements; Foaming and Antifoams.
- 5. Sterilization Methods:** Consequences Arises Due to Contamination; Expressions of Resistance; Sterility Assurance Level (SAL); Sterilization Considerations; Types of Reaction Contribute to the Loss of Nutrient Quality During Sterilization; The Methods of Batch Sterilization; The Methods of Continuous Sterilization; Sterilization Methods.
- 6. Fermentation Systems:** Brief History; Basis Function of a Fermenter for Microbial Culture; Fermenter Design and Construction; Aseptic Operation and Containment; Control of Chemical and Physical Conditions; Fermenter Control and Monitoring; Operating Modes of Industrial Fermentations; Solid-Substrate Fermentations; Fermentation Process Development.
- 7. Instrumentation and Control of Fermentation:** Methods of measuring process variables – Temperature, Flow measurement and control, Pressure measurement, Pressure control Safety valves, Agitator shaft power, Rate of stirring, Foam sensing and control, Weight, Microbial biomass, Measurement and control of dissolved oxygen, Inlet and exit-gas analysis, pH measurement and control, Redox, Carbon dioxide electrodes; On-line analysis of other chemical factors; Control systems; Combinations of methods of control; Computer applications in fermentation technology.

**8. Downstream Processing:** Upstream vs. Downstream Processing; Factors Influencing the Downstream Processing; Unit Processes in Downstream Processing; Cell Harvesting; Cell Disruption; Product Recovery; Distillation; Finishing Steps; Inclusion Bodies and the Role of Genetic Engineering in Downstream Processing.

**Course Learning Outcome (CLOs):**

**CL01:** To describe overview of fermentation technology

**CL02:** To explain use of microorganisms in fermentation technology

**CL03:** To isolate, identify and maintain industrially important microorganisms

**CL04:** To describe fermentation media, it's formulation

**CL05:** To explain sterilization and types of sterilization methods

**CL06:** To state fermenter, its function, types, importance and control

**CL07:** To describe downstream processing

**Mapping Course Learning Outcomes (CLOs) with the PLOs**

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CL01				m		m				
CL02					m	m				
CL03					m	m				
CL04						m				
CL05	m					m				
CL06						m				
CL07						m				

(Note: "m" = matched)

**Mapping course learning Outcomes (CLOs) with the Teaching-Learning and Assessment strategy**

CLOs	Teaching-Learning Strategy	Assessment Strategy
CL01	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CL02	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CL03	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CL04	Lecture, Interactive discussion, Multimedia presentation, Brain	Class Test, Mid Term, Final Exam, Class attendance, Assignment,

	storming, Feedback, Assignment	Presentation
CLO5	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO6	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO7	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation

### YEAR-3, SEMESTER-5, COURSE-40

<b>Course Code: MIC-3505</b>	<b>Course Title: Food Microbiology- II</b>	<b>Credits: 2.0</b>
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#### Rationale of the course:

To prevent food spoilage and food-poisoning contracting from the ingestion of spoiled foods, it is fundamental to know the reasons behind food spoilage and disease-causing mechanisms of these spoilage microorganisms.

#### Course Objectives:

The main objective of this course is to introduce students with food borne diseases, their causative agents, virulence factors, pathogenesis, treatment, prevention and diagnosis.

#### Course content:

- 1. Microbial ecology of foods:** Essential and perspective, food-borne infection and intoxication, recent trends and forecast for the future.
- 2. Introduction to microorganisms:** Molds, yeasts, bacteria.
- 3. Microbes responsible for food borne diseases (Gram-positive aerobes):** *Bacillus cereus*, *Staphylococcus aureus*, *Listeria monocytogenes*.
- 4. Microbes responsible for food borne disease (Gram-positive anaerobes):** *Clostridium botulinum*, *Clostridium perfringens*.
- 5. Microbes responsible for food borne disease (Gram-negative aerobes):** *Vibrio parahaemolyticus*, *Escherichia coli*, *Plessiomonus shigelloides*.
- 6. Food poisoning:** Salmonella infection, new or less common food-borne infections and intoxication's – *Campylobacter* enteritis, mycotoxin contamination.
- 7. Fish poisoning:** Microbial spoilage of fish, ciguatera poisoning and gastro-enteritis of viral or unknown antilogy, hepatitis.
- 8. Mechanisms of action of food preservation procedures:** Water-relation of cell to low  $a_w$ , mechanism of vegetative cell resistance to low pH values, mechanism of action of preservatives.

- 9. Combating food poisoning:** Factors important for outbreaks of food poisoning, economic impact of food poisoning/ contamination, methods for detection food poisoning toxins, food and sanitation-control and inspection.

**Course Learning Outcome (CLOs):**

- CLO1:** To differentiate food-borne infections and food-borne intoxications.
- CLO2:** To discuss food- borne pathogens, their virulence factors, and disease causing mechanisms, symptoms, treatment and diagnosis.
- CLO3:** To investigate the food-borne disease outbreak; discuss the factors contributing to outbreak and its economic impact.
- CLO4:** To detect food- poisoning microorganisms and their toxins.
- CLO5:** To discuss food plant sanitation, control and inspection.
- CLO6:** To describe fish spoilage, factors affecting spoilage and spoilage causing bacteria.
- CLO7:** To discuss how genetically modified crops can be created.

**Mapping Course Learning Outcomes (CLOs) with the PLOs**

CLOs	PL01	PL02	PL03	PL04	PL05	PL06	PL07	PL08	PL09	PL010
CLO1					m	m				
CLO2	m		m		m					
CLO3				m	m	m				
CLO4					m	m				
CLO5					m					
CLO6			m		m	m				
CLO7					m	m		m		

(Note: "m" = matched)

**Mapping course learning Outcomes (CLOs) with the Teaching-Learning and Assessment strategy**

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO2	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO3	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation

CLO4	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO5	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO6	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO7	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation

### YEAR-3, SEMESTER-5, COURSE-41

<b>Course Code: MIC-3506</b>	<b>Course Title: Practical</b>	<b>Credits: 2.0</b>
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#### Rationale of the course:

The intended course is designed to correlate theoretical studies with practical tasks.

#### Course Objectives:

The main objective of the course is to educate students in lab tasks such as determining polymer degrading activity of microorganisms, isolation and cultivation of pathogen from samples like stool, urine and determination of sensitivity of these pathogens to antibiotics.

#### Course content:

- 1. Relationship of free oxygen to microbial growth:** Anaerobic culture of bacteria.
- 2. Degradation of polymer by exoenzyme:** Amylase, protease.
- 3. Effect of antimicrobials on growth:** Action of antiseptics, disinfectants, UV light and photo reactivation.
- 4. Isolation, identification, and antibiotic sensitivity of pathogens:** Stool, urine, pus, blood, samples.
- 5. Preparation of cell products:** Preparation bacterial whole cell extract, preparation of outer membrane protein.
- 6. Examination and observation:** Virus infected plants, animals and humans.
- 7. Cultivation and enumeration of bacteriophages:** Methods, isolation of bacteriophages from raw sewage, detection of virus from patient's serum by serological methods.
- 8. Immunological experiments:** Collection of serum and plasma, separation of blood leucocytes.

**Course Learning Outcome (CLOs):**

- CLO1:** To explain techniques to isolate anaerobic bacteria.  
**CLO2:** To isolate polymer degrading bacteria.  
**CLO3:** To analyze the action of antimicrobials on microbial growth.  
**CLO4:** To isolate, identify and determine antibiotic sensitivity of pathogens from stool, urine, blood etc.  
**CLO5:** To isolate and Identify transformants.  
**CLO6:** To identify and isolate virus from infected plants, animals and humans.  
**CLO7:** To isolate and cultivate bacteriophages from raw sewage.  
**CLO8:** To separate Serum and plasma from blood.

**Mapping Course Learning Outcomes (CLOs) with the PLOs**

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1	m									m
CLO2	m								m	m
CLO3			m							m
CLO4	m		m						m	m
CLO5					m					m
CLO6				m	m				m	m
CLO7	m				m					m
CLO8			m						m	m

(Note: "m" = matched)

**Mapping course learning Outcomes (CLOs) with the Teaching-Learning and Assessment strategy**

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO2	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO3	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO4	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO5	Lecture, Interactive discussion, Multimedia presentation, Brain storming,	Class Test, Mid Term, Final Exam, Class attendance, Assignment,

	Feedback, Assignment	Presentation
CLO6	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO7	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO8	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation

### **YEAR-3, SEMESTER-5, COURSE-42**

<b>Course Code: MIC-CSE-3501E   Course Title: Computer Data Analysis   Credits: 2.0</b>
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**Rationale of the course:**

The desired course is planned as a building block for students who have an aim to introduce their occupation with computer basic knowledge.

**Course Objectives:**

The main objective of the course is to educate students in lab tasks such as determining polymer degrading activity of microorganisms, isolation and cultivation of pathogen from samples like stool, urine and determination of sensitivity of these pathogens to antibiotics.

**Course content:**

1. Hardware and Software
2. Computer Components
3. Microsoft Office Power-point
4. Microsoft Office Excel
5. Microsoft Office Word
6. Input Devices
7. Output Devices
8. Hard Disk, RAM, ROM
9. Computer Components
10. Transmission Media
11. Different Browsers
12. E-mail

**Course Learning Outcome (CLOs):****CLO-1:** An ability to know about different hardware and software**CLO-2:** An ability to operate computer**CLO-3:** An ability to design power-point slide**CLO-4:** An ability to calculate different mathematical functions on Microsoft office excel**CLO-5:** An ability to writes CV and documents**Mapping Course Learning Outcomes (CLOs) with the PLOs**

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1				m						m
CLO2				m						m
CLO3				m						m
CLO4				m						m
CLO5				m						m

**(Note: "m" = matched)****Mapping course learning Outcomes (CLOs) with the Teaching-Learning and Assessment strategy**

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO2	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO3	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO4	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO5	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation



## YEAR-2, SEMESTER-5, COURSE-43

**Course Code: MIC-3507**

**Course Title: Viva-voce**

**Credits: 1.0**

**Rationale of the course: N/A**

**Course content:**

Topics of all the theoretical and practical courses of 5<sup>th</sup> semester and other relevant matters will be included.

**Objective:**

The objective of the course is to enable students to demonstrate a firm understanding of all the courses of this semester, so that the examiners can have an opportunity to assess the students.

