GONO BISHWABIDYALAY

DEPARTMENT OF MICROBIOLOGY

OUTCOME BASED EDUCATION (OBE) CURRICULUM

FOR

MASTER OF SCIENCE (MS) IN MICROBIOLOGY

Faculty of Health Sciences

GONO BISHWABIDYALAY
Nolam, Mirzanagar, Savar, Dhaka - 1344, Bangladesh

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Chapter 1
General Information

1.1 Title of the Academic Program: MS (Master) in Microbiology

1.2 Name of the University: Gono Bishwabidyalay

1.3 Vision of the Gono Bishwabidyalay

Gono Bishwabidyalay, a university with a difference has been established with a vision to createa 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 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
Masters (MS) in Microbiology under the faculty of Health Sciences.

2.2 Vision of the Department
Our vision for the MS in Microbiology program is to cultivate a dynamic and inclusive learning environment that empowers students to become versatile and ethically-driven professionals in the field of microbiology. Through a robust Outcome-Based Education (OBE) curriculum, we aim to foster a transformative educational experience that integrates cutting-edge scientific knowledge, practical skills, and a commitment to lifelong learning.

2.3 Mission of the Department
The mission of the Master of Science in Microbiology program is to cultivate a dynamic learning environment that equips students with a comprehensive understanding of microbiological principles and their applications. Our program is committed to fostering intellectual curiosity, critical thinking, and hands-on skills to prepare graduates for successful careers in academia, research, industry, and healthcare. Our graduates will emerge as leaders and innovators, equipped to address global challenges and contribute meaningfully to scientific discovery, public health, and the diverse applications of microbiology in a rapidly evolving world.

2.4 Objective of the Department
Gono Bishwabidyalay opened the MS program course in Microbiology 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: MS Masters 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

1. **Advance Technical Knowledge:** Mastery of advanced microbiological techniques, analytical microbiology, and molecular genetics to solve intricate problems in microbiology. Application of acquired technical skills to address complex challenges in microbiology and related fields.
2. **Microbiological Knowledge in Interdisciplinary Contexts:** such as virology, oncology, bioprocess technology, environmental microbiology, and bacterial pathogenesis. Demonstration of expertise in addressing multifaceted challenges in research, industry, and public health by integrating knowledge from various disciplines.
3. **Lifelong Learning and Adaptability:** Commitment to continuous learning and staying abreast of advancements in microbiology and related disciplines. Adaptability to evolving technologies and methodologies in the field of microbiology. Pursuit of professional development opportunities to enhance knowledge and skills throughout their career.
4. **Effective Communication and Scientific Writing:** Clear and concise oral communication of scientific concepts and research findings to diverse audiences. Proficient scientific writing skills, demonstrated through the preparation of well-structured reports, publications, and documentation. Ability to articulate complex microbiological information in a manner accessible to both specialized and non-specialized audiences.
5. **Critical Thinking and Problem-Solving:** Ability to analyze and evaluate microbiological issues critically. Application of creative problem-solving skills to address challenges in microbiology and related fields. Capacity to develop innovative solutions based on a thorough understanding of microbiological principles.
6. **Ethical Conduct and Professional Responsibility:** Adherence to ethical standards in microbiological research and practice. Demonstration of professional responsibility in handling microbiological data, specimens, and experimental procedures. Consideration of societal and environmental implications in microbiological decision-making**.**
7. **Environmental Literacy:** An awareness of environmental implications of biotechnology and Microbiological research.
8. **Self-Motivation:** Has self-discipline, planning, organizational and time management skills and the ability to work independently.
9. **Teamwork:** Ability to work effectively as both a member and leader within a team.

2.8 Program Educational Objectives (PEO)

PEO-1 (Advanced Technical Proficiency): Graduates will apply advanced technical skills and knowledge acquired in microbiological techniques, analytical microbiology, and molecular genetics to address complex challenges in microbiology and related fields.

PEO-2 (Research Competence and Methodological Expertise): Graduates will demonstrate proficiency in designing and conducting scientific research, applying robust methodologies and molecular genetic techniques, and contributing to the advancement of knowledge in microbiology.

PEO-3 (Effective Communication and Scientific Writing): Graduates will effectively communicate scientific concepts and research findings through oral presentations, written reports, and publications, showcasing the ability to convey complex microbiological information to diverse audiences.

PEO-4 (Integration of Microbiological Knowledge in Interdisciplinary Contexts): Graduates will integrate microbiological knowledge with other disciplines, applying their expertise in virology, oncology, genetic engineering, environmental microbiology, and bacterial pathogenesis to address multifaceted challenges in research, industry, and public health.

PEO-5 (Critical Thinking and Problem Solving): Graduates will exhibit strong analytical and critical thinking skills, enabling them to identify, assess, and solve microbiological problems effectively. They will be adept at applying a multidisciplinary approach, integrating knowledge from various sub-disciplines to develop innovative solutions to real-world challenges.

2.9 Program Learning Outcome

Program Learning Outcomes (PLO)

Department of Microbiology offers MS (Masters) degree in Microbiology. Upon graduation,students of Microbiology will be able to:

PLO-1 (Demonstrate Proficiency in Microbiological and Analytical Techniques): Graduates will be proficient in fundamental microbiological techniques, including isolation, cultivation, and identification of microorganisms, as well as demonstrating a deep understanding of analytical techniques and their applications in the identification, quantification, and characterization of microorganisms.

PLO-2 (Apply Molecular Genetics in Microbiological Research): Graduates will be adept in applying molecular genetics techniques to analyze microbial genomes, gene expression, and genetic variation, and will demonstrate the ability to design and conduct research using sound methodological approaches.

PLO-3 (Assess Microbiological Safety in Various Industries): Graduates will be able to evaluate and implement microbiological safety protocols in the food, fish, and pharmaceutical industries, ensuring compliance with regulatory standards and

safeguarding public health.

PLO-4 Integrate Environmental Microbiology and Investigate Bacterial Pathogenesis: Graduates will have a deep understanding of the role of microorganisms in environmental processes and pathogenesis. They will be capable of assessing the environmental impact of microorganisms and understanding the molecular mechanisms underlying bacterial pathogenesis.

PLO-5 (Analyze Virology and Oncology Concepts): Graduates will possess a comprehensive understanding of virology and its implications in oncology, including the molecular mechanisms of viral infections and their role in cancer development, enabling them to contribute to advancements in medical research.

PLO-6 (Apply Genetic Engineering in Microbial Systems): Graduates will be capable of engineering microbes for specific purposes, including the production of biofuels, pharmaceuticals, and other biotechnological applications and also optimizing genetic modifications in microorganisms, utilizing tools such as CRISPR-Cas9, recombinant DNA technology, and synthetic biology approaches.

