ADAMAS UNIVERSITY
SCHOOL OF LIFE SCIENCE AND BIOTECHNOLOGY

Department of Biological Sciences

M.Sc. (Microbiology)

Program Code: MIB4201

(2024-26)

ADAMAS UNIVERSITY, KOLKATA

ADAMAS UNIVERSITY, KOLKATA
SCHOOL OF LIFE SCIENCE AND BIOTECHNOLOGY
DEPARTMENT OF MICROBIOLOGY

VISION OF THE UNIVERSITY

To be an internationally recognized university through excellence in inter-disciplinary education, research and innovation, preparing socially responsible well-grounded individuals contributing to nation building.

MISSION STATEMENTS OF THE UNIVERSITY

M.S 01: Improve employability through futuristic curriculum and progressive pedagogy with cutting-edge technology

M.S 02: Foster outcomes-based education system for continuous improvement in education, research and all allied activities

M.S 03: Instill the notion of lifelong learning through culture of research and innovation

M.S 04: Collaborate with industries, research centers and professional bodies to stay relevant and up-to-date

M.S 05: Inculcate ethical principles and develop understanding of environmental and social realities

CHANCELLOR / VICE CHANCELLOR

ADAMAS UNIVERSITY, KOLKATA
SCHOOL OF LIFE SCIENCE AND BIOTECHNOLOGY
DEPARTMENT OF MICROBIOLOGY

VISION OF THE SCHOOL

To achieve global standard and **excellence in research** on various **interdisciplinary and multidisciplinary domains** of biological sciences through **biotechnological innovation** along with **producing global citizens** as graduates by **intensive teaching learning process** who would be vanguard to **sustainable societal development**.

MISSION STATEMENTS OF THE SCHOOL

M.S 01: To disseminate knowledge of life science and biotechnology for scholarly progression, intellectual development and strive for innovation.

M.S 02: To enable latest skill sets in the domain of microbiology, biotechnology, biochemistry (biological sciences) with ability to evolve and engage in learn-unlearn and relearn, being a lifelong learner.

M.S 03: To establish state of art infrastructure and research ambiance in attracting the best minds to serve under the single roof of school of life science and biotechnology in undertaking scientific investigation of social relevance.

M.S 04: To inculcate values, culture along with scientific knowledge to foster the spirit of self-reliance and entrepreneurship development.

DEAN / SCHOOL CONCERNED

ADAMAS UNIVERSITY, KOLKATA
SCHOOL OF LIFE SCIENCE AND BIOTECHNOLOGY
DEPARTMENT OF MICROBIOLOGY

VISION OF THE DEPARTMENT

To achieve **excellence in microbiological education and research** for **societal development** through **innovation** and producing **technologically sound graduates** as **global citizen** fostering **life-long learning.**

MISSION STATEMENTS OF THE DEPARTMENT

M.S 01: Adopt and implement latest curriculum in microbiology with futuristic approach and innovative pedagogy fostering knowledge, intellectual and skill development.

M.S 02: To enable and enhance microbiological skill sets through rigorous training and research through multidisciplinary approach.

M.S 03: To cater professional and societal need of cutting-edge microbiological research through collaboration and industry-academic partnership.

M.S 04: To inculcate values, culture along with microbiological knowledge to foster the spirit of self-reliance and entrepreneurship development.

HOD **DEAN / SCHOOL CONCERNED**

ADAMAS UNIVERSITY, KOLKATA
SCHOOL OF LIFE SCIENCE AND BIOTECHNOLOGY
DEPARTMENT OF MICROBIOLOGY

Name of the Programme: M.Sc. Microbiology

PROGRAMME EDUCATIONAL OBJECTIVES (PEO)

PEO 01 **:** Ability to do research, comprehend fundamentals and expertise in the domain.

PEO 02 **:**Acquainted with modern tools and technology related to the field of study.

PEO 03 **:**Ability to find routes of solution of existing scientific problems of the domain through identification of research gaps.

PEO 04 **:** Develop as professional aspirants and sustainable learners**.**

PEO 05 **:**Global outlook with imbibed human values

HOD **DEAN / SCHOOL CONCERNED**

ADAMAS UNIVERSITY, KOLKATA
SCHOOL OF LIFE SCIENCE AND BIOTECHNOLOGY
DEPARTMENT OF MICROBIOLOGY

Name of the Programme: M.Sc. Microbiology

GRADUATE ATTRIBUTE / PROGRAMME OUTCOME (PO)

GA 01/ PO 01: Develop research approaches to meet the scientific gaps on microbiology and allied interdisciplinary or multidisciplinary fields.

GA 02/ PO 02: Foster the knowledge and skills in microbiology to identify and approach towards suitable solution.

GA 03/ PO 03: Ability to salvage significant biological data for meaningful solution.

GA 04/ PO 04: Develop skill set related to microbiology and allied fields

GA 05/ PO 05: Familiarized with latest and advanced tools and techniques of microbiology.

GA 06/ PO 06: Investigate an existing problem to find a suitable solutions, beneficial to the society.

GA 07/ PO 07: Strong basic knowledge to support diversification in applied field of microbiology.

GA 08/ PO 08: Ability to set career and professional goals based on a proper career planning process.

GA 09/ PO 09: Develop capacity to uphold integrity and collaborative approach in workplace.

GA 10/ PO 10: To accept and implement changes in learning towards a sustainable development through learn, unlearn-relearn approach.

GA 11/ PO 11: Practice ethical philosophies and systems in creating and partnering a progressive society.

GA 12/ PO 12: Develop as global citizen to contribute in the greater benefits of humanity.

COURSE STRUCTURE FOR M.Sc. Microbiology

ADAMAS UNIVERSITY DEPARTMENT OF MICROBIOLOGY							
M.Sc. Microbiology Semester - I							
Type of the Course	**Course Code**	**Course Name**	**Contact Hours Per Week**	**L**	**T**	**P**	**Credit**
CORE (Theory)	**MIB21501**	**Biomolecules and Biomolecular Interaction**	**3**	**3**	**0**	**0**	**3**
CORE (Theory)	**MIB21503**	**Biophysical Chemistry and Bioanalytical Techniques**	**3**	**3**	**0**	**0**	**3**
CORE (Theory)	**MIB21542**	**Bacteriology and Virology**	**3**	**3**	**0**	**0**	**3**
CORE (Theory)	**MIB21543**	**Microbial Genetics and Cell biology**	**3**	**3**	**0**	**0**	**3**
CORE (Theory)	**MIB21546**	**Ecology and Evolution**	**3**	**3**	**0**	**0**	**3**
CORE (Practical)	**MIB22544**	**Biomolecules, Biophysical Chemistry and Bioanalytical Techniques Lab**	**4**	**0**	**0**	**4**	**2**
CORE (Practical)	**MIB22545**	**Bacteriology, virology and Microbial Genetics Lab**	**4**	**0**	**0**	**4**	**2**
CORE (Theory)	**MIB21536**	**Bioethics and Intellectual Property Rights**	**3**	**3**	**0**	**0**	**3**
Foundation	**MIB22571**	**Professional Development Course 1**	**1**	**0**	**0**	**1**	**1**
Total			**27**	**18**	**0**	**9**	**23**

ADAMAS UNIVERSITY DEPARTMENT OF MICROBIOLOGY							
M.Sc. Microbiology Semester - II							
Type of the Course	**Course Code**	**Course Name**	**Contact Hours Per Week**	**L**	**T**	**P**	**Credit**
CORE (Theory)	**MIB21509**	**Molecular Biology**	**3**	**3**	**0**	**0**	**3**
CORE (Theory)	**MIB21511**	**Recombinant DNA Technology**	**3**	**3**	**0**	**0**	**3**
CORE (Theory)	**MIB21513**	**Environmental Microbiology**	**3**	**3**	**0**	**0**	**3**
CORE (Theory)	**MIB21515**	**Bioinformatics and Computational Biology**	**3**	**3**	**0**	**0**	**3**
CORE (Practical)	**MIB22547**	**Molecular Biology and Recombinant DNA technology Lab**	**4**	**0**	**0**	**4**	**2**
CORE (Practical)	**MIB22514**	**Environmental Microbiology Lab**	**4**	**0**	**0**	**4**	**2**
CORE (Practical)	**MIB22516**	**Bioinformatics and Computational Biology Lab**	**4**	**0**	**0**	**4**	**2**
CORE (Theory) Discipline Specific Elective-I	**MIB21517 / MIB21518 / MIB21519 / MIB21520 / MIB21521**	**Any One of the following*: Enzyme and Enzyme Technology / Food and Dairy: Safety and Quality Control / Drug Design and Development / Host-Pathogen Interaction / Recent Advances in Vaccine Technology.**	**3**	**3**	**0**	**0**	**3**
Foundation	**MIB22572**	**Professional Development Course 2**	**1**	**0**	**0**	**1**	**1**
Total			**28**	**15**	**1**	**13**	**22**

ADAMAS UNIVERSITY DEPARTMENT OF MICROBIOLOGY							
M.Sc. Microbiology Semester - III							
Type of the Course	**Course Code**	**Course Name**	**Contact Hours Per Week**	**L**	**T**	**P**	**Credit**
CORE (Theory)	**MIB21549**	**Immunology and medical Microbiology**	**3**	**3**	**0**	**0**	**3**
CORE (Theory)	**MIB21550/ MIB21551**	**Epidemiology and Diagnostics*/ Natural product and toxicology#**	**3**	**3**	**0**	**0**	**3**
CORE (Theory)	**MIB21526**	**Bioprocess Technology**	**3**	**3**	**0**	**0**	**3**
CORE (Theory)	**MIB21528**	**Microbial Metabolism**	**3**	**3**	**0**	**0**	**3**
CORE (Practical)	**MIB22548**	**Immunology and Medical Microbiology Lab**	**4**	**0**	**0**	**4**	**2**
CORE (Practical)	**MIB22527**	**Bioprocess Technology Lab**	**4**	**0**	**0**	**4**	**2**
CORE (Practical)	**MIB22553/ MIB22554**	**Epidemiology and Diagnostics Lab*/ Natural product and toxicology Lab#**	**4**	**0**	**0**	**4**	**2**
CORE (Theory) Discipline Specific Elective-II	**MIB21555 MIB21556/ MIB21531/ MIB21532/ MIB21557/ MIB21558**	**Any One of the following*: Applied toxicology#/ Environmental toxicology# / Research Methodology, Biostatistics and GLP /Pharmaceutical Microbiology / Advanced laboratory diagnostics* /Biomedical nanotechnology***	**3**	**3**	**0**	**0**	**3**
FOUNDATION	**MIB24535**	**Industry Internship**					**2**
Foundation	**MIB22573**	**Professional Development Course 3**	**1**	**0**	**1**	**0**	**1**
Total			**27**	**15**	**0**	**12**	**24**

*Natural product discovery and toxicology specialization; #Diagnostics and Epidemiology specialization

ADAMAS UNIVERSITY DEPARTMENT OF MICROBIOLOGY							
M.Sc. Microbiology Semester - IV							
Type of the Paper	**Paper Code**	**Theory / Practical**	**Contact Hours Per Week**	**L**	**T**	**P**	**Credit**
CORE	**MIB25540**	**Comprehensive Viva**	**4**	**4**	**0**	**0**	**4**
CORE	**MIB25541**	**Dissertation**	**6**	**0**	**0**	**6**	**15**
Total			**9**	**3**	**2**	**6**	**19**

*** Offering of DSE subjects will vary from year to year, subject to the availability of faculty**

Total credit distribution semester-wise:

Semester	I	II	III	IV	Total
Credits	23	22	24	19	88

MIB21501	Biomolecules & Biomolecular interaction (THEORY)	L	T	P	C
Version 1.0	Contact Hours - 45	3	0	0	3
Pre-requisites/Exposure	UG level knowledge of Biochemistry and Cell Biology				
Co-requisites	--				

Course Objectives

The cells of living organisms encompass thousands of biomolecules. From this course the students will identify the structure-function relationship of these biomolecules, and their importance with respect to maintenance and perpetuation of the living systems.

Course Outcomes

On completion of this course, the students will be able to

1. **Identify** the different types of chemical bonds and interactions involved in biomolecular interactions.
2. **Explain** the structure and function of biomolecules in living organisms.
3. **Apply** knowledge of biomolecules to predict how they may interact with each other.
4. **Evaluate** and **assess** the impact of biomolecular interactions on cellular functions and physiological processes.
5. **Critically** assess the significance of biomolecular interactions in disease and drug development.