**Course Learning Outcome (CLOs): N/A**

**Course Learning Outcomes (CLOs and Mapping of CLOs with Program Learning Outcomes (PLOs): N/A**

**Mapping course learning Outcomes (CLOs) with the Teaching-Learning and Assessment strategy: N/A**

## YEAR-3, SEMESTER-6, COURSE-44

**Course Code: MIC-3601**

**Course Title: Immunology-I**

**Credits: 2.0**

**Rationale of the course:**

The study of immunology will enable the student to gain a broad foundation base and build upon that base for understanding the defense mechanisms of the human body. Such foundation will be germane both for advanced courses for the student entering in Microbiology or other medical science.

**Course Objectives:**

The overall learning objective for the course are: (1) to acquire a fundamental working knowledge of the basic principles of immunology (2) to begin to understand how these principles apply to the process of immune function and (3) to develop the ability to solve problems in clinical immunology

**Course content:**

1. **History and Introduction to Immunology:** History and development of immunology, introduction to immune system, basic concept of innate and adaptive immunity, cellular and humoral immunity.

2. **Non Specific immunity:** Mechanical barrier (Skin and mucous membrane), Chemical barrier, phagocytes and phagocytosis, development of phagocytic cell, microbial evasion of phagocytosis, inflammation, Complement system, Natural Killer Cell, Moderate fever.
3. **Specific immunity:** To intracellular and extracellular bacteria, parasitic infection.
4. **Lymphoid Systems:** Primary and secondary lymphoid tissues, primary lymphoid organs, secondary lymphoid organs and tissues.
5. **Cell involved in Immune Response:** General features and functions of lymphoid cells, mononuclear phagocytes, antigen presenting cells, polymorphs, mast cell, platelets.
6. **Antigens:** General properties of antigens, antigenic determinants, haptens.
7. **Membrane Receptors for Antigens:** B cell surface receptors for antigens, T cell receptors (TCR major histocompatibility complex (MHC), antigens structure, functions of MHC class I and MHC class II molecules, gene map of MHC antigens, processing and presentation of peptides by MHC molecules, antigen recognition, antigen-antibody interaction, forces of antigen-antibody binding, haplotype restriction of T cell reactivity.
8. **Lymphocyte activation:** Interaction of T lymphocytes and APC, signals for T cell activation cell response to thymus dependent and -independent antigens, B cell activation by surface Ig and T cell.
9. **Immunoglobulin:** Basic structure and function of immunoglobulin, classes and subclasses, physiological properties, distribution and functions of different classes and subclasses of immunoglobulin, memory B cell, genetic basis of antibody heterogeneity, antibody class switching.
10. **Results of antigen-antibody binding:** Opsonization, neutralization, activation of complement, inflammation, agglutination and antibody-dependent cell-mediated cytotoxicity.
11. **Immunological techniques:** Precipitation, agglutination, enzyme link immunosorbent assay (ELISA), radio-immunoassay (RIA), immunoelectrophoresis, immunoblotting, immunofluorescence and activated cell sorter. (FACS)
12. **Monoclonal Antibody:** production of hybridoma, screening, cloning and large-scale production of monoclonal antibodies.

#### **Course Learning Outcome (CLOs):**

- CLO1.** To differentiate between innate and adaptive immunity.
- CLO2.** To describe the specific and non-specific immunity.
- CLO3.** To explain the mechanisms and differences between primary and secondary responses and their relevance to immunizations.
- CLO4.** To identify the role of different cells involved in immune response.
- CLO5.** To differentiate between humoral and cell mediated immunity
- CLO6.** To explain general concepts on antigen and haptens
- CLO7.** To describe the role of MHC molecules and activation of cells associated with immune response
- CLO8.** To explain consequences of antigen and antibody reactions

### Mapping Course Learning Outcomes (CLOs) with the PLOs

CLOs	PL01	PL02	PL03	PL04	PL05	PL06	PL07	PL08	PL09	PL010
CLO1							m			m
CLO2							m			m
CLO3							m			m
CLO4							m			m
CLO5							m			
CLO6							m			
CLO7							m			
CLO8							m			

(Note: "m" = matched)

### Mapping course learning Outcomes (CLOs) with the Teaching-Learning and Assessment strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO2	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO3	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO4	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO5	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO6	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO7	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO8	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation

## YEAR-3, SEMESTER-6, COURSE-45

<b>Course Code: MIC-3602</b>	<b>Course Title: Medical Microbiology-I</b>	<b>Credits: 2.0</b>
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### Rationale of the course:

To prevent infectious diseases contracting from pathogens, it is fundamental to study the interaction between host and microorganisms, their virulence factors and the defenses imparted by the host.

### Course Objectives:

The intended course is designed to equip students with the knowledge of disease-causing microbes, their pathogenesis, transmission and reservoirs.

### Course content:

- 1. Microbe-Human Interactions:** Infection and Disease; The Human Host – The Host-Parasite Relationship; The Normal Flora - Acquiring Resident Flora, Initial Colonization of the Newborn and Indigenous Flora of Specific Regions; Studies with Germ-free Animals.
- 2. The Progress of an Infection:** An Overview of the Events in Infection; The Portal of Entry; The Size of the Inoculum; Mechanisms of Invasion and Establishment of the Pathogen - How Pathogens Attach, How Virulence Factors Contribute to Tissue Damage, Establishment, Spread, and Pathologic Effects; Signs and Symptoms of Diseases; The Portal of Exit; The Persistence of Microbes and Pathogenic Conditions.
- 3. Factors Affecting the Course of Infection and Disease:** Pathogenicity and Virulence; Virulence Factors –Exoenzymes, Toxigenicity and Antiphagocytic Factors.
- 4. Effects on Target Organ/Spread of Infection:** Patterns of Infection - Incubation period, Prodromium, Period of invasion, Convalescent period; Type of Infections/Diseases – Localized, Systemic, Focal, Mixed, Primary, Secondary, Septicemia and bacteremia, Acute, Chronic and Subacute Infections
- 5. Epidemiology - The Study of Disease in Populations:** Tracking Disease in the Population; Epidemiologic Statistics - Frequency of Cases; Frequency of Disease - Endemic, Sporadic, Epidemic and Pandemic; Reservoirs and Sources of Infectious Agents - Living Reservoirs and Nonliving Reservoirs; Carrier; The Acquisition and Transmission of Infectious Agents - Patterns of Transmission in Communicable Diseases; Nosocomial Infections; Koch's Postulates to Determine Etiology.
- 6. The Nature of Host Defenses:** The Three Levels of Host Defenses; Immunity/Immunology; Circulatory System: Blood and Lymphatics; Functions of Leukocytes; Lymphatic System; Generalized Immune Reactions - Inflammatory Response and Phagocytosis; Important Chemical Defenses - Interferon (IFN) and Complement; Characteristics of Acquired Immunities - Immunocompetent individuals, Humoral Immunity and Cell-Mediated Immunity.
- 7. The Cocci of Medical Importance:** Gram-Positive Cocci - *Staphylococcus*; *Streptococcus* and *Enterococcus*; Gram-Negative Cocci – *Neisseria*.

8. **The Gram-Positive Bacilli of Medical Importance:** Endospore formers – *Bacillus* and *Clostridium*; Non-spore-forming Rods – *Listeria*, *Corynebacterium*, *Propionibacterium* and *Mycobacterium*; Diseases Caused by Actinomycetes - *Actinomyces* and *Nocardia*.
9. **The Gram-Negative Bacilli of Medical Importance:** Aerobic Rods – *Pseudomonas*, *Brucella*, *Francisella*, *Bordetella* and *Legionella*; Facultative Anaerobic Rods - *Escherichia*, *Klebsiella*, *Enterobacter*, *Serratia*, and *Citrobacter*; Opportunists - *Proteus*, *Morganella* and *Providencia*; True Enteric pathogens *Salmonella* and *Shigella*; True Pathogens in *Yersinia*, *Pasteurella* and *Haemophilus* genera; Nonenteric Pathogens - *Pasteurella* and *Haemophilus*.

**Course Learning Outcome (CLOs):**

- CLO1.** To discuss interaction between microbes and humans and importance of normal flora.
- CLO2.** To explain entry and exit of pathogens, stages of a disease, virulence factors
- CLO3.** To discuss evading mechanisms of pathogens
- CLO4.** To classify diseases and infections
- CLO5.** To discuss epidemiology and its classification, disease transmission and its reservoirs
- CLO6.** To explain the host defenses exerted against pathogens
- CLO7.** To describe medically important bacteria

**Mapping Course Learning Outcomes (CLOs) with the PLOs**

CLOs	PL01	PL02	PL03	PL04	PL05	PL06	PL07	PL08	PL09	PL010
CLO1	m						m			
CLO2					m	m	m			
CLO3					m	m				
CLO4	m					m	m			
CLO5					m	m				
CLO6					m					
CLO7					m					

(Note: “m” = matched)

**Mapping course learning Outcomes (CLOs) with the Teaching-Learning and Assessment strategy**

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO2	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO3	Lecture, Interactive discussion,	Class Test, Mid Term, Final Exam,

	Multimedia presentation, Brain storming, Feedback, Assignment	Class attendance, Assignment, Presentation
CLO4	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO5	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO6	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO7	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation

### YEAR-3, SEMESTER-6, COURSE-46

<b>Course Code: MIC-3603</b>	<b>Course Title: Industrial Microbiology</b>	<b>Credits: 3.0</b>
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#### Rationale of the course:

This course is designed to enable graduates to enter industry with an appropriate level of understanding of the need for both the science and business aspects to be achievable to make a viable product.

#### Course Objectives:

The objective of the course is to educate students with the knowledge of industrially important microorganism, their isolation and utilization to make economically important products.

#### Course content:

1. **Industrial Microbiology:** Historical development, importance.
2. **Microorganisms and industry:** Types of microorganisms used in industry, types of industries using microorganisms, advantages of industrial use of microbes for large scale production.
3. **Major classes of products and processes:** Microbial cells, macromolecules, primary and secondary metabolites.
4. **Microorganisms of industrial importance:** Yeasts, molds, bacteria and actinomycetes.
5. **Screening and selection of microorganisms:** Microbial biotechnology in industry – a common outline for useful microbial products.
6. **Fermentation:** Types of fermentation, methods of ethanol fermentation, use of ethanol.
7. **Microbiological production processes of food and beverages:** alcohol, red wine, beer, amino acids (food additive), vinegar, breaker yeast, SCP, MBP, fermented sausage.