PLO-7: Integrate Public Health Microbiology: Graduates will be equipped with the knowledge and skills to contribute to public health efforts through the identification, surveillance, and control of microbial agents that pose threats to human health.

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					
PEO 3		m	m			m		
PEO 4	m	m	m					
PEO 5	m		m				m	

(Note: "m" =matched)

2.11 Mapping PLOs with the PEOs

PLOs	PEO-1	PEO-2	PEO-3	PEO-4	PEO-5
PLO-1	m	m	m	m	m
PLO-2	m	m	m	m	m
PLO-3				m	m
PLO-4	m			m	m
PLO-5	m	m	m	m	m
PLO-6	m	m	m	m	m
PLO-7				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.

Course Code	Courses Name	Program Learning Outcomes (PLOs)						
		PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7
MIC-5101	Microbiological and Analytical Techniques	m	m					
MIC-5102	Molecular Genetics and Bioinformatics	m	m					
MIC-5103	Immunopathology and Vaccine Development		m				m	m
MIC-5104	Environmental Biotechnology				m			
MIC-5105	Research Methodology and Scientific Communication Skills	m	m	m	m		m	m
MIC-5201	Bacterial Pathogenesis and Molecular Epidemiology				m			m
MIC-5202	Molecular Virology and Oncology	m			m	m		m
MIC-5203	Public Health Microbiology				m			m
MIC-5204	Genetic Engineering	m	m			m	m	
MIC-5205	Microbial Food Safety Management			m				m
MIC-5106	Research proposal and Presentation (Core for Group A)	m	m	m	m	m	m	m
MIC-5206	Thesis Evaluation (Core for Group A)	m	m	m	m	m	m	m
MIC-5207	Thesis Defense (Core for Group A)	m	m	m	m	m	m	m
MIC-5107	Practical/ Laboratory works (Core for Group B)	m	m	m	m	m	m	m
MIC-5208	Short Project/ Industrial Visit/ Hands-on Training (Core for Group B)	m	m	m	m	m	m	m
MIC-5209	Seminar presentation and Viva voce (Core for Group B)	m	m	m	m	m	m	m

(Note: "m" = matched)

Chapter 3
Structure of the Curriculum

3.1 Duration of the program: 1 Year Semesters: 2

3.2 Admission Requirements and General Criteria:

- ✓ Gono Bishwabidyalay follows the rules and regulation of Bangladesh University Grand Commission for students' admission.
- ✓ A Master of Science degree must be completed by the student within a maximum duration of 1(one) academic year (not exceeding 1.6 years) from the year of enrollment. Attaining a minimum CGPA of 2.5 on a 4.00 scale and earning 36 credits are prerequisites for the successful fulfillment of the MS program. Upon meeting these requirements, the University authority will confer and award the degree to the student.
- ✓ Students who have completed coursework in Biochemistry, Molecular Biology, Genetic Engineering, Biotechnology, Pharmacy, Veterinary and Animal Sciences, MBBS, and BDS are eligible for admission to the Master's program in the Department of Microbiology within the first two years following their respective programs. However, after this initial period, students from mentioned disciplines will no longer qualify for admission to the Master's program.
- ✓ The students are categorized into two groups: Group A, designated as the Thesis Group, and Group B, identified as the Non-Thesis Group. The allocation of students into either thesis or non-thesis groups, along with the eligibility criteria, is determined by the Academic Committee of the Department. To be eligible, a student should have achieved a minimum Cumulative Grade Point Average (CGPA) of 3.50 on a 4.00 scale in their BS (Honours) degree. Students attaining a CGPA of 3.5 or above are granted the flexibility to choose between Group A and Group B based on their academic preferences and objectives.
- ✓ Both regular and in-service Master's students are required to finish their thesis within the designated timeframe; failure to do so will result in the cancellation of their degrees. Neither the supervisor nor the department will assume responsibility in such instances.
- ✓ The act of copying/ plagiarism a thesis paper submitted by someone else will lead to the revocation of the degree.

3.3 Total Minimum credit requirement to complete the program:

When a student enrolls in the Microbiology Department for the degree of MS in Microbiology he/she has to earn **36** academic credits. In case of theoretical course, one lecture per week per semester (14 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 the program: The MS Program will be of 1 (one) academic year duration, the breakdown of witch in given bellow:

Classes	28 weeks
Preparation Time for Course Final Examination	4 weeks
Course Final Examination (Theory)	4 weeks
Submission of Thesis/ Projects/ Practical/ Seminar	12 weeks
Results (Tabulation and publishing)	4 weeks
Total	**52 weeks**

3.5 Minimum CGPA requirements for post-graduation: CGPA 2.5

3.6 Duration of the degree: 1 years/ 2 semester

3.7 Maximum academic years of completion: 1.6 years/3 semesters

3.8 Category of courses:

i. Core Courses:

SL	Course Code	Course Title	Credit
1	MIC-5101	Microbiological and Analytical Techniques	3.0
2	MIC-5102	Molecular Genetics	3.0
3	MIC-5103	Immunopathology and Vaccine Development	3.0
4	MIC-5104	Environmental Biotechnology	3.0
5	MIC-5105	Research Methodology and Scientific Communication Skills	3.0
6	MIC-5201	Bacterial Pathogenesis and Molecular Epidemiology	3.0
7	MIC-5202	Molecular Virology and Oncology	3.0
8	MIC-5203	Public Health Microbiology	3.0
9	MIC-5204	Genetic Engineering	3.0
10	MIC-5205	Microbial Food Safety Management	2.0

iii. Elective courses: Not Applicable

iv. Capstone course/ thesis/ projects/ internship: Students have to complete a thesis course/ Practical related course of 8 Credits.