Catalogue Description

The core-course of '**Biomolecules & Biomolecular interaction**' will help to understand the structure and function of biomolecules: synthesis and properties of cellular macromolecules, basic properties of enzymes, principles of metabolism, bioenergetics, signal transduction, regulation of gene expression and function of biomolecules in cell structure and differentiation. All the lectures will be devoted on discussions of basic theories and advanced topics, focusing on practical implementation of knowledge. Classes will be conducted by lecture as well as power point presentation, audio visual virtual lab session as per requirement. Students will perceive the basic concepts of the subject via exercise and discussions with the coordinator.

Course Content

Unit 1 Bonding and interactions (5h): Structure of atoms, molecules and chemical bonds, Stabilizing forces of biomolecules.

Unit 2 Carbohydrate (10h): Classification, structure, general properties and functions of polysaccharides and complex carbohydrates; amino sugars, proteoglycans, glycoproteins and its significance. Hexose metabolism: pathways and energy metabolism. Metabolic labelling and glycomics.

Unit 3 Amino acids and Proteins (13h): Structure and functional group properties, peptides and covalent structure of proteins, elucidation of primary and higher order structures, Ramachandran Plot, Protein folding and its kinetics, chaperones and folding pathways, Methods to study protein structure. Overview of amino acid biosynthesis. Techniques and concepts in proteomics: LC-MS/MS and peptide mass finger printing.

Unit 4 Nucleic acids (8h): Nucleic acids as genetic information carriers, Forms and conformations of several orders of nucleic acid organizations: structure and function , Sequencing techniques and principle of NGS. Denaturation of DNA. Biosynthesis of purine and pyrimidine.

Unit 5 Lipids (9h): Classification, structure, properties and functions of fatty acids, essential fatty acids, fats, phospholipids, sphingolipids, cerebrosides, steroids, bile acids, prostaglandins, glycolipids. Fatty acid oxidation and cholesterol biosynthesis. Biosynthesis of saturated & unsaturated fatty acids and cholesterol. Lipidomics: sample preparation and analysis.

Textbook:

1. Nelson, D.L.; Cox, M.M. *Lehninger principles of biochemistry*. W.H. Freeman: 2013.
2. Biochemistry by LubertStryer (8th Ed) 2015

Reference books:

1. Campbell, MK (2012) Biochemistry, 7th ed., Published by Cengage Learning
2. Campbell, PN and Smith AD (2011) Biochemistry Illustrated, 4th ed., Published by Churchill Livingstone
3. Tymoczko JL, Berg JM and Stryer L (2012) Biochemistry: A short course, 2nd ed., W.H.Freeman
4. Berg JM, Tymoczko JL and Stryer L (2011) Biochemistry, W.H.Freeman and Company
Willey MJ, Sherwood, LM &Woolverton C J (2013) Prescott, Harley and Klein's Microbiology by. 9th Ed., McGrawHill
5. Voet,D. and Voet J.G (2004) Biochemistry 3rd edition, John Wiley and Sons
6. Biochemistry by Jeremy M. Berg, John L. Tymoczko, LubertStryer, 2007
7. Fundamentals of Biochemistry: Life at the Molecular Level, 4th Edition: Life at the Molecular Level by Voet, 2012

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Class Assessment	End Term
Weightage (%)	50	50

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	3	2	3	3	-	-	3	-	-	1	3
CO2	3	3	2	3	3	-	-	3	-	-	1	3
CO3	3	3	2	3	3	-	-	3	-	-	1	3
CO4	3	3	2	3	3	-	-	3	-	-	1	3
CO5	3	3	2	3	3	-	-	3	-	-	1	3
Avg	3	3	2	3	3	-	-	3	-	-	1	3

1=weakly mapped, 2= moderately mapped, 3=strongly mapped

Model Question Paper

Name: **Enrolment No:**	

Course: MIB21501 - BIOMOLECULES & BIOMOLECULAR INTERACTION (THEORY)
Program: M.Sc. Microbiology **Time: 03 Hrs.**
Semester: Odd 2022-23 **Max. Marks: 50**
Instructions:
Attempt any **four** questions from **Section A** (each carrying 5 marks); any **three** questions from **Section B** (each carrying 10 marks)**.**

SECTION A (Attempt **any Four questions)**			
1.	**Analyze** the role of water in biological processes. (An)*	**5**	**CO1**
2.	**Explain** why is cellulose insoluble, while starch, which appears to have a very similar structure, is soluble? **Identify** the tools used to characterize the glycome. (U, R)	**2+3**	**CO2**
3.	**Illustrate** why do proteins fold? What is peptide mass fingerprinting? (R, U)	**4+1**	**CO3**
4.	**Describe** the principle of Next Generation Sequencing (NGS) technology.(R)	**5**	**CO4**
5.	**Develop** a mass spectrometry-based lipid analysis protocol. (C)	**5**	**CO5**
6.	**How** isotope exchange can be used to visualize reaction kinetics	**5**	**CO5**
	SECTION B (Attempt any **Three questions)**		
6.	What is the role of chaperones in protein folding? How do chaperones recognize unfolded proteins? **Illustrate** one of the pathways of chaperone-mediated protein folding in the cytosol. (R, An)	**3+2 +5**	**CO3**
7.	A sugar ($C_6H_{10}O_5$) was treated by a method that reduces aldehyde groups and gave a product that was optically inactive. Assuming the sugar was D, **identify** the two possible structures of the product? **Analyze** the role of non-covalent interactions for determining the folding rate of two-state proteins. **Explain** regulation of glucokinase activity by glucokinase regulatory protein. (U, E)	**2+4 +4**	**CO1 CO2**
8.	What is allowed region in Ramachandran plot? Which amino acid residue can occupy the greatest area in a Ramachandran plot? Identify the purpose of a Ramachandran plot. **Illustrate** the role of glycoprotein in cell membrane. (R, U)	**2+1 +3+ 4**	**CO3**
9	Which amino acid is required for both purine and pyrimidine synthesis? How much ATP is used in purine synthesis? **Describe** that small local variations in B-form DNA led to a large variety of global geometries which can accommodate most DNA-binding protein motifs. **Describe** the steps of oxidation of odd-chain fatty acids. (U, R, An)	**1+1 +5+ 3**	**CO4 CO5**

MIB21503	Biophysical Chemistry & Bioanalytical Techniques (THEORY)	L	T	P	C
Version 1.0	Contact Hours - 45	3	0	0	3
Pre-requisites/Exposure	UG level knowledge of Biochemistry				
Co-requisites	--				

Course Objectives

To develop the skills of the application of basic and advanced techniques employed in quantitative and qualitative analysis of biomolecules. To be able to communicate and discuss the various methods available to purify and characterize biological molecules based on their physical and chemical properties. To be able to choose from the various methods available for purifying and characterizing biological molecules based on their physical and chemical properties. To provide scientific understanding of analytical techniques and detail interpretation of results.

Course Outcomes

On completion of this course, the students will be able to

1. **Define** various thermodynamic terms and principles related to biophysical chemistry including enthalpy, entropy, and Gibbs free energy.
2. **Apply** thermodynamic principles to analyze the stability, binding affinities, and conformational changes of biomolecules.
3. **Evaluate** the physicochemical properties of water and their role in biological systems such as hydration, hydrophobic interactions, and solvent properties.
4. **Analyze** and **interpret** spectroscopic data from techniques such as UV-Vis, NIR, IR, and fluorescence spectroscopy to characterize biomolecules and study molecular interactions.
5. **Explain** the principles of radioactivity and **design** its applications in biological research such as radiolabeling, tracer techniques, and scintillation counting.

Catalogue Description

This course contains bioanalytical techniques along with their theory, working principal, common instrumentation and possible applications. This course will be equally beneficial to various scientific areas including, life science, chemical science, material science and environmental science. The information presented in this course will provide the student with valuable insight into the characterization and separation of biological macromolecules. By the end of this course, the student should be able to choose the correct method or combination of methods to characterize and separate biological macromolecules based on the physical and chemical properties of the molecules.

Course Content

Unit 1 Thermodynamics (10h)

Laws of thermodynamics: application in biological systems, Concept of free energy, standard free energy change. Equilibrium constant; enthalpy; entropy. Membrane biophysics: osmotic pressure. Donnan equilibrium, diffusion potential, membrane potential.

Unit 2 Physicochemical Properties of Water (6h)
Ionic product of water; pH - definition, effect of pH in enzyme catalyzed reaction. Polyprotic acids, ampholytes, dissociation of polyprotic acid; titrable and true acidity, Biological buffers. Reaction Kinetics: Rates and rate equations of chemical reactions.

Unit 3 Spectroscopy (18h)
Fundamental concepts of spectroscopy, scattering absorption and dispersion.

Concept of electromagnetic radiations - UV, visible, IR; Orbital theory: Bonding and anti-bonding; Absorption and emission spectroscopy of biomolecules: UV-Visible Spectroscopy, Fluorescence Spectroscopy and Energy transfer.

Unit 4 Separation techniques (7h)
Principle of centrifugation and different types of centrifuge, Differential & density gradient centrifugation.TLC, HPLC, HPTLC & FPLC, Size-exclusion Chromatography, Affinity chromatography, Ion-exchange Chromatography.

Unit 5 Radioactivity and tracer techniques (4h)
Radioactive & stable isotopes; Units of radioactivity; Measurement of radioactivity; Measurement of stable isotopes; Falling drop method; Radiotracer techniques; Distribution studies; Isotope dilution technique; Metabolic studies; Radioimmunoassay.

Text Books:
1. Biophysical Chemistry by James P. Allen. 2008
2. Immunoassay and Other Bioanalytical Techniques by Jeanette M. van Emon, 2006

Reference Books:
1. Biochemical Techniques: Theory and Practice by John F. Robyt 2015
2. Physical Chemistry for the Life Sciences. Peter Atkins, Julio de Paula by Peter Atkins, Julio de Paula, 2011

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Class Assessment	End Term
Weightage (%)	50	50

1=weakly mapped, 2= moderately mapped, 3=strongly mapped

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	3	2	3	3	-	-	3	-	-	1	3
CO2	3	3	2	3	3	-	-	3	-	-	1	3
CO3	3	3	2	3	3	-	-	3	-	-	1	3
CO4	3	3	2	3	3	-	-	3	-	-	1	3
CO5	3	3	2	3	3	-	-	3	-	-	1	3
Avg	3	3	2	3	3	-	-	3	-	-	1	3

Model Question Paper

Name: **Enrolment No:**	

Course: MIB21503 - BIOPHYSICAL CHEMISTRY & BIOANALYTICAL TECHNIQUES (THEORY)
Program: M.Sc. Microbiology **Time: 03 Hrs.**
Semester: Odd 2022-23 **Max. Marks: 50**

Instructions:
Attempt any **four** questions from **Section A** (each carrying 5 marks); any **three** questions from **Section B** (each carrying 10marks)**.**

SECTION A (Attempt **any Four questions)**

1.	**Explain** two different models of enzyme action. (An)	**5**	**CO3**
2.	**Describe** (i) Reaction orders and (ii) Carnot Engine. (M)	**2+3**	**CO1**
3.	(i) **Explain** the Rate Law. (ii) **Describe** the factors that influence reaction rate. (An, U)	**2+3**	**CO2**
4.	(i) **Explain** Arrhenius equation? (ii) **Interpret** Transition State theory. (An, U)	**2+3**	**CO2**
5	At 1000˚C, cyclobutane (C_4H_8) decomposes in a first-order reaction, with the very high-rate constant of 87 s^{-1}, to two molecules of ethylene (C_2H_4). (i) If the initial C_4H_8 concentration is 2.00 M, **find** out the concentration after 0.010 s? (ii) **Find** the fraction of C_4H_8 that has decomposed in this time? (E, C)	**3+2**	**CO5**
6.	(i) **Explain** buffer capacity (ii) **Interpret** the pH of water (An, U)	**2+3**	**CO2**
	SECTION B (Attempt any **Three questions)**		
7.	Draw and **explain** Perrin-Jablonski diagram of fluorescence and phosphorescence. (An)	**10**	**CO3**
8.	**Describe** the important characteristics of fluorophores? **Explain** quantum yield? **Explain** intrinsic fluorescence of proteins and peptides. (M. E)	**3+3+4**	**CO2** **CO3**
9.	**Explain** the electrophoresis process? **Illustrate** the differences between SDS and non-SDS electrophoresis. (An, U)	**2+8**	**CO1** **CO5**
10.	**Explain** the mechanism of gel-exclusion chromatography. **Describe** how one can find out molecular weight of an unknown protein using gel-exclusion chromatography. (An, M)	**5+5**	**CO4**

MIB21542	Bacteriology and virology(THEORY)	L	T	P	C
Version 1.0	Contact Hours - 45	3	0	0	3
Pre-requisites/Exposure	UG level knowledge in Microbiology				
Co-requisites	--				

Course Objectives

The objective of this course is to make students understand the evolution and diversity of microbial world. The course will provide insights into study of microbial nutrition and distinguishing features associated with them based on morphological, chemical, structural and metabolic characteristics. The course is to make students familiar with general characters of prokaryotic and eukaryotic microorganisms for conventional and molecular characterization using modern methods. Knowledge of cellular organization, life cycle and economic importance of prokaryotic (Eubacteria, Archaea, Cyanobacteria) To develop understanding about viral classification, microbial metabolism and energy generation. Students will gain knowledge of various fermentation pathways and microbial energetics.