8. **Production of industrial chemicals and pharmaceuticals:** organic acid (acetic acid, citric acid, lactic acid), solvents (distilled spirits/alcohol, acetone, butanol), antibiotics, penicillin, sterols and enzymes).
9. **Control and management of microorganisms in foods and beverages:** Basic concept, desired and undesired levels of microbes in different foods and drinks, preservation of foods and drinks, use of microbes in foods and drinks, technique of maintenance of starter culture, stock culture maintenance.
10. **Important terminology:** bioreactor, upstream processing, down stream processing, biogas, anoxic decomposition.
11. **Microbes in mining:** Advantage of microbial process, brief explanation of microbial use, examples.
12. **Practical visit to industries:** Observation and evaluation of process control and microbial explanation of in prepared of foods from the view point of Microbiology.

#### Course Learning Outcome (CLOs):

**CLO1:** To describe the history and importance of industrial Microbiology.

**CLO2** To describe industrially important microbes, their merits and demerits.

**CLO3:** To discuss the contents of industrial process control.

**CLO4:** To explain the screening techniques to isolate industrial microorganisms.

**CLO5:** To describe the types of fermentation in industry.

**CLO6:** To describe the production process of food commodities, beverages, chemicals and pharmaceutical products.

**CLO7:** To explain control of the production processes.

#### Mapping Course Learning Outcomes (CLOs) with the PLOs

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CL01	m					m				
CL02					m	m				
CL03						m				
CL04	m					m				
CL05						m	m			
CL06						m	m		m	
CL07									m	

(Note: "m" = matched)

#### Mapping course learning Outcomes (CLOs) with the Teaching-Learning and Assessment strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CL01	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CL02	Lecture, Interactive discussion, Multimedia presentation, Brain storming,	Class Test, Mid Term, Final Exam, Class attendance,

	Feedback, Assignment	Assignment, Presentation
CL03	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CL04	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CL05	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CL06	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CL07	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation

### YEAR-3, SEMESTER-6, COURSE-47

<b>Course Code: MIC-3604</b>	<b>Course Title: Enzymology</b>	<b>Credits: 2.0</b>
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#### Rationale of the course:

This course is designed to enable graduates to enter industry with an appropriate level of understanding of the need for both the science and business aspects to be achievable to make a viable product.

#### Course Objectives:

The intended course is designed to introduce students with knowledge of enzymes, its properties, classification and catalytic mechanisms.

#### Course content:

- 1. Enzymes – The Basic Concept:** Enzymes as Biocatalysts; The Importance of Enzymes; Commercially Useful Enzymes; Characteristics of Enzyme-Catalyzed Reactions; How Enzymes Work; Nomenclature and Classification of Enzymes.
- 2. Protein Structure and Activity; Chemical Nature of Enzymes:** Protein Functions and Properties; Protein Structure; Protein Binding Sites; Chemical Nature of Enzymes; Enzymes and Chemical Energy.
- 3. The Control of Enzyme-Mediated Reactions and Bioenergetics:** Effect of temperature and pH; Cofactors and Coenzymes; Concentration of Enzyme and Substrate; Stimulatory and Inhibitory Effects; Metabolic Pathways; Bioenergetics.
- 4. The Mechanism of Enzyme Action:** Free-Energy Change of a Chemical Reaction; Free Energy is a Useful Thermodynamic Function for Understanding Enzymes; Principles that



Explain the Catalytic Power and Specificity of Enzymes; Catalysis Occurs at the Active Site; Specific Catalytic Groups Contribute to Catalysis.

5. **Enzyme Kinetics:** Enzyme Kinetics as an Approach to Understanding Mechanism; Kinetic Parameters are Used to Compare Enzyme Activities; Relationship between Substrate Concentration and Reaction Rate; The Michaelis-Menten Kinetics; Interpreting  $V_{max}$  and  $K_m$ ; Lineweaver–Burk Double-Reciprocal Plot; Reaction Order.
6. **Enzyme Inhibition:** Reversible Inhibition - Mechanism and Quantitatively Analysis of Competitive Inhibition, Uncompetitive Inhibition, Mixed Inhibition and Noncompetitive Inhibition; Mechanism of Irreversible Inhibition; Mechanism-Based Inactivators; Uses of Inhibitors; Regulatory Enzymes
7. **Enzyme Assays and Enzyme Purification:** Types of Enzyme Assays; Factors to Control in Enzyme Assays; Enzyme Units and Specific Activities; Turnover Number; General Purification Scheme.

**Course Learning Outcome (CLOs):**

- CLO1:** To explain the basic concept of enzymes.
- CLO2:** To describe components and mechanism of enzyme.
- CLO3:** To describe the factors influence enzymatic activity.
- CLO4:** To describe protein structure and activity and chemical nature of enzymes..
- CLO5:** To describe enzymatic assays, purification and kinetics.
- CLO6:** To differentiate between competitive and non-competitive inhibition.
- CLO7:** To describe the applications of enzymes and their inhibitors in medicine and various industries.

**Mapping Course Learning Outcomes (CLOs) with the PLOs**

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1							m			
CLO2							m			
CLO3			m				m			
CLO4			m				m			
CLO5			m							
CLO6			m							
CLO7			m				m			

(Note: "m" = matched)

**Mapping course learning Outcomes (CLOs) with the Teaching-Learning and Assessment strategy**

<b>CLOs</b>	<b>Teaching-Learning Strategy</b>	<b>Assessment Strategy</b>
CLO1	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO2	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO3	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO4	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO5	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO6	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO7	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation

**YEAR-3, SEMESTER-6, COURSE-48**

<b>Course Code: MIC-3605 Course Title: Pharmaceutical Microbiology Credits: 2.0</b>
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**Rationale of the course:**

The course is designed as an essential building block for students with a desire to have a career in pharmaceutical company.

**Course Objective:**

The main objective of the course is to educate students with the knowledge of the Microbiological analysis of pharmaceutical raw materials e.g. water, ingredients and finished products as well as the manufacturing environment and equipment.

### Course content:

- 1. Pharmaceuticals, Biologics and Biopharmaceuticals:** Introduction to Pharmaceutical Products; Biopharmaceuticals and Pharmaceutical Biotechnology; History of the Pharmaceutical Industry; the Age of Biopharmaceuticals; Biopharmaceuticals - Current Status and Future Prospects.
- 2. Microbial Spoilage of Pharmaceutical Products and Contamination Control:** Introduction; Spoilage—Chemical and Physicochemical Deterioration of Pharmaceuticals; Hazard to Health; Sources and Control of Contamination; Factors Determining the Outcome of a Medicament-Borne Infection; Preservation of Medicines Using Antimicrobial Agents: Basic Principles; Quality Assurance and the Control of Microbial Risk in Medicines.
- 3. Sterile Pharmaceutical Products:** Introduction; Types of Sterile Product; Sterilization Considerations; Sterilization Methods - Heat Sterilization, Gaseous Sterilization, Radiation Sterilization, Filtration Sterilization, New Sterilization Technologies - High-Intensity Light and Low Temperature Plasma.
- 4. Sterilization Control and Sterility Assurance:** Bioburden Determinations; Environmental Monitoring; Validation and In-Process Monitoring of Sterilization Procedures; Sterility Testing; The Role of Sterility Testing; Quality Control and Quality Assurance of Sterile Products; Measurement of Bacterial Endotoxins and Other Pyrogens.
- 5. Microbiological Assays of Antibiotics, Vitamins and Amino Acids:** Introduction - Importance and Usefulness, Principle, Methodologies and Present Status of Assay Methods; Variants in Assay Profile - Calibration of Assay, Precision of Assay, Accuracy of Assay, Evaluation of Assay Performance; Types of Microbiological (Microbial) Assays - Agar Plate Diffusion Assays, Rapid-Reliable-Reproducible Microbial Assay Methods; Radioenzymatic Assays; Analytical Methods for Microbial Assays; Examples of Pharmaceutical Microbial Assays; Assay of Antibiotics by Turbidimetric (or Nephelometric) Methods.
- 6. The Drug Development Process:** Introduction; Discovery of Biopharmaceuticals; The Impact of Genomics and Related Technologies upon Drug Discovery; Gene Chips; Proteomics; Structural Genomics; Pharmacogenetics; Initial Product Characterization; Patenting; Delivery of Biopharmaceuticals; Preclinical Studies; Pharmacokinetics and Pharmacodynamics; Toxicity Studies; The Role and Remit of Regulatory Authorities.

### Course Learning Outcome (CLOs):

- CLO1:** To describe the scope and applications of pharmaceutical Microbiology.
- CLO2:** To describe microorganism relevant to pharmaceutical industry.
- CLO3:** To describe the action of antimicrobial agents in preservation of medicines.
- CLO4:** To explain microbial contamination and spoilage of pharmaceutical formulations during production and products.
- CLO5:** To describe the principles and methods of sterilization and disinfection.
- CLO6:** To enumerate microorganisms from pharmaceutical products and pharmaceutical manufacturing environment.
- CLO7:** To describe GMP and GLP applications regarding Microbiology in pharmaceutical industry.

## Mapping Course Learning Outcomes (CLOs) with the PLOs

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1						m				
CLO2	m					m				
CLO3			m							
CLO4						m				
CLO5	m					m				
CLO6				m		m			m	
CLO7						m				

(Note: "m" = matched)

## Mapping course learning Outcomes (CLOs) with the Teaching-Learning and Assessment strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO2	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO3	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO4	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO5	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO6	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO7	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation

## YEAR-3, SEMESTER-6, COURSE-49

Course Code: MIC-3606

Course Title: Practical

Credits: 2.0

### Rationale of the course:

The intended course is designed to correlate theoretical studies with practical tasks.

### Course Objectives:

The main objective of the course is to educate students in lab tasks such as Microbiological analysis of milk, fermented and non-fermented foods, pharmaceutical raw materials and finished products.

### Course content:

- 1. Study of microbial population:** Soil, rhizosphere and rhizospheres, denitrification and ammonification, nitrogen fixation tests.
- 2. Quantitative and qualitative examination of milk:** bacteria in raw and pasteurized milk, methylene blue reduction test.
- 3. Microbiological analysis:** Fermented and non-fermented foods.
- 4. Production of molasses citric acid vinegar:** Culture, extraction, purification.
- 5. Determination properties of enzymes:** Molecular weight (gel electrophoresis), substrate specificity, enzyme activity (qualitative and quantitative) and kinetic properties, effect of activators (enzyme, cofactors) and inhibitors on enzymes.
- 6. Microbiological assay:** Pharmaceutical raw materials, solids, ointments and oral liquids, potency of antibiotics.
- 7. Detection and identification of microbial pathogens:** Poultry (*Salmonella sp*), frozen and fish.
- 8. Different Immunological Techniques:** Precipitation, Agglutination, ELISA, radioimmunoassay (RIA), immunoelectrophoretic, immunoblotting, immunofluorescence and activated cell sorter. (FACS).