SL	Course Code	Course Title	Credit
1	MIC-5106	Research proposal and Presentation (Group A)	2.0
2	MIC-5206	Thesis Evaluation (Group A)	4.0
3	MIC-5207	Thesis Defense (Group A)	2.0
4	MIC-5107	Practical/ Laboratory works (Group B)	4.0
5	MIC-5208	Short Project/ Industrial Visit/ Hands-on Training (Group B)	2.0
6	MIC-5209	Seminar presentation and Viva voce (Group B)	2.0

3.9 Year/Level/Semester/Term wise distribution of courses

First Semester

Course No.	Course Name	Credits	Marks
Core Courses			
MIC-5101	Microbiological and Analytical Techniques	3.0	100
MIC-5102	Molecular Genetics and Bioinformatics	3.0	100
MIC-5103	Immunopathology and Vaccine Development	3.0	100
MIC-5104	Environmental Biotechnology	3.0	100
MIC-5105	Research Methodology and Scientific Communication Skills	2.0	50
MIC-5106	Research proposal and Presentation (Group A-Thesis)	2.0	50
MIC-5107	Practical/ Laboratory works (Group B-Non-Thesis)	4.0	100

Second Semester

Course No.	Course Name	Credits	Marks
Core Courses			
MIC-5201	Bacterial Pathogenesis and Molecular Epidemiology	3.0	100
MIC-5202	Molecular Virology and Oncology	3.0	100
MIC-5203	Public Health Microbiology	3.0	100
MIC-5204	Genetic Engineering	3.0	100
MIC-5205	Microbial Food Safety Management	2.0	50
MIC-5206	Thesis Evaluation (Group A-Thesis)	4.0	100
MIC-5207	Thesis Defense (Group A-Thesis)	2.0	50
MIC-5208	Short Project/ Industrial Visit/ Hands-on Training (Group B-Non-Thesis)	2.0	50
MIC-5209	Seminar presentation and Viva- voce (Group B-Non-Thesis)	2.0	50

Chapter 4

Description of all courses of the program

SEMESTER–1, COURSE-01

Course Code: MIC-5101	Course Title: Microbiological and Analytical Techniques	Credits: 03

Rationale of the course:

The course intends to make highlycompetent researchers in the field of Microbiological and analytical techniques.

Course Objective:

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

Course content:

1. **Microscope and Microscopy:** Microscopy, types of microscopes, principles of microscopy, Observation of microorganisms under microscope by- Wet-mount and hanging-drop technique, Staining of Microbial samples, Mechanisms of different types of staining.
2. **Cultivation, Isolation and Growth Measurement:** Types of cultivation in different conditions, Isolation and pure culture technique, Measurement of growth by different types of measurement techniques, Direct cell counting, Measurement of biomass, Viable counts.
3. **Culture Preservation and Management:** Different methods for short-term and long-term preservation of Microbial culture, Monitoring and routine check of cultures, Management of different type culture collections.
4. **Methods of Microbial Control:** Concept of Microbial control, Factors influencing Microbial control, Different physical and chemical methods, Rate of Microbial death, Agents used to control microorganisms.
5. **Separation of insoluble:** products-filtration, centrifugation, sedimentation, flocculation; Cell disruption; separation of soluble products: liquid-liquid extraction, precipitation, chromatographic techniques, reverse osmosis, ultra and micro filtration; final purification: drying; crystallization; storage and packaging.
6. **Protein Characterization**: Determination of molecular weight, amino acid composition and number of subunit, protein sequencing.

Course Learning Outcomes:

CLO1: To know the basics of microscopes and microscopy.
CLO2 To explain cultivation, isolation and growth measurements of Microorganisms.
CLO3: To perform the culture preservation and management of microorganisms.
CLO4 To describe methods of Microbial control.
CLO5 To complete different analytical techniques.
CLO6 To characterize protein.

Mapping Course Learning Outcomes (CLOs) with the PLOs:

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

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

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture, Multimedia presentation	Class Test, Mid Term, Final Exam
CLO2	Lecture, Multimedia presentation	Quiz, Mid Term, Final Exam
CLO3	Interactive discussion, Multimedia presentation	Class Test, Mid Term, Final Exam
CLO4	Lecture, Multimedia presentation,	Tutorials, Mid Term, Final Exam
CLO5	Lecture, Multimedia presentation	Quiz, Mid Term, Final Exam
CLO6	Interactive discussion, Multimedia presentation	Class Test, Mid Term, FinalExam

SEMESTER–1, COURSE-02

Course Code: MIC-5102 Course Title: Molecular Genetics and Bioinformatics Credits: 03

Rationale of the course:

The course intends to make highlycompetent researchers in the field of molecular biology.

Course Objectives:

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

Course content:

1. **DNA Replication:** Structures and functions of DNA & RNA; Semiconservative Replication: Meselson and Stahl's Experiment; Modes of circular and linear DNA replication; Requirements of DNA replication; Mechanism of Replication of Bacterial and eukaryotic DNAs; Replication of RNA.
2. **Transcription and RNA Processing:** Basic requirements for transcription; Mechanism of bacterial transcription; the process of eukaryotic transcription; Post-transcriptional processing of mRNA, tRNA and rRNA.
3. **Translation:** The Genetic Code; Overview of bacterial translation system; Attachment of amino acids to transfer RNAs; Initiation, elongation and termination of translation in prokaryotes; Translation system in eukaryotes; Protein folding and post-translational modifications; Mechanisms of Action of translation-targeting antibiotics.
4. **Control of Gene Expression in Eukaryotes:** Control of transcription initiation in eukaryotes; Cis-acting regulatory regions: Promoters and enhancers; Trans-acting proteins: Basal transcription factors and transcriptional activators; Histone modification; Chromatin remodeling and DNA Methylation; Gene regulation by RNA processing and degradation.
5. **Human Gene Therapy:** Gene therapy and Cancer, Ethical issues raised in gene therapy, Somatic cell therapy and germ-line gene therapy, Gene Function interruption therapy: antisense RNA and ribozymes, Therapeutic use of anti-sense oligonucleotide, Pre-transcriptional inactivation of mRNA.
6. **Bioinformatics:** Introduction to DNA and protein databases, data storage, file formats, information retrieval; Database queries, sequence retrieval, Creation of restriction endonuclease maps; Sequence alignment: Local alignment, Global alignment, and Multiple alignments; Evolutionary analyses through phylogenetic tree reconstruction and selection pressure determination.

Course Learning Outcome (CLOs):

CLO1: To describe about structure and replication of DNA.

CLO2: To explain the concepts on RNA transcription.

CLO3: To know the process of Translation.

CLO4: To recognize the control of gene expression in eukaryotes.

CLO5: To discuss the process of human gene therapy

CLO6: To understand the basics of bioinformatics.

Mapping Course Learning Outcomes (CLOs) with the PLOs

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

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

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture, Multimedia presentation	Class Test, Mid Term, Final Exam,
CLO2	Lecture, Interactive discussion	Quiz, Mid Term, Final Exam
CLO3	Interactive discussion,Multimedia presentation	Class Test, Mid Term, Final Exam
CLO4	Lecture, Interactive discussion	Tutorials, Mid Term, Final Exam
CLO 5	Lecture, Multimedia presentation	Class Test, Mid Term, Final Exam
CLO6	Lecture, Interactive discussion	Quiz, Mid Term, Final Exam
CLO7	Interactive discussion, Multimedia	Class Test, Mid Term, Final Exam

SEMESTER–1, COURSE-03

Course Code: MIC-5103 Course Title: Immunopathology and Vaccine Development Credits: 03

Rationale of the course:

The course intends to make highly competent researchers in the field of immunology.