Course Outcomes

On completion of this course, the students are expected to be able to:

1. **Define** and differentiate between bacteria and viruses, Identify the structure and function of bacteria and viruses
2. **Summarize** the pathogenesis of bacterial and viral infections; explain the immune response to bacterial and viral infections
3. **Apply** appropriate infection control measures for preventing the spread of bacterial and viral infections
4. **Compare** and contrast the characteristics of different bacterial and viral pathogens
5. **Develop** protocols for isolation and identification of bacterial and viral pathogens in clinical samples, **Design** strategies for controlling the spread of antibiotic-resistant bacteria and antiviral-resistant viruses

Catalogue Description

The core-course of 'Bacteriology and virology will help to understand the remarkable environmental and metabolic diversity of prokaryotic and eukaryotic microorganisms including viruses. The course will give detailed insights into the major themes: structure and function of microbes (cellular structures, metabolism, and growth); microbial diversity (prokaryotes, eukaryotes, viruses), microbial nutrition and metabolism. All the lectures will be devoted to discussions of basic theories and advanced topics, focusing on practical implementation of knowledge. Classes will be conducted by lecture as well as PowerPoint presentation, audio visual virtual lab session as per requirement. Students will perceive the basic concepts of the subject via exercise and discussions with the coordinator.

Course Content

Unit 1: Classification (6h): Three domain classification, recent trends in microbial taxonomy, bacterial phylogeny, phylogenetic trees

Unit 2: Bacterial growth (9h): Growth, growth yield and growth kinetics. Factors affecting growth and adaptation. Optimizing growth and culture conditions. Control of microbial growth. Antibiotic and antibiotic resistance. Discovering and developing antimicrobials.

Unit 3: Morphology and ultrastructure of bacteria (9h): Different cell morphology, intracytoplasmic inclusions, endospores and exospores, sheathed bacteria, stalked and budding bacteria, gliding bacteria including Myxobacteria. Microbial developmental biology: Regulation of biofilm formation, Sporulation in Bacillus and fruiting body formation in myxobacteria. Cell cycle and regulation in microbes. Cell signalling; two component system, Chemotaxis, Quorum sensing.

Unit 4 Virology (9h):
History of virology, Viral classification and nomenclature (Baltimore and ICTV system of classification). Virus structure and morphology. Detection of viruses, Propagation, purification, isolation, characterization, identification and quantification of bacteriophages, plant viruses and animal viruses, Metagenomics for virus characterization: RNA-DNA hybrid virus, antivirals

Unit 5 Virus replication Strategies (12h): Principal events involved in replication: Adsorption, penetration, uncoating nucleic acid and protein synthesis, intracellular trafficking, assembly, maturation and release, viral-host interaction, Host response to viral infection. Cellular interactions - clathrin coated pits, lipid rafts, endocytosis and virus uncoating mechanisms. Comparison of Lytic cycle and lysogeny cycle (T2 Bacteriophage, Lambda). Morphology, Ultrastructure, Genome organization and Replication strategies of Group I Adenovirus; Group II – Banana bunchy top virus, Group III – Reovirus, Group IV-TMV, Group V – Influenza virus, Group VI – HIV, Group VII – HBV.

Textbook:

1. Tortora GJ, Funke BR and Case CL. (2008). Microbiology: An Introduction. 9th edition. Pearson Education

Reference books:

1. Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). Brock Biology of Microorganisms.14th edition. Pearson International Edition
2.Wiley JM, Sherwood LM and Woolverton CJ. (2013) Prescott's Microbiology.9th Edition. McGraw Hill International.
3. Atlas RM. (1997). Principles of Microbiology.2nd edition. WM.T. Brown Publishers.
4. Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology.5th edition. McGraw Hill Book Company.
5. General Virology by Luria and Darnel

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Class Assessment	End Term
Weightage (%)	50	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	3	2	1	3	-	-	3	-	-	-	3
CO2	3	3	2	1	3	-	-	3	-	-	-	3
CO3	3	3	2	1	3	-	-	3	-	-	-	3
CO4	3	3	2	1	3	-	-	3	-	-	-	3
CO5	3	3	2	1	3	-	-	3	-	-	-	3
Avg	3	3	2	1	3	-	-	3	-	-	-	3

1=weakly mapped
2= moderately mapped
3=strongly mapped

Name: **Enrolment No:**	

Course: MIB21542 - Bacteriology and virology(THEORY)
Program: M.Sc. Microbiology **Time: 03 Hrs.**
Semester: Odd 2022-23 **Max. Marks: 50**

Instructions:
Attempt any **four** questions from **Section A** (each carrying 5 marks); any **three** questions from **Section B** (each carrying 10 marks)**.**

SECTION A (Attempt **any Four questions)**

1.	**Describe** the phenotypic methods of classifying and identifying bacteria. (R)	**5**	**CO1**
2.	Briefly **explain** the different steps of bacterial endospore formation. (U)	**5**	**CO2**
3.	**Illustrate** the process of binary fission in bacteria, stating the functions of *Par* proteins and *FtsZ* proteins. (An)	**5**	**CO3**
4.	Write down the functions of H- and N- spikes. **Explain** in brief about the morphology and ultrastructure of an RNA virus with (+) strand. (An)	**2+3**	**CO4**
5	**Discuss** the process of hydrogen oxidation in organisms that use hydrogen aerobically. $FADH_2$ and NADH are both electron carriers that bring electrons to the inner mitochondrial membrane to be used during the electron transport chain (ETC). $FADH_2$, however, produces less ATP than NADH. Which of the following choices correctly explains why this occurs? (An)	**3+2**	**CO5**
6.	**How** can bacteria sense population density to trigger programmed cell death?	**5**	**CO3**
	SECTION B (Attempt any **Three questions)**		
6.	What characteristics distinguish archaea from bacteria? **Illustrate** the signals, regulatory networks, and materials that build and break bacterial biofilms. (M, C)	**3+7**	**CO3**
7.	**Distinguish** between 16s rRNA and 18s RRNA. Discuss the Monod model. Write down the full form of EMP pathway. Explain the key features of the EMP pathway. (U)	**2+3+1+4**	**CO1** **CO2** **CO5**
8.	**State** the possible reasons why a bacterial growth curve enters into the stationary phase? What is growth yield? **Describe** the major physical factors which influence bacterial growth. **Differentiate** between Entner-Doudoroff pathway and glycolysis. (Ap, An, R)	**2+1+5+2**	**CO2** **CO5**
9	**Discuss** the structure, variants and replication mechanism of hepatitis B virus.	**10**	**CO4**

MIB21543	Microbial Genetics and Cell biology (THEORY)	L	T	P	C
Version 1.0	**Contact Hours - 45**	3	0	0	3
Pre-requisites/Exposure	UG LEVEL MICROBIOLOGY				
Co-requisites	--				

Course Objectives

1. Develop concepts of molecular basis of microbial survival, genetic exchange and pathogenesis
2. Genetic basis of diversity in bacteria population
3. Horizontal gene transfer and genetic analysis.

Course Outcomes

On completion of this course, the students will be able to

1. **Recall** and explain the fundamental concepts of Mendelian genetics, including the laws of segregation and independent assortment, and apply them to predict genetic inheritance patterns.

2. **Classify and compare** DNA structure and function across various organisms, understand the significance of the genome in microbial genetics, and analyze the role of chromosomes in maintaining genetic information.

3. **Demonstrate** knowledge of horizontal gene transfer mechanisms and recombination events in microbial populations, including transduction, transformation, and conjugation, and evaluate their impact on genetic diversity and adaptation.

4. **Analyze** the structure and function of cell membranes, including the components and processes involved in vesicular trafficking, and differentiate between passive and active mechanisms of molecular transport.

5. **Identify** and **discuss** the main cell organelles in eukaryotic cells, including the nucleus, endoplasmic reticulum, Golgi apparatus, mitochondria, and chloroplasts, and evaluate their roles in various cellular processes.

Catalogue Description

The course of '**Microbial Genetics and Cell biology** will help to understand the basic concept of molecular microbiology and application of microbial genetics. This course includes comprehensive approach through studying fundamentals of diversity generation, diversity in molecular processes and pathogenicity. All the lectures will be devoted on discussions of basic theories and advanced topics, focusing on practical implementation of knowledge. Classes will be conducted by lecture as well as power point presentation, audio visual virtual lab session as per requirement. The tutorials will enable the students with

problem-solving ability led by the course coordinator. Students will perceive the basic concepts of the subject via exercise and discussions with the coordinator.

Course Content

Unit 1 Genome (7h): Microbial genome, extra chromosomal elements, genome maintenance, genome sequencing. Chromosome structural organization. Structural and numericalchromosomal aberrations. CHIP and chromosome capture methods.

Unit 2 Genomic variation (7h): DNA Damage, repair and recombination: studying mechanisms. Tansposition. Horiziontal gene transfer: transformation, conjugation and transduction. Classical experiments of microbial genetics and cutting edge application in gene to genome manipulation.

Unit 3 Classical and population genetics (10h): Single gene inheritance, terminology, allelic relationship, single gene crosses; Pedigree analysis; Two or more genes: Independent assortment, dihybrid cross, Linkage analysis, Chromosomal aberrations, Gene frequency; Hardy Weinberg law; Factors distinguishing Hardy Weinberg equilibrium; Mutation selection; Migration; Gene flow; Genetic drift; Human genetic diversity

Unit 4: Cell biological methods (7h): Visualization of cell: Evolution of techniques, stains and dyes, power of microscopy, concept of marker proteins, immuno-staining, immunofluorescence staining (direct and indirect), choice of antibodies, immuno-EM (gold labeled antibodies). Subcellular fractionation: Cell lysis methods, Differential centrifugation, enrichment of organelles i.e. organelle marker proteins, assay of marker enzyme/proteins in the subcellular fractions, Western blotting

Unit 5Cell- structure and function (8 h): Plasma membrane structure and dynamics. Extra cellular matrix: components. Cell surface proteins for ECM- cell interaction. Membrane biogenesis and vesicular transport. Cell cytoskeleton: microtubule, intermediate filament and actin microfilaments.

Unit 6 Cell cycle, cell death and cell signalling (5h): Cell cycle progression and regulation. Cell death: pathways: Apoptosis and Autophagy. Cell signalling: GPCR, Ca^{2+}-IP3, MAPK and steroid signalling.