### Course Learning Outcome (CLOs):

- CLO1:** To study microbial populations resided in the soil.
- CLO2:** To conduct Microbiological analysis of raw and pasteurized milk.
- CLO3:** To detect and identify pathogens from frozen foods and fish.
- CLO4:** To conduct Microbiological assay of pharmaceutical raw materials, solids, ointments and oral liquids.
- CLO5:** To determine potency of antibiotics.
- CLO6:** To enzyme activity.
- CLO7:** To production of industrial products.
- CLO8:** To perform different immunological techniques.

## Mapping Course Learning Outcomes (CLOs) with the PLOs

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1				m		m				m
CLO2					m	m				m
CLO3				m	m				m	m
CLO4						m			m	m
CLO5			m						m	m
CLO6			m					m		m
CLO7						m	m			m
CLO8					m	m	m			

(Note: "m" = matched)

## Mapping course learning Outcomes (CLOs) with the Teaching-Learning and Assessment strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO2	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO3	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO4	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO5	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO6	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO7	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO8	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation

## YEAR-3, SEMESTER-6, COURSE-50

**Course Code: MIC-3607**

**Course Title: Viva-voce**

**Credits: 1.0**

**Rationale of the course: N/A**

**Objective:**

The objective of the course is to enable students to demonstrate a firm understanding of all the courses of this semester, so that the examiners can have an opportunity to assess the students.

**Course content:**

Topics of all the theoretical and practical courses of 6<sup>th</sup> semester and other relevant matters will be included.

**Course Learning Outcome (CLOs): N/A**

**Course Learning Outcomes (CLOs and Mapping of CLOs with Program Learning Outcomes (PLOs): N/A**

**Mapping course learning Outcomes (CLOs) with the Teaching-Learning and Assessment strategy: N/A**

## YEAR-4, SEMESTER-7, COURSE-51

**Course Code: MIC-4701**

**Course Title: Immunology-II**

**Credits: 2.0**

**Rationale of the course:**

This intensive course is directed toward the students for expanding their understanding in recent advances in the biology of the immune system and addresses its role in health and disease. This is not an introductory course; students need to have a firm understanding of the basic principles of immunology and laboratory techniques.

**Course Objective:**

The general objective of the course is to acquire knowledge in advance knowledge in immunology and to perform some common methods used in clinical immunology and gain an understanding of the interpretation of patient results in a variety of clinical settings.

**Course content:**

- 1. Humoral and Cell mediated Immunity:** Classification of T-cell and B-cell, T -cell independent and dependent and defense mechanisms, B-cell independent and dependent and defense mechanisms, Interaction between Humoral and cell mediated immunity.
- 2. Immune regulation:** Regulation of immune response by antigens, antibody, antigen presenting cells and lymphocytes, idiotypic regulation of immune response.

3. **Effector molecules:** Cytokines: origin, source and effector function, cytokine action and network interaction.
4. **Immunological Tolerance:** Mechanism of tolerance, thymic tolerance to self-antigens, B cell tolerance, artificially induced tolerance.
5. **Prophylaxis:** Antigens used as vaccines, effectiveness and safety of vaccine, current vaccines, modern approaches, adjuvant.
6. **Immunodeficiency:** Primary immunodeficiencies, deficiencies of innate immunity, primary B cell deficiency, primary T cell deficiency, combine immunodeficiency, secondary immunodeficiency.
7. **Hypersensitivity:** Hypersensitivity type-I, type-II, type-III and type-IV.
8. **Transplantation:** Barriers of transplantation, law of transplantation, role of T lymphocytes in rejection, prevention of rejection.
9. **Tumor Immunology:** Surface markers of tumor cell, immune response to tumor cells, lymphoproliferative disorders due to tumor growth, cancer immunology.
10. **Autoimmunity and autoimmune Disease:** Association of autoimmunity with diseases, genetic factors in pathogenesis, etiology and treatment of autoimmune disease.

#### Course Learning Outcomes (CLOs):

- CLO1:** To discuss the fundamental mechanisms underlying protective immune responses, and discuss the recent advances and emerging themes in immunology research.
- CLO2:** To describe the fundamental mechanisms of cytokines, macrophage, lymphocytes which regulate the immune response.
- CLO3:** To appreciate the basic principles of immunological tolerance of health and underlying effective safety prophylaxis measures against the antigens.
- CLO4:** To explain and analyze the medical literature reporting immunologic advances of hypersensitivity reactions, organ transplantation, tumor immunology, auto immune disorders.

#### Mapping Course Learning Outcomes (CLOs) with the PLOs:

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1		m					m			m
CLO2							m			m
CLO3							m			m
CLO4							m			m

(Note: m= matched)



**Mapping Course Learning Outcome (CLOs) with the Teaching-Learning Strategy & Assessment Strategy:**

<b>CLOs</b>	<b>Teaching Learning Strategy</b>	<b>Assessment Strategy</b>
CL01	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CL02	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CL03	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CL04	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation

**YEAR-4, SEMESTER-7, COURSE-52**

<b>Course Code: MIC-4702    Course Title: Medical Microbiology-II    Credits: 3.0</b>
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**Rationale of the course:**

To treat patients with appropriate medications, it is prerequisite to diagnose the infections first. Diagnosis of infectious pathogens requires knowledge of their virulence factors associated with disease.

**Course Objective:**

The intended course is designed to introduce students with infectious diseases caused by pathogens, which include pathogenesis, virulence factors, diagnosis as well as treatment.

**Course content:**

- Mechanisms of Bacterial Pathogenesis, Diagnosis and Treatment Infections Caused by the Gram-Positive Cocci:** *Staphylococcus aureus* (Cutaneous Infections, Food Poisoning, Endocarditis, Toxic Shock Syndrome, etc.); *Staphylococcus epidermidis* (Endocarditis, Catheter and Shunt Infections, etc.); *Enterococcus* (Urinary Tract Infections, Septicemia, etc.); *Streptococcus pyogenes* (Pharyngitis, Impetigo, Erysipelas, Rheumatic Fever, etc.); *Streptococcus pneumoniae* (Pneumococcal Pneumonia, Otitis Media, Sinusitis, Meningitis, etc.); *Streptococcus agalactiae* (Neonatal Diseases, Other Infections).
- Mechanisms of Bacterial Pathogenesis, Diagnosis and Treatment Infections Caused by the Gram-Positive Bacilli:** *Bacillus anthracis* (Anthrax); *Listeria monocytogenes* (Neonatal Diseases, etc.); *Corynebacterium diphtheriae* (Diphtheria); *Clostridium perfringens* (Gas Gangrene, Food Poisoning, etc.); *Clostridium tetani* (Tetanus); *Clostridium botulinum* (Botulism); *Clostridium difficile* (Gastroenteritis); *Erysipelothrix rhusiopathiae* (Erysipeloid).

3. **Mechanisms of Bacterial Pathogenesis, Diagnosis and Treatment Infections Caused by the Gram-Negative Cocci and Anaerobic Bacilli:** *Neisseria gonorrhoeae* (Gonorrhoea, PID, etc.); *Neisseria meningitidis* (Meningitis, etc.); *Escherichia coli* (Gastroenteritis); *Salmonella* (Gastroenteritis, Enteric fevers, etc.); *Shigella* (Shigellosis); *Yersinia* (Bubonic Plague, Enterocolitis); *Vibrio* (Cholera, Gastroenteritis, etc.); *Campylobacter* (Gastroenteritis); *Helicobacter* (Gastritis, Gastric and Duodenal Ulcers).
4. **Mechanisms of Bacterial Pathogenesis, Diagnosis and Treatment Infections Caused by the Gram-Negative Aerobic Bacilli:** *Pseudomonas aeruginosa* (Pulmonary, Skin and Urinary Tract Infections, etc.); *Bordetella pertussis* (Whooping Cough); *Francisella tularensis* (Tularemia); *Brucella* (Undulant Fever, etc.); *Haemophilus* (Meningitis, Otitis, Chancroid, Arthritis, etc.); *Legionella pneumophila* (Legionnaires' Disease, Pontiac Fever).
5. **Mechanisms of Bacterial Pathogenesis, Diagnosis and Treatment Infections Caused by the Anaerobes, Actinomyces, Mycobacteria and Mycoplasmas:** *Actinomyces* (Endogenous Infections); *Propionibacterium* (Acne); Anaerobic Gram-Negative Bacilli (Chronic Sinusitis and Otitis, Brain Abscesses, Skin and Tissue Infections, etc.); *Nocardia* (Pulmonary and Cutaneous Infections); *Mycobacterium* (Tuberculosis, Leprosy, etc.); *Mycoplasma* (Atypical Pneumonia, etc.).
6. **Mechanisms of Bacterial Pathogenesis, Diagnosis and Treatment Infections Caused by the Spirochete, Rickettsial and Chlamydial Pathogens:** *Treponema pallidum* (Syphilis, Yaws, etc.), *Borrelia* (Relapsing Fever, Lyme Disease), *Rickettsia* (Rocky Mountain Spotted Fever, Epidemic Typhus, Endemic Typhus); *Coxiella burnetii* (Q Fever); *Chlamydia trachomatis* (Trachoma, Urogenital Infections, etc.); *Chlamydophila* (Pneumonia, Ornithosis).
7. **Fungal as Human Pathogens:** Basic Biology of Fungi; General Information on Fungal Pathogenesis; Superficial Mycoses (Pityriasis Versicolor, Tinea Nigra, Black Piedra, etc.); Cutaneous (Etiology, Ecology and Epidemiology, Clinical Manifestations); Subcutaneous Mycoses (Lymphocutaneous Sporotrichosis, Chromoblastomycosis, Phaeoerythromycosis, etc.); Systemic Mycoses (Histoplasmosis, Blastomycosis, Paracoccidioidomycosis, Coccidioidomycosis, Cryptococcosis, etc.); Opportunistic Mycoses (Candidiasis, Aspergillosis, Zygomycosis, *Pneumocystis carinii* Pneumonia).
8. **Parasitic Diseases in Humans:** Basic Biology of Parasites; Medical Importance of Parasites and Parasitic Diseases; Classification and Structure of Protozoa (Sarcomastigophora, Ciliophora, Apicomplexa, Microspora) and Metazoa (Helminths, Arthropods); Physiology and Replication of Protozoa.