Course Objective:

The major objective of the course is to help students learning the advanced concepts in vaccine developments and inventions in advanced immunology

Course Content

1. **Inactivation and Activation of Biologically Active Molecule:** Mechanism of antibody mediates inactivation: Hormone, receptor, ligand, Neutralism antibodies-cause and effect, Protective functions of inactivating antibodies.
2. **Cytotoxic and Cytolytic Reaction:** Mechanism of Cytolytic Reactions, Immunohematology disease: Erythrocyte, leukocytes and platelets, Detection of circulating cytotoxic antibodies, Protective and pathologic effects in infectious disease.
3. **Granulomatous Reaction:** Nature of glaucomatous, Granulomatous disease (infectious disease, bacterial and parasitic).
4. **Inflammation:** Non-Immune and Immune Inflammation, Immune specific protection

against infections, Interaction of immune mechanism in infectious disease, Evasion of immune defense mechanisms.

5. **Antibody Engineering:** Antibody gene cloning, Recombinant antibody gene expression, Applications of engineered antibodies; Hybrid Human-Mouse Monoclonal Antibodies: Chimeric and Humanized Antibody; Generation of a Xeno Mouse for Obtaining Human Monoclonal Antibodies; Engineered General Antibody Fragments: Single Chains (scFv) and Immunotoxins.
6. **Vaccine development:** Designing of vaccine (Attenuated vaccine, inactivated vaccine, Conjugate vaccine, Subunit vaccine, DNA based and other vaccines).
7. **Vaccine Strategy:** Different experimental vaccines (Botulism, Anthrax, Malaria, Pneumonia, Cholera, Typhoid, Hepatitis and Tumors).
8. **Vaccine safety and efficacy tests:** Serological methods of efficacy testing

Course Learning Outcomes (CLOs)

CLO1: To discuss the mechanisms for inactivation and activation of biologically active molecules
CLO2: To explain cytotoxic, cytolytic and granulomatous reactions.
CLO3: To know various processes of inflammations.
CLO4: To discuss advanced knowledge of antibody engineering.
CLO5: To explain vaccine developments designs and current vaccine strategies.

Mapping Course Learning Outcomes (CLOs) with the PLOs:

(CLOs)	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7
CLO1	m					m	m
CLO2	m						
CLO3	m						
CLO4	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
CLO1	Lecture, Interactive discussion	Class Test, Mid Term, Final Exam
CLO2	Lecture, Multimedia presentation, Brain storming	Class Test, Mid Term, Final Exam
CLO3	Lecture, Interactive discussion	Class Test, Mid Term, Final Exam
CLO4	Lecture, Multimedia presentation	Class Test, Mid Term, Final Exam
CLO5	Lecture, Interactive discussion	Class Test, Mid Term, Final Exam

SEMESTER–1, COURSE-04

Course Code: MIC-5104	Course Title: Environmental Biotechnology	Credits: 03

Rationale of the course:
The course intends to make highlycompetent researchers in the field of Environmental Biotechnology.

Course Objective
The major objective of the course is to help students learning the advanced concepts in environmental biotechnology and apply this knowledge in practical field.

Course content:

1. **Environmentally transmitted pathogens:** Transmission, survival and distribution of various type of bacterial and viral pathogens including opportunistic ones, endemic, emerging and re-emerging bacterial and viral pathogens.
2. **Risk Assessment:** The concept of risk assessment, the process of risk assessment (Hazard identification, Exposure assessment, and Dose-response assessment), Risk characterization, and Microbial risk assessment.
3. **Microorganisms and Metal Pollutants:** Source of Metals, Metal bio-availability in the environment, Metal toxicity effects on the Microbial cells, Mechanisms of Microbial metal resistance and detoxification, the benefits of metal, (Microbial interaction, Innovative Microbial approaches to the remediation of metal, Contaminated aquatic system with special reference to: arsenic, chromium and lead).
4. **Biosensor:** Recent developments in biosensors and their use, Characteristics of biosensor, Biochemical application of biosensors in environmental pollution detection.
5. **Non-culturable Microorganisms in the Environment:** Concept of viable but nonculturable cells (VBNC), Molecular genetic methods for detection and identification of VBNC, Implication and significance of VBNC in environment and human health.
6. **Pollution Control Biotechnology:** Use of commercial blend of microorganisms and enzymes in wastewater treatment, Immobilized cells in the waste treatment, Potential application of recombinant DNA technology in waste treatment.
7. **Xenobiotic and Degrading Bacteria and their Catabolic Genes in Bioremediation:** In situ Analysis of Microbial community and activity in bioremediation, DNA based methods, RNA based methods Genetic finger-printing techniques, Recent development of methods increasing specificity detection.

Course Learning Outcome (CLOs):

CLO1: To know about various environmentally transmitted pathogens.

CLO2: To discuss the processes of risk assessment

CLO3: To explain metal pollution, toxicity and using microorganism to tackle it

CLO4 To describe various practical applications of biosensors.

CLO5 To know non-cultural microorganisms in environments

CLO6 To understand the pollution control biotechnology, xenobiotic compounds and degrading bacteria with catabolic genes

Mapping Course Learning Outcomes (CLOs) with the PLOs:

(CLOs)	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7
CLO1			m	m			
CLO2			m	m			
CLO3				m			m
CLO4	m			m		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	Class Test, Mid Term, Final Exam
CLO2	Lecture, Interactive discussion	Quiz, Mid Term, Final Exam
CLO3	Interactive discussion,Multimedia presentation	Tutorials, Mid Term, Final Exam,
CLO4	Lecture, Interactive discussion	Class Test, Mid Term, Final Exam, Class attendance
CLO5	Lecture, Interactive discussion	Quiz, Mid Term, Final Exam
CLO6	Interactive discussion,Multimedia presentation	Tutorials, Mid Term, Final Exam,

SEMESTER–1, COURSE-5

Course Code: MIC-5105 Course Title: Research Methodology and Communication Skills Credits: 02

Rationale of the course:

The course intends to encourage and train the students on a basic foundation for research in their interest area.

Course Objective

To provide knowledge about tools and techniques related with research methodology and scientific communication**.**

Course Content:

1. **Foundations of Research:** Meaning, Objectives, Motivation, Utility. Concept of theory, empiricism, deductive and inductive theory. Characteristics of scientific method – Understanding the language of research – Concept, Construct, Definition, Variable. Research Process.
2. **Problem Identification & Formulation:** Research Question – Investigation Question – Measurement Issues – Hypothesis – Qualities of a good Hypothesis –Null Hypothesis & Alternative Hypothesis. Hypothesis Testing – Logic & Importance.
3. **Qualitative and Quantitative Research:** Qualitative research – Quantitative research –

Concept of measurement, causality, generalization, replication. Merging the two approaches.