Text Book:

1. Bacterial Pathogenesis: a Molecular Approach. Wilson, Winkler and Ho, Wiley
2. Molecular Genetics of Bacteria, Sneider, ASM press

Reference Book:

3. Microbial Genetics, David Freifelder, Narosa

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Class Assessment	End Term
Weightage (%)	50	50

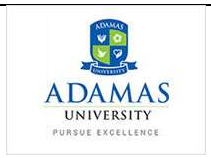
Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

1=weakly mapped

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	3	2	1	3	-	-	3	-	-	-	3
CO2	3	3	2	1	3	-	-	3	-	-	-	3
CO3	3	3	2	1	3	-	-	3	-	-	-	3
CO4	3	3	2	1	3	-	-	3	-	-	-	3
CO5	3	3	2	1	3	-	-	3	-	-	-	3
Avg	3	3	2	1	3	-	-	3	-	-	-	3

2= moderately mapped
3=strongly mapped

Model Question Paper

Name: **Enrolment No:**	

Course: MIB21543- MICROBIAL GENETICS AND CELL BIOLOGY(THEORY)
Program: M.Sc. Microbiology **Time: 03 Hrs.**
Semester: Odd 2022-23 **Max. Marks: 50**

Instructions:
Attempt any **four** questions from **Section A** (each carrying 5 marks); any **three** questions from **Section B** (each carrying 10 marks)**.**

SECTION A (Attempt any Four questions)

1.	**How** chromosomal duplication is **linked** to gene evolution? **Define** mutation and polymorphism (U, M)	**2+3**	**CO1**
2.	**What** is chromosome painting? How FISH can be **implemented** in identifying various chromosomal aberrations? (M, Ap)	**2+3**	**CO2**
3.	**Compare** NER and BER. (An)	**5**	**CO3**
4.	How chemical mutagenesis can be **used** in forward genetic screens? **Why** 5MeC rich regions are hot spots of mutation? (C, U)	**3+2**	**CO4**
5	**How** bacterial conjugation is linked to emergence of antibiotic resistance? Can you **perform** interrupted mating experiment with following crosses? (a) Hfr lac+his+ recA+ strrXF'lac-his-recA+strs (b) Hfr lac+his+ recA+strrXF-lac-his-recA+strs (U, C)	**2+3**	**CO5**
6	**Compare** replicative and non-replicative transposons. How transposition is linked to emergence of antimicrobial resistance.	**2+3**	**CO3**
	SECTION B (Attempt any **Three questions)**		
7.	What is the **difference** between vertical and horizontal gene transfer? Can you predict if a region of genome is derived by HGT? How competence development is regulated by a two-component system? (U, C, An)	**4+2+4**	**CO3**
8.	RecA can play dual role in different repair systems in bacteria-**discuss**. **What** are conditional and leaky mutations? How can you experimentally **determine** if reversion of a phenotype is true reversion or suppressor mutation? (U, M, C)	**2+3+5**	**CO1 CO2**
9.	Briefly **outline** the translation repair system in eukaryotes. **What** is the importance of rat liver extract in Ames test? (M, Ap)	**5+5**	**CO1 CO2**
10	**What** are pathogenicity islands? How those can be **identified**? Can mutation in such islands affect fitness of bacterial population while encountering immunoglobulins? **Explain**(M, Ap, U)	**3+3+4**	**CO5**

MIB22544	Biomolecules, Biophysical Chemistry and Bioanalytical Techniques Lab	L	T	P	C
Version 1.0	Contact Hours – 60	0	0	4	2
Pre-requisites/Exposure	UG LEVEL MICROBIOLOGY				
Co-requisites	--				

Course Objectives

1. To gain a deeper understanding on analytical biochemistry techniques
2. To gain a deeper understanding on biophysical chemistry techniques

Course Outcomes
On completion of this course, the students will be able to

CO1 Students will be able to **recall** the basic principles and concepts of biophysical chemistry and bio-analytical techniques, including the theory behind paper chromatography, TLC, SDS-PAGE, and agarose gel electrophoresis.
CO2 Students will be able to **demonstrate** an understanding of the procedures involved in conducting paper chromatography, TLC, SDS-PAGE, and agarose gel electrophoresis, including the principles of separation and detection of biomolecules.
CO3 Students will be able to **apply** the techniques of paper chromatography, TLC, SDS-PAGE, and agarose gel electrophoresis to separate and analyze various biomolecules, and interpret the results to draw conclusions about the composition and characteristics of the samples.
CO4 Students will be able to **analyze** experimental data obtained from paper chromatography, TLC, SDS-PAGE, and agarose gel electrophoresis experiments to identify proteins, nucleic acids, and other biomolecules present in the samples.
CO5 Students will be able to **critically evaluate** the effectiveness and limitations of paper chromatography, TLC, SDS-PAGE, and agarose gel electrophoresis as tools for bio-analytical techniques, and **propose** improvements or alternative methods for specific research purposes.

Catalogue Description

Familiarize students with the specific characteristics of a laboratory of analytical biochemistry & biophysical chemistry. To know the analytical methods commonly used in the clinical laboratory. Know how can contribute the clinical laboratory to assess the health status of individuals. At the end of the course the student will know the techniques and applications of molecular biology and biochemistry. Emphasis on current techniques and structure/function relationships of biological macromolecules and how they interact to each other. This course covers the tools and techniques by which biological molecules are isolated, separated, identified, and analyzed. Detailed discussion of experimental methods for macromolecule purification and characterization is included.

The Introductory Biochemistry course covers fundamental biochemical and molecular biological laboratory techniques, supporting concepts, and data analysis. The aims of this course are 1. To provide students with practical knowledge and hands-on experience with some of the most common experimental methods used in biochemical and molecular biological research, and 2. to introduce students to the fundamentals of scientific writing. Methods include reagent preparation, proper use of instrumentation, biochemical analysis,

Course Content

Topic	Contact hours
Separation of amino acid mixture by Paper chromatography	4 hrs + 3 hrs
Cell lysis methods.	4 hrs
Measurement of a bacterial cell's total protein and carbohydrate content.	4 hrs
Estimation of DNA and RNA of a bacterial cell.	4 hrs
Chromatography: ~~Paper,~~ TLC for sugar / lipid / amino acid.	4 hrs
Determination of activity of amylase, protease. Effect of pH, temperature on enzyme activity; Enzyme kinetics.	4 hrs + 2 hrs
SDS-PAGE electrophoresis	4 hrs
2D – gel electrophoresis and Gel documentation system demonstration. Demonstration	4 hrs

Books & Other Resources

Text Book(s)	
T1	Introduction To Practical Biochemistry by Plummer D T , 2006
T2	Biochemistry (Lippincott Illustrated Reviews Series) by R. Harvey
T3	Practical Physiological Chemistry: A Book Designed for Use in Courses in Practical Physiological Chemistry in Schools of Medicine and of Science (Classic Reprint) by Philip Bovier Hawk, 2017

T = Text Book

Modes of Examination: Assignment/Quiz/Project/Presentation/Written Exam

Examination Scheme:

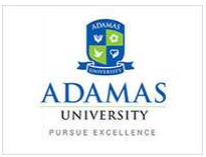
Components	Internal	End Term
Weightage (%)	50	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	3	2	3	3	-	-	3	-	-	1	3
CO2	3	3	2	3	3	-	-	3	-	-	1	3
CO3	3	3	2	3	3	-	-	3	-	-	1	3
CO4	3	3	2	3	3	-	-	3	-	-	1	3
CO5	3	3	2	3	3	-	-	3	-	-	1	3
Avg	3	3	2	3	3	-	-	3	-	-	1	3

1=weakly mapped
2= moderately mapped
3=strongly mapped

Model Question Paper

Name: **Enrolment No:**	

Course: MIB22544 – Biomolecules, Biophysical Chemistry and Bioanalytical Techniques Lab (PRACTICAL)
Program: M.Sc. Microbiology **Time: 03 Hrs.**
Semester: Odd 2022-23 **Max. Marks: 50**

Instructions:
Attempt any **three** questions from **Section A** (each carrying 10 marks); **Section B** is Compulsory (carrying 10 marks)**.**

	Section A (Attempt any Three)		
1.	a) **Identify** the instrument shown in the picture. (Ap) b) **Write** the operating principle and uses of this instrument (An)	**3** **7**	**CO1**
2.	a) **Identify** sample A using specific reagent provided. (Ap) b) **Write** principle of this procedure and interpret the result (An)	**3** **7**	**CO3**
3.	a) **Identify** sample B using specific reagent provided. (Ap) b) **Write** principle of this procedure and interpret the result (An)	**5** **5**	**CO3**
4.	You want to purify two proteins with identical molecular weights. **Design** suitable chromatography technique to execute this process. **Interpret** the result. (An, Ap)	**5+5**	**CO2** **CO5**
	SECTION B is compulsory		
5.	**Viva-voce** (U/An/Ap/R/Ev)	**10**	**CO1** **CO2** **CO3** **CO4** **CO5**
6.	**Practical copy** (U/Ap/Ev)	**10**	**CO1** **CO2** **CO3** **CO4**

MIB22545	Bacteriology, virology and Microbial Genetics Lab	L	T	P	C
Version 1.0	Contact Hours – 60	0	0	4	2
Pre-requisites/Exposure	UG LEVEL MICROBIOLOGY				
Co-requisites	--				

Course Objectives

1. To gain a deeper understanding on principle and applications of important instruments like biological safety cabinets, autoclave, incubator, BOD incubator, hot air oven, light microscope, pH meter used in the microbiology laboratory.
2. To gain a deeper understanding of different culture media, staining and sterilization techniques.

Course Outcomes

CO1 Students will be able to **identify** different bacterial and viral species based on their unique characteristics.
CO2 Students will be able to **interpret** the results of various laboratory tests used to identify bacteria and viruses.
CO3 Students will be able to **perform** aseptic techniques and handle microbial cultures safely in a laboratory setting.
CO4 Students will be able to **critically evaluate** and **explain** the significance of microbial interactions in various environments.
CO5 Students will be able to **evaluate** the reliability and validity of experimental results obtained in the laboratory.

Catalogue Description

Familiarize the students with Good Laboratory Practices and Biosafety of a microbiology laboratory. To know the methods commonly used in the microbiology laboratory. After completion of the course students will demonstrate the aseptic techniques and perform routine culture handling tasks safely and effectively. They can apply scientific methods to collect, interpret, and present scientific data in microbiology fields. Students will learn the proper use of a phase contrast microscope to observe microorganisms and report observed characteristics. They can practice and apply calculations related to the preparation of media, stock/working solutions, and culture dilutions.

Course Content (3 h/ experiment)

1. Preparation of culture media for bacterial cultivation.
2. Sterilization of heat sensitive material by membrane filtration and assessment for sterility
3. Identification and presence of microflora in the environment.
4. Cultivation of microbes using Pour plate, Spread plate and Streak plate (types) methods.
5. Study of colony and cell morphology of different microbial species.
6. Study of *Rhizopus*, *Penicillium*, *Aspergillus* using temporary mounts
7. Study of *Spirogyra* and *Chlamydomonas, Volvox* using temporary Mounts
8. Study of the following protozoans using permanent mounts/photographs: *Amoeba*, *Entamoeba*, *Paramecium* and *Plasmodium*
9. Staining techniques: Smear preparation and ~~simple staining~~
10. Gram staining
11. Capsule staining
12. Endospore staining
13. Genetic transformation in *Sachcharomyces cerevisiae*
14. Bacterial conjugation.
15. Replica plating and auxotroph isolation
16. Mutagenesis and phenotypic screening
17. Phage assays: prophage induction and determining phage titre
18. Observing swarming and twitching motility of bacteria
19. Assays for quorum sensing and biofilm associated attributes

Books & Other Resources

Text Book(s)	
T1	Tortora GJ, Funke BR and Case CL (2008). Microbiology: An Introduction, 9th edition, Pearson Education.
T2	Madigan MT, Martinko JM, Dunlap PV and Clark DP (2014). Brock Biology of Microorganisms, 14th edition, Pearson International Edition.
T3	Cappucino J and Sherman N (2010). Microbiology: A Laboratory Manual, 9th edition, Pearson Education.

T = Text Book

Modes of Examination: Assignment/Quiz/Project/Presentation/Written Exam

Examination Scheme:

Components	Internal	End Term
Weightage (%)	50	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	3	2	3	3	3	3	3	1	3	3	3
CO2	3	3	2	3	3	3	3	3	1	3	3	3
CO3	3	3	2	3	3	3	3	3	1	3	3	3
CO4	3	3	2	3	3	3	3	3	1	3	3	3
CO5	3	3	2	3	3	3	3	3	1	3	3	3
Avg	3	3	2	3	3	3	3	3	1	3	3	3

1=weakly mapped
2= moderately mapped
3=strongly mapped

Name: **Enrolment No:**	

Course: MIB22545 – GENERAL MICROBIOLOGY AND MICROBIAL GENETICS LAB(PRACTICAL)
Program: M.Sc. Microbiology **Time: 03 Hrs.**
Semester: Odd 2022-23 **Max. Marks: 50**

Instructions:
Attempt any **three** questions from **Section A** (each carrying 10 marks); **Section B** is Compulsory (carrying 10 marks)**.**

	Section A (Attempt any Three)		
1.	a) **Identify** the instrument shown in the picture. (Ap) b) **Write** the operating principle and uses of this instrument (An)	**3** **7**	**CO1**
2.	a) **Identify** specimen A using microscopy. (Ap) b) **Write** the procedure and interpret the result (An)	**3** **7**	**CO4**
3.	a) **Identify** sample B using specific staining. (Ap) b) **Write** the principle of this procedure and interpret the result (An)	**5** **5**	**CO3**
4.	You want to identify an unknown microorganism. **Design** suitable culture and staining techniques to execute this process. **Interpret** the result. (C)	**7+3**	**CO3** **CO4** **CO5**
	SECTION B is compulsory		
5.	**Viva-voce** (U/An/Ap/R/Ev)	**10**	**CO1** **CO2** **CO3** **CO4** **CO5**
6.	**Practical copy** (U/Ap/Ev)	**10**	**CO1** **CO2** **CO3** **CO4**

Course Code: MIB21546	Course Name: Ecology and Evolution	L	T	P	C
Version 1.0	Contact Hours - 45	3	0	0	3
Pre-requisites/Exposure	B. Sc LEVEL BIOLOGY				
Co-requisites	---				

Course Objectives:

1. Provide students with the scope to develop knowledge base covering all attributes of the environment and enable them to attain scientific/technological capabilities to find answers to the fundamental questions before the society with regards to human action and environmental effects with due diligence.
2. Enhance the ability to apply this knowledge and proficiency to find solutions relating to environmental and ecological concerns of varied dimensions of present times through research activities.
3. Provide with a direction and technical capability to carry on collaborative endeavour, and decision making.
4. Help graduates appreciate requirement of framing environmental policy guidelines.
5. Motivate graduates to appreciate that they are an integral stakeholder in the environmental management of India irrespective of their future jobs or working.