### Course Learning Outcomes (CLOs):

- CLO1:** To describe importance of pathogenic bacteria in human diseases with respect to infections of respiratory tract, gastrointestinal tract and skin.
- CLO2:** To describe microbial virulence mechanisms and host responses to infections.
- CLO3:** To explain basic and molecular techniques to diagnosis bacterial infections.
- CLO4:** To describe resistant mechanisms encoded in bacteria to neutralize antibacterial agents.

**CLO5:** To describe the pathogenesis of fungal and parasitic infections in humans.

**CLO6:** Mention prevention and treatment of pathogenic infections in humans.

**Mapping Course Learning Outcomes (CLOs) with the PLOs:**

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1				m	m	m			m	
CLO2				m	m					
CLO3							m		m	
CLO4			m				m			m
CLO5			m		m		m			
CLO6			m				m			

(Note: m= matched)

**Mapping Course Learning Outcome (CLOs) with the Teaching-Learning Strategy & Assessment Strategy:**

CLOs	Teaching Learning Strategy	Assessment Strategy
CLO1	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO2	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO3	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO4	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO5	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO6	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation

## YEAR-4, SEMESTER-7, COURSE-53

Course Code: MIC-4703	Course Title: Environmental Biotechnology	Credits: 3.0
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### Rationale of the Course:

Control Environmental pollutions and keep better Environment by using Biological agents.

### Course Objective:

Implementation of Biotechnological methods to improve polluted environment & living Standards.

### Course content:

- 1. Introduction to Environmental Biotechnology:** Role of microorganisms in geochemical cycles; Environmental pollutants and their microbial transformation.
- 2. Bioremediation for Soil Environment:** Environment of Soil Microorganisms; Soil Organic Matter and Characteristics; Soil Microorganisms Association with Plants; Pesticides and Microorganisms; Petroleum Hydrocarbons and Microorganisms; Industrial solvents and Microorganisms; Biotechnologies for *Ex-situ* Remediation of Soil; Biotechnologies for *In-situ* Remediation of Soil; Phytoremediation Technology for Soil Decontamination.
- 3. Bioremediation for Air Environment:** Atmospheric Environment for Microorganisms; Microbial Degradation of Contaminants in Gas Phase; Biological Filtration Processes for Decontamination of Air Stream – Biofiltration, Biotrickling Filtration and Bioscrubbers.
- 4. Bioremediation for Water Environment:** Biochemical, Molecular, and Ecological Foundations of Bioremediation; Contaminants in Groundwater; *Ex-situ* Decontamination of Groundwater - Characterizing the Site and Contaminant Complexity and Selecting the Bioremediation Option; Process Optimization; *In-situ* Bioremediation of Groundwater - Factors Affecting Bioaugmentation, Delivery Systems for Oxygen, Nutrients, and Inoculation; Landfill Leachate Biotreatment Technologies; Industrial Wastewater Biotreatment Technologies; Biotreatment of Surface Waters.
- 5. Biotreatment of Metals:** Microbial Transformation of Metals; Biological Treatment Technologies for Metals Remediation; Bioleaching and Biobenification; Bioaccumulation; Oxidation/Reduction Processes; Biological Methylation; Case studies.
- 6. Overcoming Limitations of Bioremediation:** Factors Affecting the Bioremediation Processes; Effects of Co-substrates on Microorganisms; Global Application of Bioremediation Technologies; Successful and Unsuccessful Case Studies.
- 7. Emerging Environmental Biotechnologies:** Phytoremediation; Sequestering Carbon Dioxide; Biomonitoring; Application of Microbial Enzymes; Biomembrane Reactors.
- 8. Case Studies in Environmental Biotechnology:** Environmental Biotechnology Research Activities in European Union, Japan, The USA and Other Countries.
- 9. Clean Technology: Biomining;** Microbially enhanced oil recovery (MEOR); Production of bioplastics; Production of Biosurfactants - Bioemulsans and Paper Production; Microbial Desulphurization of Coal; Organic Waste Bioconversion - Composting and Ensiling;

**Biological Control of Insects and Pests; Biofertilizers; Environmental Biotechnology and biofuels.**

**Course Learning Outcome (CLOs):**

**CLO:** To describe about environmental biotechnology and its applications.

**CLO:** To explain basic concepts on different types of Biotreatment technologies to control environmental pollutions.

**CLO:** To explain the history of Environmental Biotechnology.

**CLO:** To DNA markers, their importance & applications.

**CLO:** To discuss the function of antimicrobial agents.

**CLO:** To discuss the development and role of Biofertilizers and Biofuels.

**CLO:** To identify different sources of environmental pollutions and utilized their Biotreatment ways.

**Mapping Course Learning Outcomes (CLOs) with the PLOs**

CLOs	PL01	PL02	PL03	PL04	PL05	PL06	PL07	PL08	PL09	PL010
CLO1						m	m	m		
CLO2		m					m	m		
CLO3					m	m	m	m		m
CLO4								m		
CLO5			m							
CLO6						m	m	m		
CLO7		m						m		

(Note: "m" = matched)

**Mapping course learning Outcomes (CLOs) with the Teaching-Learning and Assessment strategy**

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO2	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO3	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO4	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO5	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation

CL06	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CL07	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation

## YEAR-4, SEMESTER-7, COURSE-54

<b>Course Code: MIC-4704</b>	<b>Course Title: Genetic Engineering</b>	<b>Credits: 2.0</b>
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### Rationale of the course:

The course is designed as a building block for students who have a desire to have complete understanding of molecular biology. The topics included in the course will cover the information related to molecular biology.

### Course Objective:

The objective of the course is to equip students with knowledge of fundamentals of molecular biology like isolation and purification of DNA, manipulation of DNA, gene cloning and gene expression.

### Course content:

1. **Purification of DNA from Living Cells:** Preparation of Total Cell DNA; Preparation of Plasmid DNA; Preparation of Bacteriophage DNA.
2. **Manipulation of Purified DNA:** The Range of DNA Manipulative Enzymes; Enzymes for Cutting DNA—Restriction Endonucleases; Ligation – Joining DNA Molecules Together.
3. **Introduction of DNA into Living Cells:** Transformation—The Uptake of DNA by Bacterial Cells; Identification of Recombinants; Introduction of Phage DNA into Bacterial Cells; Identification of Recombinant Phages; Introduction of DNA into Non-Bacterial Cells.
4. **Vectors for Gene Cloning:** Plasmids and Bacteriophages; Cloning Vectors Based on *E. coli* Plasmids; Cloning Vectors Based on M13 Bacteriophage; Cloning Vectors Based on  $\lambda$ Bacteriophage; Lambda ( $\lambda$ ) and Other High-Capacity Vectors Enable Genomic Libraries to be Constructed.
5. **Production of Protein from Cloned Genes:** Overview of Gene Expression; Regulation of Gene Expression; Requirements for Gene Expression; Expression Vector; *Escherichia coli* Expression Vector Features; General Problems with the Production of Recombinant Protein in *E. coli*; *In vitro* Translation; Important Element for Translation; Production of Recombinant Protein by Eukaryotic Cells.
6. **Studying Gene Expression and Function:** Transcription of cloned gene, identifying protein binding sites on a DNA molecule, Identifying and studying the translation product of a cloned gene: hybrid-release translation (HRT) and hybrid-arrest translation (HART). Analysis of protein by *in vitro* mutagenesis; studying protein-protein interaction phage display, yeast two hybrid system.

**Course Learning Outcome (CLOs):****CLO1:** To isolate total cell DNA, plasmid DNA and bacteriophage DNA.**CLO2:** To describe the enzymes employed in recombinant DNA technology.**CLO3:** To describe the techniques for uptake of DNA, Identify recombinants from non-recombinants.**CLO4:** To describe gene expression, its regulation and requirements to express**CLO5:** To isolate and detect biodegradative microbes from environment.**CLO6:** To explain protein-protein interaction, *in vitro* mutagenesis and yeast two hybrid system.**Mapping Course Learning Outcomes (CLOs) with the PLOs**

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1								m	m	m
CLO2								m	m	m
CLO3								m	m	m
CLO4								m	m	m
CLO5								m	m	m
CLO6					m			m	m	m

(Note: "m" = matched)

**Mapping course learning Outcomes (CLOs) with the Teaching-Learning and Assessment strategy**

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO2	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO3	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO4	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO5	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO6	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation

## YEAR-4, SEMESTER-7, COURSE-55

<b>Course Code: MIC-4705</b> <b>Course Title: Practical/Research Project</b> <b>Credits: 4.0</b>
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### Rationale of the Course:

The intended course is designed to correlate theoretical studies with practical tasks.

### Course Objective:

The main objective of the course is to introduce students with the molecular techniques like DNA isolation, purification, restriction and cloning employed in molecular biology.

### Course content:

- Detection of indicators and pathogens in water:** *E. coli*, *Klebsiella*, *Salmonella*, *Shigella*, *Vibrio*.
- Isolation, screening and identification:** Microorganisms producing antibiotic, pectinase and cellulose.
- Isolation and identification of common pathogens:** Food spoilage, *Bacillus cereus* and *Staphylococcus aureus* in fast-food, *E.coli* and *Aeromonas hydrophila* in salad dressings, *Aspergillus flavus* from oil seeds.
- Detection of toxins:** Hemolysin and phospholipase C (Toxins) from *B. cereus*.
- Enrichment and isolation of biodegradative microbes from environment:** Non-cultivable state of microorganisms (detection by FA or Acridine orange DVC).
- Production and purification of enzyme:** Amylase by fungal isolates, culture, separation-ammonium sulphate precipitation, column chromatography, dialysis, gel-electrophoresis (SDS-PAGE)
- Whole cell Immobilization:** Whole microbial cell technique and application.
- Experiments with nucleic acids:** DNA extraction and purification, agarose gel electrophoresis of DNA, DNA digestion by restriction enzyme, transformation of genes into component, *E. coli* cells, ligation of DNA with appropriate vector, study of genetic map.
- Detection of antigen (Ag) and antibody (Ab):** By different immunological techniques, immunoblotting of bacterial proteins, HLKA typing, detection of viral DNA by PCR amplification and dot-blot hybridization, detection of viral Ag and Ab by RPHA method, tritration of virus using immunofluorescent microscope, PCR amplification of HBV core and surface gene
- Research Project:** Research Projects on specific topics of scientific importance will be set for selective student(s).