4. **Measurement:** Concept of measurement – what is measured? Problems in measurementin research – Validity and Reliability. Levels of measurement – Nominal, Ordinal, Interval, Ratio.
5. **Sampling:** Concepts of Statistical Population, Sample, Sampling Frame, Sampling Error, Sample Size, Non-Response. Characteristics of a good sample. Probability Sample – Simple Random Sample, Systematic Sample, Stratified Random Sample & Multi-stage sampling. Determining size of the sample – Practical considerations in sampling and sample size.
6. **Data Analysis:** Data Preparation – Univariate analysis (frequency tables, bar charts, pie charts, percentages), Bivariate analysis – Cross tabulations and Chi-square test including testing hypothesis of association; Interpretation of data.
7. **Technical Writing Skills:** Types of reports; layout of a formal report; scientific writing skills - importance of communicating science; problems while writing a scientific document; plagiarism, software for plagiarism; scientific publication writing: elements of a scientific paper including abstract, introduction, materials & methods, results, discussion, references; drafting titles and framing abstracts; publishing scientific papers -peer review process and problems, plagiarism; ethical issues; scientific misconduct.
8. **Use of Database:** Encyclopedias, Research Guides, Handbook etc., Academic Databases for Computer Science Discipline.
9. **Use of Tools / Techniques for Research:** Methods to search required information effectively, Reference Management Software like Zotero/Mendeley, Software for paper formatting like LaTeX/MS Office, Software for detection of Plagiarism.
10. **Presentation Skills:** Formal presentation skills; preparing and presenting using over-head projector, PowerPoint; defending interrogation; scientific poster preparation & presentation; participating in group discussions.

Course Learning Outcomes (CLOs)

CLO1: To understand the existence of scientific knowledge in ancient times.
CLO2: To acquire the skills of scientific reading, writing and presentations.
CLO3: To appreciate the scientific ethics through case studies

Mapping Course Learning Outcomes (CLOs) with the PLOs

(CLOs)	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7
CLO1	m						m
CLO2		m		m	m	m	m
CLO3	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	Class Test, Mid Term, Final Exam
CLO2	Lecture, Multimedia presentation	Quiz, Mid Term, Final Exam
CLO3	Lecture, Multimedia presentation	Class Test, Mid Term, Final Exam

Semester-1, COURSE-06

Group-A (Thesis)

Course Code: MIC-5106	Course Title: Research proposal and presentation	Credits: 2.0

Rationale of the course:

The course intends to make researchproposals and synopsis presentations for thesis purposes.

Course Objective:

The major objective of the course is to help students fulfilling synopsis presentation in PowerPoint.

Course Content: N/A

Course Learning Outcomes (CLOs):

CLO1: To formulate research strategies; presenting synopsis in PowerPoint format.

Mapping Course Learning Outcomes (CLOs) with the PLOs:

(CLOs)	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7
CLO1	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	Power point presentation	Synopsis presentation

Semester–1, COURSE-7

Group-B (Non-Thesis)

Course Code: MIC-5107	Course Title: Practical/ Laboratory works	Credits: 04

Rationale of the course:

The course intends to the purpose of providing adequate practical knowledgefor conducting any microbiological analysis.

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:

1. Microscopic Techniques

a) Different Techniques in microbial staining (Gram staining, Simple Staining and negativeb) Staining, Gram staining, Acid fast staining and spore staining).

c) Different Techniques for inoculation and cultivation of microorganism (Pure culture andd) their characterization, Anaerobic culture of Bacteria)

e) Techniques of enumeration of microorganism (Direct and indirect techniques)

f) Techniques for preservation and maintenance of pure culture.

g) Identification of microorganism: Biochemical tests (Catalase test, Coagulase test, h) Oxidase test, Nitrate reduction test, Litmus milk reaction test, MIU, KIA, IMVIC test,

i) Lipid, Casein, Hydrolysis of gelatin test); Carbohydrate Fermentation tests (Glucose,j) Fructose, Lactose, Maltose, Sucrose, Starch)

k) Control of microbial growth by physical and chemical agents

l) Antibiotic sensitivity tests

2. Food Microbiology

a) Standard of qualitative and quantitative analyses of water

b) Microbiological analysis of milk and dairy products, beverage, powdery food, fish andmeat.

c) Methods for controlling contamination in food industry

3. Pharmaceuticals Microbiology

a) Microbiological Assay of pharmaceutical raw materials, solids, ointments, and oral

b) liquids, potency of antibiotics.

c) Isolation and screening of antibiotic producing bacteria from soil

d) Methods for controlling contamination in pharmaceuticals industry

e) Endotoxin Test

4. Medical Microbiology/ Diagnostic Microbiology

a) Diagnosis of Pathogens from clinical samples, Stool, Urine, pus, blood, CSF samples

b) Study of different fungal isolates-yeasts and molds

c) Laboratory diagnosis of common fungal infection.

5. **Immunopatholog**y

a) Widal Test

b) Immuno-electrophoresis/ Gel Electrophoresis/ Western Blot

c) ELISA method

d) Identification of S. typhi by serotyping.

e) Blood Grouping

6. Molecular Microbiology

a. PCR

b. Immuno-electrophoresis/ Gel Electrophoresis/ Western Blot

c. ELISA method

d. Identification of S. typhi by serotyping.

7. Bioinformatics

a) Introduction to Nucleic acid database, retrieving sequence from NCBI, Exploring EnsEMBL Biomart portal, Retrieve BED file of genomic locations, Retrieve FASTA sequence of a gene

b) Open, Edit and Ensure sequence quality, looking for open reading frame, predict eukaryotic gene from a sequence, Finding UTR location

c) Promoter Prediction from Eukaryotic sequences, finding repeats from a given sequence

d) Detect and mask interspersed repeats in a sequence, CpG island prediction, Prediction of Transcription Factor Binding Sites (TFBS)

e) De-novo discovery & search of DNA regulatory motif, Restriction Digestion and

Computing restriction map (pGLO and PUC19)

f) Designing a PCR primer, Sequence Data submission to NCBI, Database of Similarity search
g) Sequence Alignment, MSA using Progressive and Consistency based alignment methods,
h) Phylogenetic Tree Construction, Predicting the main physico-chemical properties of a protein
i) Digesting a protein in a computer, Primary Structure Analysis of protein, Looking for transmembrane segments
j) Predicting Post-Translational, Modifications in Protein, Finding Known Domains in Protein
k) Predicting the secondary structure, tertiary structure of a protein sequence, Retrieving protein 3D structure
l) Displaying a 3D structure, Protein Network databases, Protein-protein interaction network construction, Visualization
m) Detection and analysis of mutation, Drug resistance gene identification, Drug design, Prediction of vaccine.