Course Outcome:

Upon completion of this course, students will be able to:

1. **Recall** and **identify** key concepts and terms related to ecology and evolution such as population dynamics, succession, evolutionary genetics, theories of evolution, and population genetics.
2. **Explain** the fundamental principles of ecology and evolution, including the mechanisms of natural selection, genetic drift, and gene flow.
3. **Apply** ecological and evolutionary concepts to analyze and interpret data related to population dynamics, genetic variation, and evolutionary processes.
4. Critically **evaluate** scientific literature on ecology and evolution to draw conclusions and generate hypotheses related to population dynamics and evolutionary patterns.
5. **Design** and **plan** research projects to investigate ecological and evolutionary patterns in natural populations.

Course Content:

Unit I: Ecology and Taxonomy:

A. Principles and methods of taxonomy: Concepts of species and hierarchical taxa, biological nomenclature, classical and quantitative methods of taxonomy.

B. The Environment: Physical environment; biotic environment; biotic and abiotic interactions.

C. Habitat and niche: Concept of habitat and niche; niche width and overlap; fundamental and realized niche; resource partitioning; character displacement.

D. Population ecology: Characteristics of a population; population growth curves; population regulation; life history strategies (*r* and *K* selection); the concept of metapopulation – demes and dispersal, intergenic extinctions, age-structured populations.
E. Species interactions: Types of interactions, interspecific competition, herbivory, carnivory, pollination, symbiosis.
F. Community ecology: Nature of communities; community structure and attributes; levels of species diversity and its measurement; edges and ecotones.
G. Ecological succession: Types; mechanisms; changes involved in succession; the concept of climax.
H. Ecosystem: Structure and function; energy flow and mineral cycling (CNP); primary production and decomposition; structure and function of some Indian ecosystems: terrestrial (forest, grassland) and aquatic (freshwater, marine, eustarine).
I. Biogeography: Major terrestrial biomes; theory of island biogeography; biogeographical zones of India.
J. Conservation biology: Principles of conservation, major approaches to management, Indian case studies on conservation/management strategy (Project Tiger, Biosphere reserves).

Unit II: Evolution:

A. Historical review of evolutionary concept
Lamarckism, Darwinism, Neo-Darwinism, Geological time scale.
B. Sources of variations and Population genetics
Heritable variations and their role in evolution, Hardy-Weinberg Law (statement and derivation of equation, application of law to human Population); Evolutionary forces upsetting H-W equilibrium;
Natural selection (concept of fitness, selection coefficient, derivation of one unit of selection for a dominant allele, genetic load, mechanism of working, types of selection, density-dependent selection, heterozygous superiority, kin selection, adaptive resemblances, sexual selection. Genetic Drift (mechanism, founder's effect, bottleneck phenomenon; Role of Migration and Mutation in changing allele frequencies), Speciation.
C. Product of evolution: Micro evolutionary changes (inter-population variations, clines, races, Species concept, Isolating mechanisms, modes of speciation—allopatric, sympatric, Adaptive radiation / macroevolution (exemplified by Galapagos finches).
D. Phylogenetic trees: Multiple sequence alignment, construction of phylogenetic trees, interpretation of trees
E. Animal Behaviour Instinctive and learning behaviour, Fixed action pattern, Communication in honeybees (dance Language), Elements of Sociobiology: Altruism and selfishness.

Reference books:

1. Diversity of Life: The Five Kingdoms by Lynn Margulis, 1992
2. The Diversity of Living Organisms by Richard Stephen Kent Barnes, 2009
3. Ecology by Michael L. Cain, William D. Bowman, 2008
4. Fundamentals of Ecology by Odum and Barrett, 2005
5. Biodiversity: an introduction by Kevin J. Gaston, 2004

Modes of Examination: Assignment/Quiz/Project/Presentation/Written Exam

Examination Scheme:

Components	Internal	End Term
Weightage (%)	50	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	3	2	1	3	-	-	3	-	-	-	3
CO2	3	3	2	1	3	-	-	3	-	-	-	3
CO3	3	3	2	1	3	-	-	3	-	-	-	3
CO4	3	3	2	1	3	-	-	3	-	-	-	3
CO5	3	3	2	1	3	-	-	3	-	-	-	3
Avg	3	3	2	1	3	-	-	3	-	-	-	3

1=weakly mapped
2= moderately mapped
3=strongly mapped

ADAMAS UNIVERSITY PURSUE EXCELLENCE	**ADAMAS UNIVERSITY** **END SEMESTER EXAMINATION** **(EVEN SEMESTER 2022)**		
Name of the Program:	M.Sc. (Microbiology)	**Semester:**	IV
Paper Title:	Microbial Ecology and Evolution	**Paper Code:**	MIB21538
Maximum Marks:	50	**Time Duration:**	3 Hrs
Total No. of Questions:	17	**Total No of Pages:**	3
(Any other information for the student may be mentioned here)	**1.** At top sheet, clearly mention Name, Univ. Roll No., Enrolment No., Paper Name & Code, Date of Exam. **2.** All parts of a Question should be answered consecutively. Each Answer should start from a fresh page. **3.** Assumptions made if any, should be stated clearly at the beginning of your answer.		

Group A **Answer All the Questions (5 x 1 = 5)**			
1	Accumulating evidence suggest that Domain Archaea is more closely related to Domain Eukarya than to Domain Bacteria. Which of the following properties are shared between eukaryotes and archaea? (i) Protein biogenesis (ii) Presence of sterol containing membranes (iii) Ribosomal subunit structures (iv) Adaptation to extreme environmental conditions (v) Fatty acids with ester linkages in the cell membrane (A) (ii), (iii) and (v) (B) (i), (ii), (iv), and (v) (C) (i) and (iii) (D) (iii) and (iv)	**U**	**CO1**
2	Which of the following is the correct increasing order for the daily net primary productivity (NPP) per unit leaf area in different ecosystems? (i) Desert < Temperate forests < Tropical forests (ii) Desert < Tropical forests < Temperate forests (iii) Temperate forests < Tropical forests < Desert (iv) Tropical forests < Temperate forests < Desert	**E**	**CO2**
3	An orchid living on a tree exhibits a) Predator b) Mutualism c) Commensalism d) Parasitism	**U**	**CO3**
4	What is strand composition bias of bacterial genome?	**A**	**CO4**
5	The collection of individuals which belongs to the same species when live together in a region is known as _____	**A**	**CO5**

	a) Keystone species b) Community c) Guild d) Population		
Group B **Answer All the Questions (5 x 2 = 10)**			
6	What do you mean by protocooperation?	**An**	**CO1**
7	What are three characteristics of climax communities?	**An**	**CO2**
8	Differentiate between pyramids of Biomass & standing Crop.	**U**	**CO3**
9	Cite an example of Batesian mimicry.	**A**	**CO4**
10	What should be the criteria for designing primers for RAPD?	**Ap**	**CO5**
Group C **Answer All the Questions (7 x 5 = 35)**			
11	How do we reconstruct phylogeny? How do we represent it in a formal classification? 2+3	**An**	**CO1**
12	What traits might an ideal species have? 5	**An**	**CO2**
13	Define the following terms. i) Monophyletic ii) Taxon iii) Rank iv) Additional Rank 5	**E**	**CO3**
14	What is climax community? Name two events that will initiate primary succession. Define stratification with an example. (1+2+2)	**A**	**CO4**
15	What do you mean by Founder Effect Speciation? Give example to explain the same. Would it be possible to determine founder effect for gut microbiome? (2+3)	**Ap**	**CO4**
16	Mention the application of RAPD. Why 16S or 18S rDNA sequence is considered to be a better choice over other house-keeping genes? (3+2)	**Ap**	**CO5**
17	Mention the features of horizontally acquired genes. How shot gun sequencing approach changed the conventional approach of microbial genome analysis? (2+3)	**A**	**CO5**

MIB21536	BIO-ETHICS AND INTELLECTUAL PROPERTY RIGHTS (THEORY)	L	T	P	C
Version 1.0	**Contact Hours - 60**	3	2	0	3
Pre-requisites/Exposure	Basic Knowledge of Biology, application of biotechnology and concept of innovation.				
Co-requisites	--				

Course Objectives

1. To provide the students with understanding of components and process of obtaining protection using IPR.
2. It will also discuss various aspects of bioethics
3. To study the scope of entrepreneurship development using biotechnology and imbibe skills.

Course Outcomes

Course Outcomes

On completion of this course, students will be able to:

1. **Identify** significant agreements and treaties relevant to IPR and biotechnology, such as TRIPS and UPOV, and major international bioethics frameworks.
2. **Explain** the importance of IPR in biotechnology and how bioethics governs research, innovation, and commercialization in life sciences.
3. **Implement** bioethics principles in evaluating case studies on biotechnology innovations, ensuring compliance with IPR laws and ethical standards.
4. **Analyze** the role of bioethics in shaping biotechnology safety standards and how IPR protects innovations in life sciences.
5. **Critically evaluate** and **explain** the balance between ethical concerns and intellectual property rights in biotechnology research and entrepreneurship.

Catalogue Description

The core-course of bioethics, IPR and biological patent is a core course that discusses various concepts of IPR along with its background, history and method of obtaining them. This is a fundamental course that would help students to be aware of the legal protection of innovation

and innovative products. Several bio-ethical concepts are also discussed to provide critical appraisal on various biological processes. The scope of entrepreneurship utilizing biotechnological ideas are also dealt in this course.

Course Content

Unit I. Intellectual Property Right (IPR) (15h)

1. Concept and provisions of IPR

Patents, Trademarks, Copyright, Conditional information, Breeder's right. Patent; importance, types, scope, criteria, applying for a patent. Protection of Biotechnological inventions. Patent infringement- meaning, scope, litigation, case studies and examples

2. Agreements and Treaties----History of GATT & TRIPS Agreement; Madrid Agreement; Hague Agreement; WIPO Treaties; Budapest Treaty; PCT

Unit II. Safety in Biotechnology (15h)

Introduction to Biological Safety Cabinets; Primary Containment for Biohazards; Biosafety Levels of Specific Microorganisms; Recommended Biosafety Levels for Infectious Agents and Infected Animals; Biosafety guidelines , Overview of Biotechnology Regulations and relevant International Agreements including Cartegana Protocol.

Unit III. Bioethics (15h)

Biotechnology information, communication and public perception, Future prospects of consumers and social acceptance .Case studies

Unit IV. Bio-entrepreneurship (15 h)

Support mechanism for entrepreneurship in India; Leadership skills; Managerial skills; Team building; teamwork;. Taking decision on starting a venture; Assessment of feasibility of a given venture/new venture; Approach a bank for a loan; Sources of financial assistance; Making a business proposal/Plan for seeking loans from financial institution and Banks. Information technology for business administration, E-business setup and management.