### Course Learning Outcome (CLOs):

**CLO1:** To detect indicators and pathogen from water.

**CLO2:** To identify metabolic byproducts produced by microbes.

**CLO3:** To detect food borne pathogens from food samples.

**CLO4:** To detect microbes in molecular level by PCR.

**CLO5:** To describe the procedure of plasmid DNA isolation and Gel electrophoresis.



**CLO6:** To isolate and detect biodegradative microbes from environment.

**CLO7:** To detect pathogens using antigen-antibody binding reactions.

**Mapping Course Learning Outcomes (CLOs) with the PLOs**

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1				m					m	m
CLO2								m	m	m
CLO3					m	m				m
CLO4									m	m
CLO5								m	m	m
CLO6			m					m		m
CLO7							m		m	m

(Note: "m" = matched)

**Mapping course learning Outcomes (CLOs) with the Teaching-Learning and Assessment strategy**

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO2	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO3	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO4	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO5	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO6	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO7	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation

## YEAR-4, SEMESTER-7, COURSE-56

Course Code: MIC-4706

Course Title: Viva-voce

Credits: 1.0

**Rationale of the course:** N/A

**Course Objective:**

The objective of the course is to enable students to demonstrate a firm understanding of all the courses of this semester, so that the examiners can have an opportunity to assess the students.

**Course content:**

Topics of all the theoretical and practical courses of 7<sup>th</sup> semester and other relevant matters will be included.

**Course Learning Outcome (CLOs):** N/A

**Course Learning Outcomes (CLOs and Mapping of CLOs with Program Learning Outcomes (PLOs):** N/A

**Mapping course learning Outcomes (CLOs) with the Teaching-Learning and Assessment strategy:** N/A

## YEAR-4, SEMESTER-8, COURSE-57

Course Code: MIC-4801

Course Title: Microbial Biotechnology

Credits: 3.0

**Rationale of the Course:**

To implement biotechnology for the improvement of biological processes or alternative to chemical processes, it is fundamental to know about biotechnology, its components and techniques.

**Course Objective:**

The main objective of the course is to equip students with the knowledge of biotechnology and its techniques employed in sectors like food industry, beverages and chemical.

**Course content:**

- 1. Fundamental aspects:** Historical development, scope and essential feature of microbial biotechnology.
- 2. Energy and biotechnology:** Biomass, biofuel, conservation of fuel, ethanol and methane fermentation, cells and other bioelectrochemical devices.
- 3. Food, drink and biotechnology:** Biotransformation of materials, dairy products (cheese, yogurt, butter and cultured milk), cereal product (bread and baked foods, starch hydrolysates), brewing (alcoholic beverage), vinegar, protein products (SCP), food additives and ingredients.

4. **Biotechnology of microbial Enzymes:** Types of microbial enzymes, enzymes production, different methods of extraction and purification, characterization of enzyme, applications of microbial enzymes.
5. **Chemistry and biotechnology:** The current development, generation of chemicals from biomass.
6. **Materials and biotechnology:** Microbial leaching, metal transformation and immobilization, biopolymers, biodegradation of materials.
7. **Environmental and biotechnology:** Processing of waste, biological control of microbial waste treatment system, biological processing of industrial wastes.
8. **Genetics and biotechnology:** Conventional routes to strain improvement, in vivo and in vitro genetic manipulation.
9. **Chemical engineering and biotechnology:** Microbial factors and process engineering.
10. **Factors affecting process:** Performance and economics, feature development in industrial biotechnological process.
11. **Immobilization technology:** Immobilization of enzymes and whole cells.

**Course Learning Outcome (CLOs):**

- CLO1:** To Describe scope and essential feature of microbial biotechnology.
- CLO2:** To describe about biofuel formation.
- CLO3:** To describe about biofuel formation.
- CLO4:** To explain the immobilization techniques of cells or enzymes and its applications
- CLO5:** To describe the leaching and transformation process using microbes.
- CLO6:** To explain the generation process of chemicals from biomass.
- CLO7:** To discuss the biological control of microbial waste.
- CLO8:** To describe the processes of strain improvement.

**Mapping Course Learning Outcomes (CLOs) with the PLOs**

CLOs	PL01	PL02	PL03	PL04	PL05	PL06	PL07	PL08	PL09	PL010
CLO1							m	m		m
CLO2		m						m		
CLO3						m		m		
CLO4							m	m		
CLO5			m					m		
CLO6			m					m		
CLO7									m	m
CLO8						m			m	m

(Note: "m" = matched)

**Mapping course learning Outcomes (CLOs) with the Teaching-Learning and Assessment strategy**

<b>CLOs</b>	<b>Teaching-Learning Strategy</b>	<b>Assessment Strategy</b>
CL01	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CL02	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CL03	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CL04	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CL05	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CL06	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CL07	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CL08	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation

**YEAR-4, SEMESTER-8, COURSE-58**

<b>Course Code: MIC-4802</b>	<b>Course Title: Diagnostic Microbiology</b>	<b>Credits: 2.0</b>
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**Rationale of the Course:**

To treat diseases caused by microorganisms, it requires accurate diagnosis of causative agents

**Course Objective:**

The major objective of the study is to introduce students with the techniques e.g. serological and nucleic acid based to diagnose medically important pathogens. The topics included in the course will also cover specimen collection and sensitivity of the pathogens against antimicrobials.

**Course content:**

- 1. Specimen Management:** Brief History: Specimen Collection and Handling; Examination of Specimen; Primary Culture - Selection of Culture Media, Specimen Preparation, Inoculation of Solid Media and Incubation Conditions; Specimen Workup.
- 2. Role of Microscopy:** Overview of the Role of Microscopy in Diagnostic Microbiology - Common Laboratory Procedure Use in the Laboratory Diagnosis of Infectious Diseases, Application of Microscopy in Diagnostic Microbiology and Types of Microscopy for Diagnosis of Infectious Diseases; Bright-Field (Light) Microscopy; Phase Contrast Microscopy; Dark-Field Microscopy; Electron Microscopy.
- 3. Traditional Cultivation and Identification:** Principle of Bacterial Cultivation; Nutritional Requirement; Artificial Media for Routine Bacteriology; Environmental Requirements; Bacterial Cultivation; Bacterial Identification - Principles of Identification, Organism Identification Using Genotypic and Phenotypic Criteria; Types of Enzyme-Based Tests; Principles of Phenotype-Based Identification Schemes; Analysis of Metabolic Profiles; Commercial Identification Systems; Chromatography.
- 4. Laboratory Methods and Strategies for Antimicrobial Susceptibility Testing:** Goals and Limitations Antimicrobial Susceptibility Testing; Standardization; Principle of Testing Methods; Methods That Directly Measure Antimicrobial Activity - Conventional Testing Methods, Commercial Susceptibility Testing Systems, and Alternative Approaches for Enhancing Resistance Detection; Methods That Directly Detect Specific Resistance Mechanisms - Phenotypic and Genotypic Methods; Special Methods from Complex Antimicrobial–Organism Interactions; Laboratory Strategies for Antimicrobial Susceptibility Testing – Relevance, Accuracy and Communication.
- 5. Immunochemical Methods Used for Organism Detection:** Limitations of Traditional Diagnostic Methods; Production of Antibodies for Use in Laboratory Testing - Polyclonal and Monoclonal Antibodies; Principles of Immunochemical Methods Used for Organism Detection - Precipitin Tests, Particle Agglutination Method, Immunofluorescent Assays, Enzyme Immunoassays and Other Immunoassays.
- 6. Serologic Diagnosis of Infectious Diseases:** Features of the Immune Response; Characteristics of Antibodies; Antibody Related Diagnostic Testing; Principles of Serologic Test Methods; Methods of Antibody Detection - Direct Whole Pathogen Agglutination Assays, Particle Agglutination Tests, Flocculation Tests, Counter immunoelectrophoresis, Immunodiffusion Assays, Hemagglutination Inhibition Assays, Neutralization Assays, Complement Fixation Assays, Enzyme-Linked Immunosorbent Assays, Indirect Fluorescent Antibody Tests, Radioimmunoassay, Fluorescent Immunoassays and Western Blot Immunoassays.
- 7. Nucleic Based Analytic Methods for Microbial Identification and Characterization:** Overview of Molecular Methods; Nucleic Acid Hybridization Methods - Principle of Nucleic Acid Hybridization, Hybridization Steps and Components, Hybridization Formats, and Solid Support Materials and Common Solid Formats; PCR-Based Amplification Methods - Overview of Polymerase Chain Reaction (PCR), Derivations of the PCR Method, Technical Aspects of Real-Time PCR Assays, Fluorogenic Probes for Detection of Amplified Product in Real-Time PCR Assays; Non-PCR-Based Amplification Methods; Application of Nucleic Acid-Based Methods.

**Course Learning Outcome (CLOs):****CLO1:** To collect medically important specimen collection using safety protocols.**CLO2:** To use various microscopes for diagnosis pathogens.**CLO3:** To cultivate and identify clinically well-known pathogens**CLO4:** To interpret the result of antimicrobial susceptibility of microbes.**CLO5:** To describe Ag-Ab detection method for detection purpose.**CLO6:** To describe serology based, nucleic acid based detection of pathogens etc.**Mapping Course Learning Outcomes (CLOs) with the PLOs**

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1										
CLO2									m	m
CLO3									m	m
CLO4									m	m
CLO5									m	m
CLO6									m	m

(Note: "m" = matched)

**Mapping course learning Outcomes (CLOs) with the Teaching-Learning and Assessment strategy**

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO2	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO3	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO4	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO5	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO5	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation

## YEAR-4, SEMESTER-8, COURSE-59

<b>Course Code: MIC-4803</b>	<b>Course Title: Analytical Microbiology</b>	<b>Credits: 2.0</b>
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### Rationale of the Course:

To analyze molecules like DNA, RNA and protein, it is prerequisite to know the principles and techniques behind the analysis of these macromolecules.

### Course Objective:

The main objective of the course is to provide a framework for understanding the techniques used for the analysis of micro and macromolecules of the cell.