Course Learning Outcomes (CLOs):

CLO1: To conduct various microbiological analysis of different samples.
CLO2: To complete microbiological analysis of pharmaceutical products.
CLO3: To learn about modern bioinformatics tools.

Mapping Course Learning Outcomes (CLOs) with the PLOs:

(CLOs)	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7
CLO1	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	Practical Task, Feedback	Quiz, Mid Term, Final Exam
CLO2	Practical Task, Feedback	Tutorials, Mid Term, Final Exam
CLO2	Practical Task, Feedback	Quiz, Mid Term, Final Exam

SEMESTER–2, COURSE-08

Course Code: MIC-5201 Course Title: Bacterial pathogenesis and Molecular Epidemiology Credits: 03

Rationale of the course:

The course intends to have a complete study of bacterial pathogenesis and the distribution and determinants of infectious diseases in human populations and animals.

Course Objective

The main objective of the course is to introduce students to the knowledge of bacterial structures, virulence factor and their relation to pathogenesis; understand the public health approaches to prevent bacterial disease, genetically identifying techniques of bacteria and their epidemiology.

Course Content:

1. **Pathogenesis with Special Reference to Molecular Basis:** Shigellosis and Cholera, Bacterial ulcer in human, Meningitis and epiglottis, Botulism and Gas gangrene, Plague and Pelvic Inflammatory disease (*Haemophilus influenza*, *Listeria monocytogenes*.
2. **Bacterial Resistance to Antibiotic:** Mechanism of antibiotic resistance, Antibiotic tolerance: Transfer of resistance genes, Trace back of antibiotic resistance genes.
3. **Infection control and prevention:** Epidemic versus endemic, Steps in epidemiologic evaluation, Role of the laboratory in epidemiologic evaluation (Potential problems related to laboratory activities in epidemiology investigations).
4. **Epidemiologic Analysis: Criteria** for evaluating typing system, Phenotypic techniques (Bio typing, Anti-Microbial susceptibility testing, Serotyping, Bacteriophage typing, MLEE).
5. **Genotypic Techniques:** Plasmid analysis, REA of chromosomal DNA, Southern blot analysis of RRLPs, PFGE of chromosomal DNA typing system applying PCR, PCR-based detection of restriction sites, Nucleotide sequence analysis, Molecular typing of specific organisms, Application of Microbial typing system, Implementing a molecular epidemiologiclaboratory.

Course Learning Outcomes (CLOs)

CLO1: To Know about bacterial virulence factor and their relation to

CLO2: To describe antibiotic resistance mechanisms, host resistance, and genetic transfer of antibiotic resistance gene.

CLO3: To discuss the public health approaches to prevent and control the bacterial disease.

CLO4: To explain genetically identifying techniques of bacteria and their structure.

CLO5: To discuss the implementation of molecular epidemiology.

Mapping Course Learning Outcomes (CLOs) with the PLOs

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

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

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecture, Interactive discussion	Class Test, Mid Term, Final Exam
CLO2	Lecture, Multimedia presentation	Quiz, Mid Term, Final Exam
CLO3	Lecture, Multimedia presentation	Class Test, Mid Term, Final Exam
CLO4	Lecture, Interactive discussion	Class Test, Mid Term, Final Exam
CLO5	Lecture, Multimedia presentation	Quiz, Mid Term, Final Exam

SEMESTER–2, COURSE-09

Course Code: MIC-5202 Course Title: Molecular Virology and Oncology Credits: 03

Rationale of the course:

The course intends to have a complete study of persistent virus infection, pathogenesis, and their epidemics as well as the basic study of oncology with different types of cancer and their causes, cancer development, and the concept of therapeutic intervention in controlling cancer.

Course Objective:

The main objective of the course is to introduce the students to the knowledge of persistence of virus infection, pathogenesis, some special virus infection and their epidemiology, the study of emerging viruses in aspects of Bangladesh, the introduction of oncology and development of cancer, spreading, pathogenesis and their therapy.

Course Content:

1. **Persistence of Viruses:** Patterns of virus infections, Mechanisms of viral persistence, Persistence of HSV, EPV, and HIV in humans.
2. **Viruses of Special Interest:** Dengue and Japanese encephalitis virus, Nipah Virus, Ebola virus infection, Severe acute respiratory syndrome (SARS) and SARS corona virus, Other important viruses of recent epidemics.
3. **Virus Evolution and Emerging Viruses:** How do viruses evolve, Emerging viruses, Emergence of dengue virus infection in Bangladesh.
4. **Oncology:** Introduction and general terminology of oncology causes of cancer, cancer related genes, including oncogenes with their normal cellular function, mutagenesis and

consequences of their mutant state in cancer

5. **Cancer:** Development of cancer, Spread of cancer, Molecular mechanisms of transformation by DNA and RNA viruses, Physical and chemical factors to cancer development, Cancer therapy.
6. Oncogenic viruses: Different types of oncogenic viruses. Viral oncogenes, molecular mechanisms of transformation by DNA and RNA viruses.

Course Learning Outcomes (CLOs)

CLO1: To Know about virus infection, mechanism and persistence of virus.

CLO2: To discuss importance of some recent viruses and their epidemics.

CLO3: To know the virus evolution and emerging viruses in aspects of

CLO4: To learn about oncology

CLO5: To know development of cancer, spreading, molecular mechanisms, transformation and therapy

Mapping Course Learning Outcomes (CLOs) with the PLOs

(CLOs)	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7
CLO1					m		
CLO2					m		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	Class Test, Mid Term, Final Exam
CLO2	Lecture, Multimediapresentation	Quiz, Mid Term, Final Exam
CLO3	Lecture, Interactive discussion	Tutorials, Mid Term, Final
CLO4	Lecture, Interactive discussion	Class Test, Mid Term, Final Exam
CLO5	Lecture, Multimediapresentation	Quiz, Mid Term, Final Exam

SEMESTER–2, COURSE-10

Course Code: MIC-5203 Course Title: Public Health Microbiology Credits: 03

Rationale of the course:

The course intends to have a complete study of epidemiology and epidemic disease, as well as controlling the epidemic disease globally.

Course Objective

The main objective of the course is to learn the occurrence, abundance and distribution of microorganism in the community and their role in the associated with Public health and also learn different methods for their detection and characterization.