Suggested Books:

4. The Ethics of Biotechnology by Jonathan Morris, 2005
5. Understanding Bioethics and the Law: The Promises and Perils of the Brave New World of Biotechnology by Barry R. Schaller, 2007
6. Nexus of Law and Biology: New Ethical Challenges by Barbara Ann Hocking, 2009
7. Intellectual Property and Biotechnology: Biological Inventions by Matthew Rimmer, 2008
8. An Introduction to Ethical, Safety and Intellectual Property Rights Issues in Biotechnology by Padma Nambisan, 2017
9. Biotechnology Entrepreneurship by Craig Shimasaki, 2014

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Class Assessment	End Term
Weightage (%)	50	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	3	3	2	3	3	3	3	2	3	3	2
CO2	3	3	3	2	3	3	3	3	2	3	3	3
CO3	3	3	3	2	3	3	3	3	2	3	3	2
CO4	3	3	3	2	3	3	3	3	2	3	3	2
CO5	3	3	3	2	3	3	3	3	2	3	3	2
Avg	3	3	3	2-	3	3	3	3	2	3	3	3

1=weakly mapped, 2= moderately mapped, 3=strongly mapped

Model Question Paper

Name: **Enrolment No:**	

Course: MIB21536 – BIO-ETHICS AND INTELLECTUAL PROPERTY RIGHTS (THEORY)
Program: M.Sc. Microbiology **Time: 03 Hrs.**
Semester: IV (Even 2021-22) **Max. Marks: 50**

Instructions:

Attempt any **four** questions from **Section A** (each carrying 5 marks); allquestions from **Section B** (each carrying 10 marks)**.**

SECTION A (Attempt **any four questions)**

1.	**Define** IPR and Mention its components (R, U)	**2+3**	**CO1**
2.	**Analyze** the ethical issues of using GM crops (An)	**5**	**CO2**
3.	Which category of Biosafety is required to work with COVID:19? **Mention** the facilities required in such lab. (An)	**1+4**	**CO3**
4.	**Identify** and enlist the skill-sets required to become an Entrepreneur. (Ap)	**5**	**CO4**
5	**Write** a short role on Infringement of Patent (R,U)	**5**	**CO5**
6	Describe the condition when natural products can be patented (U).	**5**	**CO5**
	SECTION B (Attempt all **questions)**		
7.	**Discuss** the origin of WIPO. Why an International organization like WIPO is required? Mention the administrative components of WIPO. The logo of a company is protected through IPR: **Justify** and mention the benefits. (R,U,An)	**2+2+2+4**	**CO1**

8.	A person has invented a new method of doing non-invasive treatment of removing kidney stone in human. He had applied for patent but his patent was rejected. **Justify** the decision of Controller of Patents for such decision. Mention any other criterion for an invention being non-patentable. Write a note on the types of patent application. **Mention** the validity of a patent in terms of duration. (An,Ap)	**2+4+3+1**	**CO1,CO2**
9.	**Name** one convention related to Biosafety of biodiversity. **Describe** major amendments of that convention. Mention the source of finance for a start-up and the method to approach them. (U, An)	**1+5+4**	**CO3, CO4**

MIB22571	Professional Development Course-1 (Practical)	L	T	P	C
Version 1.0	Contact Hours - 30	0	0	1	1
Pre-requisites/Exposure	PLUS B.SC LEVEL SCIENCE				
Co-requisites	--				

Catalog Description: This professional development course aims to help you discover and achieve your goals by focusing on organization and action. You'll learn techniques to enhance goal-setting, communication, self-motivation, and a positive attitude, empowering you to maximize your performance both academically and professionally.

Course Syllabus:

The syllabus for Professional Development Course-I for senior students (1st Semester- 3rd Semester for P.G students)

1. Introduction to Pre-Placement Training.
2. Resume Building & Cover Letter Writing.
3. Interview Skills.
4. Aptitude and Technical Skills.
5. Group Discussion and Communication Skills.
6. Personal Branding and Online Presence.
7. Professional Skills.
8. Industry Insights and Company Presentations.
9. Career Guidance for competitive entrance exams and Job Search Strategies
10. Mock Tests and Assessments.

Course learning outcomes:

CO1: Identify the components of an effective resume and cover letter for job applications

CO2: Explain the importance of developing aptitude skills for placement tests..

CO3: Interpret the results of aptitude tests and identify areas for improvement.

CO4: Participate in mock interviews to improve interview skills and confidence.

CO5: Critically assess personal interview performance and identify areas for development.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	CA	End Term
Weightage (%)	50	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	-	3	3	1	3	3	3	3	-	3	2	2
CO2	-	3	3	1	3	3	3	3	-	3	2	2
CO3	-	3	3	1	3	3	3	3	-	3	2	2
CO4	-	3	3	1	3	3	3	3	-	3	2	2
CO5	-	3	3	1	3	3	3	3	-	3	2	2
Avg	-	3	3	1	3	3	3	3	-	3	2	2

1=weakly mapped, 2= moderately mapped, 3=strongly mapped

MIB21509	Molecular Biology (THEORY)	L	T	P	C
Version 1.0	Contact Hours – 45	3	0	0	3
Pre-requisites/Exposure	UG LEVEL MICROBIOLOGY				
Co-requisites	--				

Course Objectives

1. Develop concepts of molecular basis of genome maintenance
2. In-depth knowledge of gene expression regulation
3. To develop basic concept of post-translational modification

.

Course Outcomes:

On completion of this course, the students will be able to

1. **Recall** the basic concepts of molecular biology such as DNA structure, genetic code, and nucleotide base pairing.
2. **Explain** the process of DNA replication, including the roles of DNA polymerase, helicase, and primase, and the mechanisms of DNA recombination and repair, including homologous recombination and non-homologous end joining.
3. **Design** experiments to study gene expression at the transcriptional or translational level.
4. **Analyze** the mechanisms of gene expression at the transcriptional or translational level.
5. **Critique** and **explain** the current methods for studying gene expression and regulation and existing technologies in DNA manipulation and sequencing.

Catalogue Description

The course of '**Molecular Biology**' will help to understand the basic concept of genome replication-repair. Also, the course would deal with details of gene expression regulation. Classes will be conducted by lecture as well as power point presentation, audio visual virtual lab session as per requirement. The tutorials will enable the students with problem-solving ability led by the course coordinator. Students will perceive the basic concepts of the subject via exercise and discussions with the coordinator.

Course Content

Unit 1 DNA Structure; Replication; Repair & Recombination (9h)

Bacterial DNA replication: modes, mechanisms and key experiments. Discobery of various polymerases. DNA replication in archeae. Mitochondrial DNA replication. Features of eukaryotic DNA replication: identification of components and roles of various DNA polymerases. Transposition, Homologous and site-specific recombination: mechanism and application. DNA damage: mutagenesis and various repair systems. Gene knock-in, knock-out and over-expression, Site directed mutagenesis, Gene editing: TALEN, CRISPR-Cas.

Unit 2 Prokaryotic & Eukaryotic Transcription (9h)
Prokaryotic Transcription; Transcription; Operon concept: lac, trp and ara operon.

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12

Transcriptional control in lambda phage; Eukaryotic transcription and regulation; RNA polymerase structure and assembly; RNA polymerase I, II, III; Eukaryotic promoters and enhancers; General Transcription factors.

Unit 3 Post Transcriptional Modifications (9h)
Role of noncoding RNA in bacteria and eukaryotes. Gene silencing.Processing of hn-RNA, t-RNA, r-RNA; 5'-Cap formation; 3'-end processing and polyadenylation; mRNA Splicing; RNA editing; Nuclear export of mRNA; mRNA stability; Catalytic RNA: ribozymes. Riboswitch.

Unit 4. Translation (9h)
Characteristics of genetic code; Wobble hypothesis; Mechanism of initiation, elongation and termination; tRNA and amino acyltRNA synthetase. Ribosomes; Composition and assembly; Polysome profile and Ribo-seq. Protein stability; Protein turnover and degradation: proteasome.

Text Book:

1. Molecular Biology. Weever, 2002.

Reference Book:

2. Molecular Biology: Watson, 2007
3. Molecular Cell Biology by Harvey Lodish, 2003

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Class Assessment	End Term
Weightage (%)	50	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

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

1=weakly mapped
2= moderately mapped
3=strongly mapped

Model Question Paper

Name: **Enrolment No:**	

Course: MIB21509- MOLECULAR BIOLOGY (THEORY)
Program: M.Sc. Microbiology **Time: 03 Hrs.**
Semester: Even 2022-23 **Max. Marks: 50**

Instructions:
Attempt any **four** questions from **Section A** (each carrying 5 marks); any **three** questions from **Section B** (each carrying 10 marks)**.**

SECTION A (Attempt any four questions)			
1.	In one genome of 5 Mb there are 5000 genes. In another genome of 3000 Mb there are 25000 genes. **Judge** which one is originating from bacteria and justify. Mention the **application** and type of data generated by chromosome conformation capture. (An, Ap)	**2+3**	**CO1**
2.	"Mammalian chromosome maintenance requires DNA polymerase and reverse transcriptase activity"- **justify** the statement. (An)	**2+3**	**CO2**
3.	Mention the levels of eukaryotic chromosome organization. "Mutation in centromeric protein coding genes might lead to chromosomal anomalie"-**explain**. (R, U)	**5**	**CO3**
4.	**What** kind of radiochemical would you use to label the following molecules with P^{32}? a. replicative DNA b. nascent RNA chain- **explain** (C)	**3+2**	**CO4**
5	What are the functional **differences** of bacterial DNApolI and DNApolIII? Can you **demonstrate** the difference experimentally? (U, C)	**2+3**	**CO1**
6.	Explain how non-Watson-Crick Base pairing determine codon degeneracy.	**5**	**CO5**
	SECTION B (Attempt any **Three questions)**		
6.	**What** are the biological significances of rolling circle replication? -elaborate. Mention the **difference** of progressing replicative fork associated DNA polymerase organization in bacteria and eukaryotes. (R, U)	**4+6**	**CO3**
7.	**What** is a merozygote? Do bacterial operons such as ara **relate** to eukaryotic trans-acting proteins in terms of regulating gene expression? You want to **perform** a site-directed mutagenesis to make TRP operon constitutively expressed. What should be the preferred target site for you? **Justify** your answer in light of basic concept of attenuation. (R, U, An)	**5+5**	**CO1** **CO2**

8.	**Explain** why the rate of successful promoter clearance is apparently low for RNA polymerases? **What** is the significance of pseudo circularization of mRNA? **Demonstrate** the structure of a putative intron. Point out regions which, if mutated, can affect final gene product. (U, Ap)	**2+3+5**	**CO1** **CO2**
9	"Aminoacyl tRNA synthetases are crucial for fidelity of translation"-**explain**. **How** does polysome profile indicate status of ribosomal activity in a cell? (An, Ap)	**5+5**	**CO5**

MIB21511	Recombinant DNA Technology	L	T	P	C
Version 1.0	Contact hour- 45	3	0	0	3
Pre-requisites/Exposure	**12th level English + B.Sc. Microbiology or allied life sciences**				
Co-requisites					

Course Objectives

1. To acquaint the students to versatile tools and techniques in recombinant DNA technology
2. To implement skills about restriction and modification systems
3. To impart knowledge about polymerase chain reactions and their applications
4. To apply the knowledge of techniques for analysis of gene expression.
5. To outline concepts of transcriptomics, genomics and their application in recombinant DNA technology.

Course Outcomes

On completion of this course, the students will be able to

CO1: Recall the fundamental principles, tools, and techniques of recombinant DNA technology, including vectors, enzymes, and gene cloning methods.

CO2: Explain the mechanisms and applications of gene manipulation and molecular cloning in biotechnology and genetic research.

CO3: Apply recombinant DNA techniques to solve problems in genetic engineering, such as gene expression, sequencing, and the creation of genetically modified organisms (GMOs).

CO4: Analyze experimental data from recombinant DNA experiments, including gene splicing, cloning, and transformation, to draw valid conclusions.

CO5: Design and **develop** recombinant DNA-based solutions for real-world challenges, such as gene therapy, vaccine development, or agricultural improvements.

Catalogue Description

This course will cover strategies for cloning and expression of proteins, library construction, PCR strategies and troubleshooting, blotting techniques and recombinant gene expression systems. The course

Course Content

Unit 1 Basics of DNA cloning (5h)
Simple cloning and cloning using linkers and adaptors.Gene Isolation and expression, Cloning into various kinds of vectors – plasmids, phages lambda and M13, phagemids, cosmids, P1 phage, PACs, BACs and YACs.Selection and screening of clones.

Unit 2 Methods of DNA and Protein Analysis (8h)
Agarose, polyacrylamide and pulsed field gel electrophoresis of DNA, Southern and Northern Blotting. Radio labelling probes. Isolation and purification of DNA.RFLP, RAPD analysis.DNA fingerprinting and its application in forensics, in disease diagnosis and in identification of strains.Native PAGE, SDS-PAGE and two-dimensional PAGE analysis of proteins.Western Blotting analysis.

Unit 3 Polymerase Chain Reaction (8h)
Concept of PCR and various thermophilic enzymes used in PCR.Gradient PCR versus Touchdown PCR.Designing primers. Cloning PCR products. Long PCR, Inverse PCR, RT-PCR, 5' and 3' RACE, qPCR, Real Time PCR using SYBR Green, Scorpion primers and TaqMan probes, Multiplex PCR, Differential Display PCR, RAPD fingerprinting of micro-organisms, Ligation Chain Reaction, Overlap PCR, Rolling Circle Amplification Technology.