### Course content:

- 1. Spectroscopic techniques:** Visible, ultraviolet and infra-red spectrophotometer, spectrofluorimetry, lumimetry, NMR, and mass spectrometry.
- 2. Centrifugation techniques:** Principle of sedimentation, centrifuges and their use, density gradient centrifugation and ultracentrifuge.
- 3. Chromatographic techniques:** Principle, different types (column, thin-layer, paper, adsorption, gas-liquid, ion-exchange, exclusion, affinity and high-performance liquid chromatography).
- 4. Electrophoretic techniques:** Principle, factors affecting electrophoresis, low and high voltage electrophoresis, gel electrophoresis, SDS-PAGE, isoelectric focusing, isoelectrophoresis and preparative electrophoresis.
- 5. Protein characterization:** Determination of molecular weight, amino acid composition and number of subunits, protein sequencing.
- 6. Microbial growth rate measurement techniques:** Enumeration of microorganisms, measurement of biomass, biomass components and biomass environment.
- 7. Instrumentation for monitoring and controlling bioreactors:** Basic evaluation for in-line and on-line monitoring: fermentation process control.
- 8. Radioisotope technique:** Nature, detection and measurement of radioactivity, application of radioisotopes in the biological sciences, safety aspects of the use of radioisotopes.
- 9. Cell culture:** Primary, secondary and continuous cell culture- animal cell.

### Course Learning Outcome (CLOs):

- CLO1:** To describe spectroscopic, centrifugation and chromatographic tech.
- CLO2:** To describe electrophoretic tech.
- CLO3:** To characterize Protein.
- CLO4:** To mention the methods for microbial growth rate measurement, techniques for detection, isolation and enumeration.
- CLO5:** To describe the instruments for monitoring and controlling bioreactors.
- CLO6:** To describe radioisotopes and cell culture techniques.

### Mapping Course Learning Outcomes (CLOs) with the PLOs

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1									m	m
CLO2									m	m
CLO3									m	m
CLO4			m						m	m
CLO5						m				
CLO6									m	m

(Note: "m" = matched)

### Mapping course learning Outcomes (CLOs) with the Teaching-Learning and Assessment strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO2	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO3	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO4	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO5	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO6	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation



## YEAR-4, SEMESTER-8, COURSE-60

Course Code: MIC-4804 Course Title: Quality Control of Food and Pharmaceuticals Credits: 2.0

### Rationale of the Course:

To prepare safe foods for human consumption and immunological products such as antibiotics, vaccines for human welfare, knowledge about preparing, determining and maintaining its quality is necessary.

### Course Objective:

The main objective of the course is to provide students with knowledge of ensuring food quality and establishment of the documentation (HACCP) rules for safe food preparations well as preparation of immunologic products.

### Course content:

- 1. Indicators of Food Safety and Quality, Principles of Quality Control, and Microbial Criteria:** Indicators of Food Microbial Quality and Safety - Indicators of Product Quality, Indicators of Food Safety, The Possible Overuse of Fecal Indicator Organisms and Predictive Microbiology/Microbial Modeling; The HACCP System and Food Safety - Hazard Analysis Critical Control Point System and Microbiological Criteria.
- 2. Regulatory and Safety Issues in Food and Pharmaceutical Industry:** Introduction; Biological Precautions; Chemical Precautions; Personal Precautions; Biosafety - Development of Genetic Engineering Biotechnology, Transgenic Organisms; Biosafety Guidelines and Regulations; Intellectual Property Right (IPR) and Protection (IPP); Protection of Biotechnological Inventions.
- 3. Factory and Hospital Hygiene:** Introduction; Definitions - Manufacture, Quality Assurance (QA), Good manufacturing practice (GMP), Quality control (QC), In-process control; Control of microbial contamination during manufacture - General Aspects, Hazard Analysis of Critical Control Points (HACCP), Environmental Cleanliness and Hygiene, Quality of Starting Materials, Process Design, Quality Control and Documentation and Packaging, Storage and Transport; Manufacture of Sterile Products - Clean and Aseptic Areas, General Requirements, Design of Premises, Internal Surfaces, Fittings and Floors, Services, Air Supply, Clothing, Changing Facilities, Cleaning and disinfection and Operation; Aseptic areas - additional requirements, Clothing, Entry to aseptic areas, Equipment and operation, Isolator and Blow/Fill/Seal Technology; Guide to Good Pharmaceutical Manufacturing Practice.
- 4. Manufacture of Antibiotics:** Introduction; Background; The Production of Benzylpenicillin - The Organism, Inoculum Preparation, The Fermenter, Oxygen Supply, Temperature Control, Defoaming Agents and Instrumentation, Media Additions, Transfer and Sampling Systems; Control of the Fermentation - Batched Medium, Fed Nutrients, Stimulation by PAA and Termination; Extraction - Removal of Cells, Isolation of Benzylpenicillin and Further Processing; The production of penicillin V; The Production of Cephalosporin C; Good Manufacturing Practice (GMP).

- 5. The Production of Immunological Products:** Introduction; Vaccines - Vaccines Used in Conventional Immunization Programmes, The Seed Lot System, Production of the Bacteria and the Cellular Components of Bacterial Vaccines, Fermentation, Production of the Viruses and the Components of Viral Vaccines, Blending, Filling and Drying and Quality Control; *In-Vivo* Diagnostics – Preparation and Quality Control; Immune Sera – Preparation and Quality Control; Human Immunoglobulins - Source Material, Fractionation and Quality Control.

**Course Learning Outcome (CLOs):**

- CLO1:** To identify the biohazards that is important in food safety and quality.  
**CLO2:** To describe the principles of quality assurance in food manufacturing.  
**CLO3:** To mention international standard for quality management systems.  
**CLO4:** To describe the principles of HACCP in food processing.  
**CLO5:** To explain principles and importance of cleaning and sanitation in food processing.  
**CLO6:** To explain regulatory issues in food safety and quality management.  
**CLO7:** To describe manufacture of immunological products such as antibiotics, vaccines and maintenance of quality.

**Mapping Course Learning Outcomes (CLOs) with the PLOs**

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1					m	m			m	m
CLO2									m	m
CLO3									m	m
CLO4					m	m			m	m
CLO5					m				m	m
CLO6									m	m
CLO7									m	m

(Note: “m” = matched)

**Mapping course learning Outcomes (CLOs) with the Teaching-Learning and Assessment strategy**

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO2	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CLO3	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation

CL04	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CL05	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CL06	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CL07	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation

## YEAR-4, SEMESTER-8, COURSE-61

<b>Course Code: MIC-4805 Course Title: Molecular Biology and Bioinformatics Credits: 3.0</b>
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### Rationale of the Course:

To understand the molecular process occurred in the cell, it is prerequisite to get idea about the fundamentals of these molecular processes.

### Course Objective:

The major objective of the course is to educate students with the knowledge of the techniques and software's utilized in molecular biology to extract information coded in the organism's genomes.

### Course content:

- 1. The Techniques of Molecular Biology:** Basic Techniques Used to Identify, Amplify, and Clone Genes; Construction and Screening of DNA Libraries: The Molecular Analysis of DNA, RNA, and Protein.
- 2. Selective Amplification of Genomic DNA Fragments:** Constraints on DNA Replication: Primers and 5'-to-3' Strand Elongation; The Polymerase Chain Reaction; After the PCR: Studying PCR Products; Conventional PCR vs. Real-Time PCR; Real-Time PCR Enables the Amount of Starting Material to be Quantified; PCR Amplification of Full-Length cDNAs; Gene Synthesis by PCR.
- 3. Sequencing Genes and Genomes:** Chain Termination DNA Sequencing; Chemical Cleavage DNA Sequencing; DNA Sequencing by Primer Walking; Pyrosequencing; Sequencing Using Reversible Chain Terminators; Sequencing by Ligation; How to Sequence a Genome; Using a Map to Aid Sequence Assembly.
- 4. DNA Markers:** DNA Markers Present in Genomic DNA; Single-Nucleotide Polymorphisms (SNPs); Restriction Fragment Length Polymorphisms (RFLPs); Random Amplified

Polymorphic DNA (RAPD); Amplified Fragment Length Polymorphisms AFLPs); Simple Tandem Repeat Polymorphisms (STRPs); Applications of DNA Markers.

5. **Introduction to Genome and Genomics:** Genome and Genomics; Genome Annotation; A Glimpse at Comparative Genomics; Metagenomics; Transcriptomics or Functional Genomics; Proteomics; Metabolomics and Systems Biology.
6. **Introduction to Bioinformatics:** philosophical, directional and application-oriented background of bioinformatics.
7. **Human Genome Project (HGP):** Influence area in Bioinformatics, Application in different industries, and its Indian scenario, as a business, problem and future aspects.
8. **Information Network:** Internet, web Browser and address (NCBI, EBI etc). Databases – information resources for Proteins and Genomics.
9. **Spaced Repetition Software (SRS):** SRS programs; Algorithms; Alignment.
10. **Phylogenetic Analysis:** Fundamental of Phylogenetic model, Tree interpretation – Paralogues and orthologues, Tree building and tree evaluation, Phylogenetic software.
11. **Comparative Genome Analysis:** Introduction, application, genome analysis and annotation.

**Course Learning Outcome (CLOs):**

- CLO1:** To describe recombinant DNA tech, DNA libraries, southern, northern and western blotting.
- CLO2:** To explain PCR and its types, Agarose gel electrophoresis.
- CLO3:** To techniques for sequencing genomes.
- CLO4:** To DNA markers, their importance & applications.
- CLO5:** To genomics and its sub disciplines.
- CLO6:** To bioinformatics and its applications for analysis of genome.
- CLO7:** To phylogenetic analyses and comparative genome analyses

**Mapping Course Learning Outcomes (CLOs) with the PLOs**

CLOs	PL01	PL02	PL03	PL04	PL05	PL06	PL07	PL08	PL09	PL010
CLO1					m	m		m	m	m
CLO2									m	m
CLO3									m	m
CLO4									m	m
CLO5								m	m	m
CLO6								m	m	m
CLO7								m	m	m

(Note: “m” = matched)

## Mapping course learning Outcomes (CLOs) with the Teaching-Learning and Assessment strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CL01	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CL02	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CL03	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CL04	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CL05	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CL06	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CL07	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation

### YEAR-4, SEMESTER-8, COURSE-62

<b>Course Code: MIC-4806</b> <b>Course Title: Practical/ Research project</b> <b>Credits: 4.0</b>
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#### Rationale of the course:

The intended course is designed to correlate theoretical studies with practical tasks in advance level.

#### Course Objective:

The main objective of the course is to introduce students with the advance molecular techniques which is very much applicable to industry, diagnostics and research field.

#### Course content:

- Making of useful products:** Dough fermentation by baker's yeast for bread making, acetic acid by *Azotobacteraceti*, Yogurt by lactic starter, citric acid by *Aspergillus niger*.
- Test for Microbiological quality of water and beverages:** Standard quality analysis of water MPN, and quantitative analysis of water by membrane filter method.