Course Content:

1. **Fundamentals:** Definition, Basic concept of epidemiology, Definitions; Mortality, Morbidity, Disease Progression, Endemic, Epidemic,Pandemic, Outbreak Agents, sources, reservoirs.
2. **Infectious Diseases:** The leading human killers**,** emerging and resurgent infectious diseases, Transmission, emergence factors.
3. **Public Health Measures for Controlling Epidemics:** Controls directly against the reservoirs, Controls directly against Transmission of the pathogens, Vaccination, quarantine, surveillance, environmental control.
4. **Global Health Considerations:** Infectious diseases in developing and developed countries, Travel to endemic areas.
5. **Types of Epidemiological Study:** Concepts of cause and risk of diseases, survey and survey methods, Cohort studies, Case-control studies, Intervention studies, Medical demography, Health education and nutrition.
6. **Zoonosis:** Conception and Classification of Zoonosis, impact of zoonosis, factors affecting the spread of zoonotic diseases.
7. **Zoonotic diseases:** Bacterial, viral and parasitic zoonotic diseases, prevention, control and eradication of zoonotic diseases, general method of epidemiological investigation of zoonotic diseases.

Course Learning Outcomes (CLOs)

CLO1: To Know basic concept of epidemiology, and some terminology.

CLO2: To discuss infectious disease and epidemic disease agents, sources, Reservoir and transmission.

CLO3: To know the public health approaches to prevent and control the epidemics.

CLO4: To know different types survey methods to study the epidemiology.

CLO5: To discuss the management, laws and regulations on travelling to endemic area.

Mapping Course Learning Outcomes (CLOs) with the PLOs

(CLOs)	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7
CLO1							m
CLO2					m		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	Class Test, Mid Term, Final Exam
CLO2	Lecture, Multimedia presentation	Quiz, Mid Term, Final Exam
CLO3	Lecture, Interactive discussion	Tutorials, Mid Term, Final Exam
CLO4	Lecture, Interactive discussion	Class Test, Mid Term, Final Exam
CLO5	Lecture, Multimedia presentation	Quiz, Mid Term, Final Exam

SEMESTER–2, COURSE-11

Course Code: MIC-5204 Course Title: Genetic Engineering Credits: 03

Rationale of the course:

The course intends to manipulate genetic materials that can be applied to a wide range of plants, animals, and creatures and has uses in health, research, industry, and agriculture.

Course Objective

The objective of the course is to train the students about gene cloning, role of enzymes and vectors for genetic engineering, gene transfer methods and to create experts who apply genetic engineering methods in a variety of contexts.

Course Content:

1. **Introduction:** Historical and milestones in genetic engineering; Emergence of rDNA technology; Five main techniques used for gene cloning: Isolation of DNA to be cloned, Insertion of foreign DNA into a vector, Transfer of rDNA into host cell, Detection of recombinant clone and replication and expression of rDNA.
2. **Purification of DNA from living cells:** Preparation of Total Cell DNA: Concentration of DNA samples, Measurement of DNA concentration and purity; Preparation of Plasmid DNA: Separation of plasmid DNA on the basis of size and conformation; Plasmid amplification; Preparation of lambda (λ) phage DNA; Preparation of M13 phage DNA.
3. Range of DNA manipulative e**nzymes**: Nucleases, Ligases, Polymerases and DNA modifying enzymes; Restriction edonucleases: Bacterial defence system, Recognition sequences of restriction endonucleases, Type II restriction enzymes; Ligation systems: Sticky-end and blunt-end ligation, Techniques of putting sticky ends onto a blunt-ended DNA.
4. **Introduction of recombinant DNA into living cells**: Transformation: Preparation of competent *E. coli* cells, Selection for transformed cells; Identification of recombinants: Insertional inactivation, Recombinant selection with pBR322 and pUC8; Introduction of phage DNA into bacterial cells: Transfection of M13 cloning vectors, in vitro packaging of lambda cloning vectors; Identification of recombinant phages; Introduction of DNA into plant and animal cells; Transformation of whole organisms.
5. **Vectors for gene cloning:** Plasmid-based Cloning Vectors: pBR322, pBR327, pUC8, pUC18,

pUC19 and pGEM3Z; cloning vectors based on λ bacteriophage: Insertion and replacement vectors, Cosmids; Cloning vectors based on M13 bacteriophage: Construction of M13 cloning vectors, Phagemids; High-capacity cloning vectors.

6. **Studying the translation product:** Hybrid-release translation (HRT) and Hybrid-arrest translation (HART); Studying protein–protein Interactions; Studying protein interactions: Phage display, Yeast two hybrid system (Y2H), Yeast three hybrid system (Y3H).
7. **Application of gene cloning and protein engineering**: Site-directed mutagenesis; Synthetic gene and PCR-based mutagenesis; Protein engineering.
8. **Genome engineering using CRISPR-Cas technology**: CRISPR-Cas systems: RNA-guided bacterial adaptive immune systems; Composition of CRISPR-Cas systems: CRISPR-Cas locus, CRISPR array and CRISPR associated (Cas) genes; CRISPR-Cas technologies and application: CRISPR-Cas9 structure and mechanism, Construction of a CRISPR-Cas9 genome editing toolbox; Expanding class 2 CRISPR-Cas engineering toolbox: CRISPR-Cas12 and CRISPR-Cas13; Deactivated Cas system (dCas).

Course Learning Outcomes (CLOs)

CLO1: To illustrate creative use of modern tools and techniques for manipulation and analysis of genomic sequences.

CLO2: To develop a clear understanding of the experimental methods that leads to setting cloning experiments.

CLO3: To expose students to application of recombinant DNA technology in biotechnological research.

CLO4: To gain sufficient understanding of the rapidly advancing science involved in creating transgenic plants, animals, and microbes.

Mapping Course Learning Outcomes (CLOs) with the PLOs

(CLOs)	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7
CLO1		m				m	
CLO2		m				m	
CLO3		m		m		m	
CLO4		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
CLO1	Lecture, Interactive discussion	Class Test, Mid Term, Final Exam
CLO2	Lecture, Multimedia presentation	Quiz, Mid Term, Final Exam
CLO3	Lecture, Interactive discussion	Class Test, Mid Term, Final Exam
CLO4	Lecture, Interactive discussion	Tutorials, Mid Term, Final Exam
CLO5	Lecture, Multimedia presentation	Class Test, Mid Term, Final Exam

SEMESTER–2, COURSE-12

Course Code: MIC-5205	Course Title: Microbial Food Safety Management	Credits: 02

Rationale of the course:

The course intends to prepare and preserve foods and beverages in a safe way for human consumption, the use of these foods and beverages, knowledge about preparing, determining and maintaining its quality in every steps of preparation.

Course Objective

The objective of the course is to prevent illnesses by focusing food-manufacturing attention and activities on preventing or minimizing exposure of the consumer to pathogen and establishment of the food safety rules for safe food and beverage preparations products.