Unit 4 Construction of cDNA and Genomic DNA Libraries (8h)
Vectors used in the construction of cDNA versus genomic DNA libraries. Steps and enzymes involved in the construction of cDNA versus genomic DNA libraries. Screening libraries by colony hybridization and colony PCR.Screening expression libraries. Enriching for clones in cDNA libraries by positive selection and subtractive hybridization. Identifying genes in complex genomes by direct selection of cDNA and exon trapping.

Unit 5 Transcriptional Analysis of Gene Expression and Transcriptomics (8h)
Gene expression analysis by Northern Blotting, RT-PCR, EST analysis and the use of reporter genes.Enzymatic and bioluminescent reporters. Reporters used in protein localization and trafficking studies. Promoter analysis – deletion analysis and linker scanning analysis coupled to reporter assays, mapping transcriptional start sites by S1 nuclease mapping, primer extension studies or 5' RACE. Transcriptome analysis by DD-PCR and EST analysis, DNA microarrays (cDNA arrays and oligo arrays), Serial Analysis of Gene Expresion (SAGE).

Unit 6 Overexpression of Recombinant Proteins (8h)
Overexpression and tagging of recombinant proteins in *E.coli,* driven by lac, T7 and Tet-regulatable promoters, Expression in *B. subtilis*. Overexpression systems in *S.cerevisiae*, *P.pastoris, S.pombe*AQ and *K.lactis*. Baculovirus overexpression system. Mammalian cell overexpression system, Analysis of protein-DNA and protein-protein interactions: Gel retardation assay, DNA footprinting by DNase I and chemical methods, yeast one-hybrid assay, ChIP- chips. Yeast two hybrids, three-hybrids, split hybrids and reverse hybrids. Co-immunoprecipitations, pull-downs and Far-Westerns.GFP and FRET.Phage display.

Suggested Readings:

1. Recombinant DNA: Genes and Genomes - a Short Course by James D. Watson, 2006
2. Principles of Gene Manipulation and Genomics by Sandy Primrose and Twyman, 2006
3. From genes to genomes concepts and applications of DNA technology by Jeremy W dale and Malcolm von Scrantz, 2011
4. Molecular Biotechnology: Principles and Applications of Recombinant DNA by Bernard Glick 2009
5. Genomes 3 by T.A. Brown, 2006

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Class Assessment	End Term
Weightage (%)	50	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	3	2	3	3	-	-	3	-	-	1	3
CO2	3	3	2	3	3	-	-	3	-	-	1	3
CO3	3	3	2	3	3	-	-	3	-	-	1	3
CO4	3	3	2	3	3	-	-	3	-	-	1	3
CO5	3	3	2	3	3	-	-	3	-	-	1	3
Avg	3	3	2	3	3	-	-	3	-	-	1	3

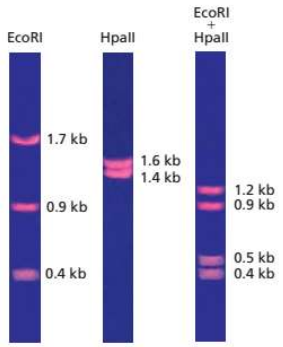
Model Question Paper

Name: **Enrolment No:**	ADAMAS UNIVERSITY PURSUE EXCELLENCE

Course: MIB21511 –RECOMBINANT DNA TECHNOLOGY (THEORY)
Program: M.Sc Microbiology **Time: 03 Hrs.**
Semester: Even 2022-23 **Max. Marks: 50**

Instructions:
Attempt any **four** questions from **Section A** (each carrying 5 marks); any **Three Questions** from **Section B** (each carrying 10 marks)**.**

	Section A (Attempt any Four)		
1.	**Distinguish** betweencloning vector and expression vector. (An)	**5**	**CO1**
2.	**List** four limitations of Taq polymerase (U)	**5**	**CO3**
3.	**Outline** important considerations for design of PCR primers. (C)	**5**	**CO3**
4.	Assuming the human genome is 2.8 x 106 Kilobases (Kb) in size and that a lambda vector (maximum insert size = 20Kb) is used to make a gene library, how many actual clones would be required to achieve a 99% probability of including a particular gene sequence? (C)	**5**	**CO2**
5.	**Outline** the basis of Gibson cloning (An)	**5**	**CO3**
6.	Can you use blunt cutters for directional cloning? - **explain** (An)	**5**	**CO2**
	SECTION B (Attempt any **Three Questions)**		
7.	**Discuss** in brief methodology adopted to use pUC vectors to efficiently clone your gene of interest and the assay method to screen the positive clones. (U)	**5+5**	**CO1**
8.	You wish to make a restriction map of a 3.0-kb BamHI restriction fragment. You digest three samples of the fragment with EcoRI, HpaII, and a mixture of EcoRI and HpaII. You then separate the fragments by gel electrophoresis and visualize the DNA bands by staining with ethidium bromide (Figure below). From these results, **draw** a restriction map that shows the relative positions of the EcoRI and HpaII recognition sites and the distances in kilobases (kb) between them. (Ap)	**10**	**CO1**

			
9.	**Discuss** the strengths and limitations of expressing heterologous proteins in bacteria. (R, U)	**5+5**	**CO5**
10.	Schematically **discuss** how S1 nuclease mapping can be used to map 5' and 3' end of a transcript (Ap)	**10**	**CO6**

MIB21513	Environmental Microbiology	L	T	P	C
Version 1.0	Contact Hours - 45	3	0	0	3
Pre-requisites/Exposure	Basic knowledge of environmental microbiology from UG level				
Co-requisites	--				

Course Objectives:

1. Students will be able to **summarize** the different microbial ecosystems and identify the various phenomena of microbial worlds.
2. Students will be able to **demonstrate** and categorize the interactions of microbes present in different ecosystems.
3. Students will be able to **illustrate** the different microbial biogeochemical cycles of macro and micro elements in different ecosystems.
4. Students will be able to **appraise** the regulations associated with waste management, and apply the knowledge to judge the potability of water samples.
5. Students will be able to **comprehend** microbial bioremediation and **design** screening studies.

Course Outcomes

On completion of this course, the students will be able to

CO1. **Identify** different types of microbes present in air, soil, and water environments.

CO2. **Compare** and contrast various microbial interactions and their impact on ecosystems.

CO3. **Design** a bioremediation plan for a contaminated environment using appropriate microbial techniques.

CO4. **Analyze** the interactions between microorganisms in different environments and their implications for ecosystem functioning.

CO5. **Critically evaluate** and **design** experiments to assess the impact of human activities on microbial diversity and ecosystem health.

Catalogue Description

The student will be able to use the knowledge obtained from the core course “Environmental Microbiology” to understand different components of the ecosystem and the interrelationship between them along with the significance of ecological balance for existence of life. Also the awareness about different forms of pollutions and environmental deterioration attributed to man-made as well as natural causes will be enhanced. The knowledge gained will be helpful in implementing different preventive strategies to protect the environment from the harmful effect of pollutions. Information regarding historical and contemporary laws and regulations will help the students to use application of biotechnology for environmental protection and

also to reprimand the harmful effects of pollutions. All the lectures will be devoted on discussions of basic theories and advanced topics, focusing on practical implementation of knowledge. Classes will be conducted by lecture as well as power point presentation, audio visual virtual lab session as per requirement. The tutorials will enable the students with problem-solving ability led by the course coordinator. Students will perceive the basic concepts of the subject via exercise and discussions with the coordinator.

Course Content

Unit 1 Microbial diversity in normal environments (10 h)
Diversity of microbes in terrestrial (agriculture and desert soils), aquatic (fresh water and marine), atmosphere (stratosphere) and animal (cattle, termites, pests such as nematodes and human being) and their potential applications; Aquatic Environment: Microflora of fresh water and marine habitats; Atmosphere: Aeromicroflora and dispersal of microbes

Unit 2 Microbial diversity in extreme environments (8 h)
Occurrence, diversity, adaptations and potential applications of oligotrophs, thermophiles, psychrophiles, barophiles, organic solvent and radiation tolerants, metallophiles, acidophiles, alkaliphiles and halophiles. Molecular adaptation to extremity.

Unit 3 Soil Microbiology (12 h)
Microbe interactions: Mutualism, synergism, commensalism, competition, amensalism, parasitism, predation; Microbe-Plant interaction: Symbiotic and non ymbiotic interactions; Compost and Biofertilizers, Biological Pest control Biogeochemical Cycling: Carbon cycle: Microbial degradation of cellulose, hemicelluloses, lignin and chitin Nitrogen cycle: Nitrogen fixation, ammonification, nitrification, denitrification and nitrate reduction; Phosphorus cycle: Phosphate immobilization and solubilisation Sulphur cycle: Microbes involved in sulphur cycle; Other elemental cycles: Iron and manganese

Unit 4 Waste Management (8 h)
Solid Waste management: Sources and types of solid waste, Methods of solid waste disposal (composting and sanitary landfill); Liquid waste management: Composition and strength of sewage (BOD and COD), Primary, secondary (oxidation ponds, trickling filter, activated sludge process and septic tank) and tertiary sewage treatment.
Treatment and safety of drinking (potable) water, methods to detect potability of water samples: (a) standard qualitative procedure: presumptive test/MPN test, confirmed and completed tests for fecal coliforms (b) Membrane filter technique and (c) Presence/absence tests

Unit 5 Microbial Bioremediation of environmental pollutants (7 h)
Principles and degradation of common pesticides, organic (petroleum hydrocarbons, oil spills) and inorganic (metals) matter, biosurfactants, bioleaching (Copper ,Gold and Uranium)

Text Book(s)
T1. Fundamentals of Ecology (2010), 5th edition, Eugene. P. Odum, Gary W. Barrett, Saunders,

T2. Ecology and environment, (2017), 13th edition, P.D. Sharma, Rastogi Publications, ISBN: 9789350781227, 9350781220
T3. Environmental Microbiology (2015), 3rd Edition, Ian L. Pepper, Charles P. Gerba, Terry J. Gentry. Elseviers
T4. Pepper IL, Gerba CP, Gentry TJ (2014). Environmental Microbiology, 3rdedition, AcademicPress

Reference Book(s) & Other Resources
R1. Prescott's Microbiology, 10 edition (2017) McGraw-Hill Education;
Christopher J. Woolverton, Joanne Willey, and Linda Sherwood, ISBN-10: 9813151269
ISBN-13: 978-9813151260
R2. Brock Biology of Microorganisms, 14th edition, (2014) Pearson, Madigan MT, Martinko JM and Parker J.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Class Assessment	End Term
Weightage (%)	50	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	3	2	3	3	-	-	3	-	-	1	3
CO2	3	3	2	3	3	-	-	3	-	-	1	3
CO3	3	3	2	3	3	-	-	3	-	-	1	3
CO4	3	3	2	3	3	-	-	3	-	-	1	3
CO5	3	3	2	3	3	-	-	3	-	-	1	3
Avg	3	3	2	3	3	-	-	3	-	-	1	3

1=weakly mapped, 2= moderately mapped, 3=strongly mapped

Model Question Paper

Name: **Enrolment No:**	

Course: MIB21513- ENVIRONMENTAL MICROBIOLOGY (THEORY)
Program: M.Sc. Microbiology **Time: 03 Hrs.**
Semester: Even 2022-23 **Max. Marks: 50**

Instructions:
Attempt any **four** questions from **Section A** (each carrying 5 marks); **all** questions from **Section B** (each carrying 10 marks)**.**

SECTION A (Attempt any Four questions)			
1.	**Give** the diagrammatic representation of zonation in marine ecosystem ®. What do you mean by denitrification? (U)	**3+2**	**CO1**
2.	**Why** do the halophiles require high salinity for their survival (An)? **What** is the compatible solute in halophiles? (R)	**4+1**	**CO4**
3.	**Write** a note on the bioleaching of copper. (U)	**5**	**CO1, CO4**
4.	**What** are faecal and non-faecal coliform bacteria? (U) What is the significance of adding bromothymol blue in Simmon's citrate agar media? (An)	**2+3**	**CO2, CO4**
5	**What** are psychro-tolerant microorganisms? (R) Name an acidophile and an alkaliphile. (R)What is the role of these nodules in nitrogen fixation? (U)	**1+2+2**	**CO2, CO3**
6	Explain the microbial niche of acid mine drainage	**5**	**CO4**
	SECTION B (Attempt **all questions)**		
7.	**Illustrate** the mutualistic relationship between microbes in ore leaching. (An) **Explain** antagonism among microorganisms with suitable example. (U) What is synergism? (R)	**4+4+2**	**CO1, CO5**
8.	**Discuss** the working principle of trickling filter and activated sludge system of secondary water treatment. (U)What is meant by BOD_5? (U) **Write** a note on enumeration of air microbiota by method of impaction on solid media. (R)	**3+3+2+2**	**CO1** **CO2**
9.	**What** are barophiles? (R) Why is halorhodopsin important for the halophiles? (An)What is the biochemistry behind PHA production? (U) **How** is it modulated in commercial process? (An)	**1+5+4**	**CO4** **CO5**

MIB21515	Bioinformatics & Computational Biology (THEORY)	L	T	P	C
Version 1.0	**Contact Hours - 45**	3	0	0	3
Pre-requisites/Exposure	UG LEVEL BIOLOGY				
Co-requisites	--				

Course Objectives

1. To provide those students with apt introductory level knowledge to Biostatistics, Bioinformatics & Computer Applications.
2. It will also provide in depth knowledge of biostatistics.
3. Elaborating the database and biological database
4. Explore the knowledge of modern methods of Bioinformatics such as Microarray experiment, Clustering of microarray data, Principal component analysis

Course Outcomes

On completion of this course,

1. Students will be able to **define** and describe fundamental concepts in applied probability and biostatistics techniques.
2. Students will be able to **explain** the importance of biological databases and their roles in bioinformatics.
3. Students will be able to **use** cluster analysis, phylogenetic clustering, and sequence comparison techniques to analyze biological data.
4. Students will be able to **evaluate** modern bioinformatics methods such as microarray experiments, clustering of microarray data, and principal component analysis.
5. Students will be able to **assess** the effectiveness of structure-based applications in bioinformatics, including **predicting** protein structures through homology modeling.