3. **Estimation of biodeterioration:** Determination of microbes from corrosive surfaces, bacterial pollutions in sewage and industrial of effluents, and COD, BOD, ammonia, residual chlorine in wast water.
4. **Microbial biotechnology:** Methods of whole cell immobilization by Ca-alginate, separation of amino acids by thin layer chromatography, separation of sugars by paper chromatography.
5. **Growth kinetics and substrate utilization:** Demonstration of a fermentor and its operation, detection of specific growth rate substrate utilization constant and biomass in a steady state batch culture.
6. **Pesticide degradation:** Biodegradation of halogenated pesticide by bacterial dehalogenases, determination of organic Carbone in soil and waste –water,
7. **Clinical diagnosis:** Direct fluorescent antibody (DFA) detection, demonstration of DNA fingerprinting in clinical diagnosis, gene detection and DNA-hybridization analysis in clinical diagnosis, determination of plasma fibrinogen level, determination of fibrin degradation product (FDP), radioimmuno detection of immunoglobulin (RID).
8. **Tuberculin test:** Anti Mycobacterium tuberculosis complex (IgA, IgG, IgM), determination of C-reactive protein (CRP).
9. **Research Project:** Research projects on specific topics of scientific importance will be set for selective students (s).

**Course Learning Outcome (CLOs):**

- CLO1:** To Understand the making of various useful products through fermentation techniques and function of a fermenter.
- CLO2:** To explain PCR and its types, Agarose gel electrophoresis.
- CLO3:** To Detect various environmental pollutions related to Microbiology.
- CLO4:** To Understand advance analytical and diagnostic techniques.
- CLO5:** To Isolate and detect biodegradative microbes from environment
- CLO6:** To Detect pathogens using serological techniques.

**Mapping Course Learning Outcomes (CLOs) with the PLOs**

CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1						m		m		m
CLO2				m		m			m	m
CLO3	m		m	m					m	m
CLO4			m						m	m
CLO5	m							m		m
CLO6								m	m	m

(Note: “m” = matched)

**Mapping course learning Outcomes (CLOs) with the Teaching-Learning and Assessment strategy**

<b>CLOs</b>	<b>Teaching-Learning Strategy</b>	<b>Assessment Strategy</b>
CL01	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CL02	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CL03	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CL04	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CL05	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation
CL06	Lecture, Interactive discussion, Multimedia presentation, Brain storming, Feedback, Assignment	Class Test, Mid Term, Final Exam, Class attendance, Assignment, Presentation

**YEAR-4, SEMESTER-8, COURSE-63**

<b>Course Code: MIC-4807</b>	<b>Course Title: Viva-voce</b>	<b>Credits: 2.0</b>
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**Rationale of the course: N/A**

**Course Objective:**

The objective of the course is to enable students to demonstrate a firm understanding of all the courses of this semester, so that the examiners can have an opportunity to assess the students.

**Course content:**

Topics of all the theoretical and practical courses of 8<sup>th</sup> semester and other relevant matters will be included.

**Course Learning Outcome (CLOs): N/A**

**Course Learning Outcomes (CLOs and Mapping of CLOs with Program Learning Outcomes (PLOs): N/A**

**Mapping course learning Outcomes (CLOs) with the Teaching-Learning and Assessment strategy: N/A**

# Chapter 5

## Grading/Evaluation

### 5.1 Grading scale:

A student's overall performance in a given course is based on a continuous assessment scheme. A continuous assessment is done through class participation, class test, homework, assignments and midterm examination. Final assessment for evaluation of credit is done through compilation of the marks obtained by the students in the continuous assessment and the semester final examination. The distribution of marks in terms of percentage is as follows:

Grading System		
Numerical Equivalent (%)	Grade	Grade Point (GP)
80 and above	A+ (A plus)	4.00
75 to below 80	A (A regular)	3.75
70 to below 75	A- (A minus)	3.50
65 to below 70	B+ (B plus)	3.25
60 to below 65	B (B regular)	3.00
55 to below 60	B- (B minus)	2.75
50 to below 55	C+ (C plus)	2.50
45 to below 50	C (C regular)	2.25
40 to below 45	D	2.00
Less than 40	F	0.00

'F' means fail.

### 5.2 Grading Description

The Grades (with numeric values) as described as follows:

- A+ Exceptional Performance / Excellent
- A Outstanding Performance
- A- Brilliant Performance
- B+ Very Good Performance; Most of the course objectives achieved; objectives met in a consistently thorough manner
- B Good Performance
- B- Above Average
- C+ Average, At least majority of the course objectives achieved; objectives met satisfactorily
- D Minimally Acceptable Performance; Less than the majority but more than the minimum required course objectives achieved; Objectives achieved at a minimally acceptable level
- F Unacceptable Performance; minimum required course objectives not met; objectives not met for minimally acceptable level; no credit earned



(a) A Course in which a student has obtained “D” or a higher grade will be counted as Credits earned by him/her. Any course in which a student has obtained “F” grade will not be counted towards his/her earned credit.

(b) Thirty percent (30%) of marks of a theoretical course is allocated for continuous assessment i.e. class participant/attendance, quizzes/assignment and class tests/Mid-term. The remaining (70 %) of the marks is allotted to Semester Final Examination. The distribution of theory marks for a given course is as follows:

Class participation/Attendance	10%
1 <sup>st</sup> class test	10%
2 <sup>nd</sup> class test/ Midterm	10%
Semester Final	70%
<b>Total</b>	<b>100%</b>

Controller of examination appoint external examiner to conduct final examinations. External examiners are proposed by the department. Practical examination includes laboratory experiments both written and demonstration, attendance, practical note book and viva voce. Marks for class attendance or participation are as follows;

Percent of class attendance	Marks (%) for 3/4 credits	Marks (%) for 2 credits
95% and above	10	5
90% to 94%	9	4.5
85% to 89%	8	4
80% to 84%	7	3.5
75% to 79%	6	3
70% to 74%	5	2.5
Less than 70%	0	0

Students having attendance less than 70% in any of the courses is not allowed to the semester final examination, he/she has to repeat the course in the next semester with fresh enrollment.

### (c) Teaching-Learning Strategy

The Teaching-Learning Strategy depends mostly on the course teacher or instructor and the duration of the classes. Most of the teaching learning strategies followed in the faculty are as follows-

- i. Class lecture with multimedia presentation
- ii. Group discussion
- iii. Demonstration
- iv. Practical experiment and result oriented study
- v. Identification of field problem and find out effective solution
- vi. Assignment
- vii. Brain storming
- viii. Feed back
- ix. Seminar, tutorial, workshop
- x. Field tour
- xi. Industry visit
- xii. Internship

### (d) Assessment Strategy

Assessment strategy is important to meet the objective of the curriculum. Various standard methods are used for the assessment. The assessment methods are reviewed at regular intervals to upgrade and adapt the quality assessment. The followed assessment strategies are;

- Quizzes
- Class test
- Term examinations
- Short answer
- Essay type/ broad answer
- Experiment demonstration performance
- Clinical examination performances
- Reports
- Assignment
- Multimedia presentations
- Class Attendance

Students are well informed about the assessment process and assessment results are published as soon as possible. Justice and transparency are ensured in the assessment system.

### 5.3 Grade point Average (GPA) and Cumulative Grade Point Average (CGPA):

#### GPA Calculation

Grade Point Average (GPA) is the weighted average of the Grade Points obtained by the students in all the courses in the examination of the Semester. For example, if a student passes/ completes, five courses in a semester having credits C1, C2, C3, C4 and C5 and his grade points in these courses are G1, G2, G3, G4 and G5 respectively then –

$$GPA = \frac{\sum C_i G_i}{\sum C_i} \quad \text{where, } i=1 \text{ to } 5$$

For example, if a student takes 6 courses in one semester and obtains the following grades

Course	Credits	Letter Grade	Grade Points
01	4	A+	4.00
02	4	C+	2.50
03	4	A-	3.50
04	2	B-	2.75
05	2	B	3.00
06	2	F	0.00

Then the GPA for the semester, calculated to two digits after decimal point will be –

$$GPA = \frac{4(4.00) + 4(2.50) + 4(3.50) + 2(2.75) + 2(3.00) + 2(0.00)}{(4+4+4+2+2+2)} = 2.86$$

### CGPA Calculation

Cumulative Grade Point Average (CGPA) is the weighted average of the GPA secured over the total number of semesters for a course of studies. We can calculate the CGPA of a student using following formula:

$$CGPA = \frac{(Grade\ point\ average\ earned\ in\ semester\ i \times Total\ credit\ hours\ in\ semester\ i)}{(Total\ credit\ hours\ in\ semester)}$$

For example:

Semester	GPA	Credits
1	4.00	20
2	3.00	30
3	3.50	25
4	3.00	20

The CGPA in this case will be –

$$CGPA = \frac{(20 \times 4) + (30 \times 3) + (25 \times 3.5) + (20 \times 3)}{20 + 30 + 25 + 20} = 3.34$$

**5.4 Course withdrawal:** All courses are compulsory.

**5.5 Incomplete courses:** If any student failed to obtain 40% marks in any of the courses in a semester, that courses are incomplete courses. He/she has to complete it in the next semester.

**5.6 Retake:** A student who receives an 'F' grade in a course will be required to retake/supplement that course. When a student repeats a course in which he or she previously received an 'F' grade, he or she is not eligible to receive a grade higher than a 'B+' in that repeated course.

**5.7 Grade improvement:**

- If a student obtains a Grade equal to or lower than “B” in a course, he/she will be allowed to repeat the course only once during the following Supplementary Examination but he/she will not be eligible to get a Grade better than “B+” in such a course.
- If a student fails to improve his Grade then his/her earlier Grade will be retained.
- If a student likes to improve the Grade earned in a course of 4th year (8th semester), he must apply for such improvement examination before the issuance of transcript. Improvement examination shall not be allowed once the degree is awarded.

**5.8 Dropout:**

A student must secure at least a GPA of 2.00 in Semester Final Examination for promotion to next higher Semester subject to the condition that he/she has not failed in more than two core courses in Semester. Otherwise, he/she will be considered as detained on that semester.

A Student who (a) is debarred from appearing at the examination due to shortage in class attendance or (b) fails in a Semester Final Examination may seek readmission within two weeks after the announcement of the result of the Semester. The student will have to pay prescribed fees for the Semester and a Readmission Fee as prescribed by the University. After readmission the student has to attend the classes regularly and must obtain 70% attendance from the date of readmission.