Course content:

1.Food Safety Management Systems (FSMS): Concept, elements and challenges of FSMS; Food hazards- biological, chemical and physical hazards; Food and personal hygiene; Hygienic design in food premises and food equipment; Food safety standards; Ethics in food safety management.

2. Microbiological Hazards in Food Supply Chains: Microbiological hazards and safety management in domestic, import and export food supply chains - fruits and vegetables, crops, poultry and eggs, livestock and meat, milk and dairy products, fish and shellfish and other food products; Supply chain verification; Food defense from farm to fork.

3. Preventive Management of Food Production: Primary production – natural and GM crops, Good Agricultural Practice (GAP), Sanitary and Phytosanitary (SPS); Secondary production- Good Hygiene Practice (GHP), Good Manufacturing Practice (GMP), HACCP plan, Code of practice, Standard operating procedures, ISO 22000 and other guidelines for food safety and quality.

4. Microbiological Food Safety Analysis and Surveillance Systems: Food safety laboratory supports; Food safety analysis- safety assessment, management and communication; Investigation of microbiological food borne disease outbreaks and surveillance systems; Management of food safety incidence and emergency.

5. Food Safety Regulations and Enforcement: National legislation and enforcing agency; Safety of domestic, import and export foods; Roles of national, regional and international organizations/agencies; National and International policies on Food Safety and Quality; Global food safety initiatives (GFSI).

Course Learning Outcomes (CLOs)

CLO1. To state the importance of food safety management.

CLO2. To describe hazards in food supply chain.

CLO3. To understand the preventive management of food production.

CLO4. To know food safety and surveillance system.

CLO5. To know the Food Laws and Regulation.

Mapping Course Learning Outcomes (CLOs) with the PLOs

(CLOs)	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7
CLO1			m				m
CLO2			m				m
CLO3			m				
CLO4			m				m
CLO5			m				
CLO6			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	Class Test, Mid Term, FinalExam
CLO2	Lecture, Multimedia presentation	Quiz, Mid Term, Final Exam
CLO3	Lecture, Interactive discussion	Tutorials, Mid Term, Final Exam
CLO4	Lecture, Interactive discussion	Class Test, Mid Term, FinalExam
CLO5	Lecture, Multimedia presentation	Quiz, Mid Term, Final Exam

SEMESTER–2, COURSE-13

Group-A (Thesis)

Course Code: MIC-5206 Course Title: Thesis Evaluation Credits: 04

Rationale of the course:

The course intends to make good quality final researchthesis.

Course Objective:

The major objective of the course is to help students fulfilling thesis dissertations

Course Content: N/A

Course Learning Outcomes (CLOs):

CLO1: To write a successful thesis work

Mapping Course Learning Outcomes (CLOs) with the PLOs:

(CLOs)	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7
CLO1	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	Writing thesis book	Written thesis

SEMESTER–2, COURSE-14

Group-A (Thesis)

Course Code: MIC-5207	Course Title: Thesis Defense	Credits: 02

Rationale of the course:

The course intends to make final research thesis.

Course Objective:

The major objective of the course is to help students fulfilling thesis dissertations

Course Content:

During the progress of courses, the students of both groups shall deliver at least one seminar related to their thesis work/ project work or recent advancement of microbiological sciences. The students participate in research seminars and other seminars arranged by the Department throughout their tenure in the MS program.

Course Learning Outcomes (CLOs):

CLO1:	To present thesis work in PowerPoint format

Mapping Course Learning Outcomes (CLOs) with the PLOs:

(CLOs)	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7
CLO1	m	m	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	Thesis Evaluation	PowerPoint

SEMESTER–2, COURSE-15

Group-B (Non-Thesis)

Course Code: MIC-5208	Course Title: Short Project/ Industrial Visit/ Hands-on Training	Credits: 02

Rationale of the course: NA

Course Objective: The main objective of the course is to introduce students with the industrial working environment and practical gaining advance microbiological knowledge. **Course content:** NA

The Department will provide all laboratory facilities to the students for the project works. The students may also avail the opportunity to work in other reputed research laboratories for carrying out part of their works. Upon completion of the short project, students prepare written reports based on his or her research findings and are

reviewed by the respective project supervisor, and the project report is presented in a final examination along with a prescribed submission form provided by the Department. Students or the department will help to manage an industrial visit to any reputed pharmaceuticals or any other microbiology related organization or industries and then they will submit a formal report to the department. Student also mange various microbiology related training himself and then they will submit the certificate to the department.

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:

CLOs	Teaching Learning Strategy	Assessment Strategy
CLO1	Interactive discussion, Brain storming, Feedback	Power point presentation and Viva

SEMESTER–2, COURSE-16

Group-B (Non-Thesis)

Course Code: MIC-5209 Course Title: Seminar presentation and Viva voce Credits: 02

Rationale of the course: The course intends to present the practical works and short projects in front of evaluation committee.

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: NA

During the progress of courses, the students of both groups shall deliver at least one seminar related to their thesis work/ project work or recent advancement of microbiological sciences. The students participate in research seminars and other seminars arranged by the Department throughout their tenure in the MS program.

Course Learning Outcomes (CLOs):

CLO1:	To present thesis work in PowerPoint format

Mapping Course Learning Outcomes (CLOs) with the PLOs:

(CLOs)	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7
CLO1	m	m	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	Evaluation of all courses	Power point presentation and Viva

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%
1st class test	10%
2nd class test/ Midterm	10%
Semester Final	70%
Total	**100%**

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-

a) Class lecture with multimedia presentation
b) Group discussion
c) Demonstration
d) Practical experiment and result oriented study
e) Identification of field problem and find out effective solution
f) Assignment
g) Brain storming
h) Feed back
i) Seminar, tutorial, workshop
j) Field tour
k) Industry visit
l) 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;

i. Quizzes
ii. Class test
iii. Term examinations
iv. Short answer
v. Essay type/ broad answer
vi. Experiment demonstration performance
vii. Clinical examination performances
viii. Reports
ix. Assignment
x. Multimedia presentations
xi. Class Attendance
xii. 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 –

$$GPA = \frac{\Sigma C_i G_i}{\Sigma C_i} \quad \text{where, i=1 to 5}$$

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:

$$CGPA = \frac{(Gradepointaverageearnedinsemesteri \times Totalcredithoursinsemesteri)}{(\text{Total credit hours in semester})}$$

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 –

$$CGPA = \frac{(20\times4) + (30\times3) + (25\times3.5) + (20\times3)}{20+30+25+20} = 3.34$$

5.4 Course withdrawal: All core 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:

a) 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.
b) If a student fails to improve his grade then his/her earlier Grade will be retained.
c) If a student likes to improve the Grade earned in a course of 1st year (1st 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 student has to attend the classes regularly and must obtain 70% attendance from the date of readmission.