Catalogue Description

The core-course of 'Biostatistics, Bioinformatics & Computer Applications' will help to understand the introductory level knowledge to biostatistics, bioinformatics & computer applications. This course is a beginning to the biostatistics, the application of different bioinformatics methods to biological data analysis, biological database and some current research activities in the field of bioinformatics. Furthermore, the possible applications of this knowledge in biostatistics, bioinformatics & computer applications would also be illuminated. All the lectures will be devoted on discussions of basic theories and advanced topics, focusing on practical implementation of knowledge. Classes will be conducted by lecture as well as power point presentation, audio visual virtual lab session as per

requirement. The tutorials will enable the students with problem-solving ability led by the course coordinator. Students will perceive the basic concepts of the subject via exercise and discussions with the coordinator.

Course Content

Unit I (9h)

Fundamental concepts in applied probability; Exploratory data analysis and statistical inference; Probability and analysis of one and two way samples; discrete and continuous probability models; Expectation and variance; Central limit theorem; Inference; Hypothesis; Critical region and error probabilities; Tests for proportion; Equality of proportions; equality of means of normal populations(variance known, variance unknown); Chi-square test for independence; P-value of the statistic; Confidence limits; Introduction to one way and two-way analysis of variance; Data transformations.

Unit II (9h)

Elements of programming languages - C and PERL/ python; Data base concept; Database management system; Database browsing and Data retrieval; Sequence database and genome database; Data Structures and Databases; Databases such as GenBank; EMBL; DDBJ; Swissprot; PIR; MIPS; TIGR; Hovergen; TAIR; PlasmoDB; ECDC; Searching for sequence database like FASTA and BLAST algorithm.

Unit III (9h)

Cluster analysis; Phylogenetic clustering by simple matching coefficients; Sequence Comparison; Sequence pattern; Regular expression-based pattern; Theory of profiles and their use in sequence analysis; Markov models; Concept of HMMS; Baum-Welch algorithm; Use of profile HMM for protein family classification; Pattern recognition methods

Unit IV (9h)

PDB (Protein Data Bank) and NDB (Nucleic Acid Data Bank); File formats for storage and dissemination of molecular structure. Methods for modelling; Homology modelling; Threading and protein structure prediction; Structure-structure comparison of macromolecules with reference to proteins; Force fields; Molecular energy minimization; Monte Carlo and molecular dynamics simulation **G**raphical tools in EXCEL for presentation of data. Introduction to SYSTAT package. Searching PubMed, Introduction to NCBI, NCBI data bases, BLAST BLASTn, BLASTp, PSI-BLAST, Sequence manipulation Suite, Multiple sequence alignment, Primer designing, Phylogenetic Analysis. Protein Modelling, Protein structure Analysis, Docking, Ligplot interactions.

Suggested Books:

1. Bioinformatics: Sequence and Genome Analysis by David W. Mount, 2004
2. Introduction to Bioinformatics by Arthur M.Lesk, 2002
3. Biostatistics: A Foundation for Analysis in the Health Sciences by Wayne W. Daniel, 2004

4. Computational Biology by David Fenyo, 2010
5. Statistical Methods by Statistical Methods by William G. Cochran, George W. Snedecor 1972.
6. Let us C – Kanetkar.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

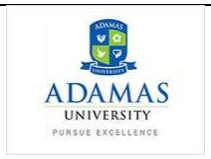
Components	Class Assessment	End Term
Weightage (%)	50	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	3	2	3	3	-	-	3	-	-	1	3
CO2	3	3	2	3	3	-	-	3	-	-	1	3
CO3	3	3	2	3	3	-	-	3	-	-	1	3
CO4	3	3	2	3	3	-	-	3	-	-	1	3
CO5	3	3	2	3	3	-	-	3	-	-	1	3
Avg	3	3	2	3	3	-	-	3	-	-	1	3

1=weakly mapped, 2= moderately mapped, 3=strongly mapped

Model Question Paper

Name: **Enrolment No:**	

Course:MIB21515 - BIOINFORMATICS & COMPUTATIONAL BIOLOGY(THEORY)
Program: M.Sc. Microbiology Time: 03 Hrs.
Semester: Even 2022-23 Max. Marks: 50

Instructions:
Attempt any **four** questions from **Section A** (each carrying 5 marks); any **three** questions from **Section B** (each carrying 10marks)**.**

SECTION A (Attempt any Four questions)

1.	What is Great mean? **Explain** Scatter plot. (An)	**2+3**	**CO1**
2.	**Demonstrate** the role of Database development in Bioinformatics (R)	**5**	**CO2**
3.	**Explain** the process of X-ray crystallography for 3D structure determination of protein (Ap)	**2+3**	**CO4**
4.	**Describe** 3 features of PDB and 2 features of NDB. (U)	**5**	**CO4** **CO5**
5	**Demonstrate** the Box Plot and Histogram with diagram. (C)	**2+3**	**CO5**
6.	**Outline** the scoring for MSA. Why gap opening penalty is greater than extension penalty?	**5**	**CO3**
	SECTION B (Attempt any **Three questions)**		
7.	**What** is Phylogenetic Tree? Draw a label diagram of a phylogenetic tree? **Explain** different types of the Phylogenetic Tree. (U)	**2+3+5**	**CO3**
8.	**What** is microarray? **Illustrate** the microarray using flowchart and normalization of microarray data (Ap)	**2+5+3**	**CO4**
9.	Some trees are having the following heights: 150 cm, 200 cm, 250 cm, 300 cm, 350 cm, 400 cm, 450 cm, 500 cm. **Calculate** the mean, variance and standard deviation (An)	**2+3+5**	**CO1** **CO5**
10.	"Hidden Markov Model (HMM) is used in modelling of eukaryotic gene, two sequences **analysis** and multiple sequences **analysis**. **Explain** this statement (An, Ap)	**5+5**	**CO3** **CO5**

MIB22547	Molecular Biology and Recombinant DNA technology Lab	L	T	P	C
Version 1.0	**Contact Hours - 60**	0	0	4	2
Pre-requisites/Exposure	UG LEVEL BIOLOGY				
Co-requisites	--				

Course Objectives

1. Developing knowledge of preparing reagents for molecular biology
3. To train DNA amplification and cloning
4. To demonstrate DNA and protein preparation and separation technology

Course Outcomes

On completion of this course, the students will be able to

1. Students will be able to **identify** and describe different types of DNA and RNA structures, as well as models of replication, using micrographs and model/schematic representations.

2. Students will be able to **demonstrate** the isolation of plasmid DNA and genomic DNA from E. coli, applying laboratory techniques and protocols.

3. Students will be able to **quantify** DNA and RNA using colorimetric methods or a UV spectrophotometer, applying appropriate analytical techniques.

4. Students will be able to **demonstrate** and analyze the resolution and visualization of DNA through Agarose Gel Electrophoresis, interpreting the results and identifying DNA fragments.

5. Students will be able to demonstrate and **analyze** the resolution and visualization of proteins using SDS-PAGE, **interprete** the results to assess protein size and purity.

Catalogue Description

The core-course of '**Molecular Biology and Recombinant DNA technology Lab**' will help to understand the basic concept and application of molecular techniques. Furthermore, the application of molecular separation technology (parts) will also be elaborated. All the lab sessions will be both demonstrative and performing. The classes will aim maximal individual skill enhancement.

Course Content

1. a. Evaluation of transformants and preparation of glycerol stock (4h ×3)
b. Demonstration of electroporation
c. Plasmid miniprep
3. Isolation and characterization of genomic DNA for *E. coli* (12 h)
4. Demonstration of PCR (6h×3)
   a. Setting up PCR reaction
   b. Analysis of amplified product

5. Demonstration of restriction digestion and gel electrophpresis (6h)
6. Performing gene cloning in bacteria.
7. Performing bacterial conjugation
8. Prophage induction assay

Text Books:

1. Biotechnology: A laboratory course by by Becker Jeffrey M Zachgo Eve Ann Caldwell Guy a, 2014

Reference books:

2. Molecular Cloning: A laboratory manual by Sambrook, J, 2000
3. Cell and Molecular Biology: A Lab Manual by K. V. Chaitanya, 2013

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

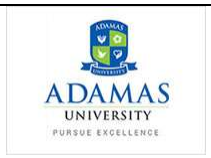
Components	Class Assessment	End Term
Weightage (%)	50	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	3	2	3	3	3	3	3	1	3	3	3
CO2	3	3	2	3	3	3	3	3	1	3	3	3
CO3	3	3	2	3	3	3	3	3	1	3	3	3
CO4	3	3	2	3	3	3	3	3	1	3	3	3
CO5	3	3	2	3	3	3	3	3	1	3	3	3
Avg	3	3	2	3	3	3	3	3	1	3	3	3

1=weakly mapped, 2= moderately mapped, 3=strongly mapped

Model Question Paper

Name: **Enrolment No:**	

Course: MIB22547- MOLECULAR BIOLOGY AND RECOMBINANT DNA TECHNOLOGY LAB
Program: M.Sc. Microbiology **Time: 03 Hrs.**
Semester: Even 2022-23 **Max. Marks: 50**
Instructions:
Attempt **all** questions from **Section A** (each carrying 15 marks) and from **Section B** (each carrying 10 marks)**.**

SECTION A (Attempt all questions)			
1.	**Perform** polymerase chain reaction (Ap)	**15**	**CO1**
2.	Visualize and **analyse** identification of amplicon through gel electrophoresis (Ap, An)	**15**	**CO2**
SECTION B (Attempt all questions)			
3.	Lab note book. (R, U, An, Ap, C)	**10**	**CO1, CO2, CO3, CO4, CO5**
4.	Viva-voce. (R, U, An, Ap, C) .	**10**	**CO1, CO2, CO3, CO4, CO5**

MIB22514	Environmental Microbiology Lab (Practical)	L	T	P	C
Version 1.0	**Contact Hours - 60**	0	0	4	2
Pre-requisites/Exposure	Concept of Environmental science and basic microbiology				
Co-requisites	--				

Course Objectives

1. Students will learn to assess physical parameters that characterize the natural resources wherefrom microorganisms may be obtained.
2. Students will be able to identify, and estimate the microbial populations in different natural resources
3. Students will be able to illustrate the different microbial interactions with other microbes and plants and requirement of oxygen by the microbes.
4. Students will be able to assess the potability of water samples.
5. Students will be able to comprehend microbial bioremediation.

Course Outcomes

On completion of this course,

CO1. Students will be able to **identify** various soil microbes and their roles in soil health.
CO2. Students will be able to **understand** the role of Rhizobium in nitrogen fixation and its importance in agriculture.
CO3. Students will be able to **interpret** BOD values to assess water quality.
CO4. Students will be able to **evaluate** the effectiveness of Rhizobium isolates in nitrogen fixation.
CO5. Students will be able to **develop** protocols for monitoring and **improve** the microbiological quality of water sources.

Catalogue Description

The student will be able to characterize the physical parameters defining the natural resources inhabited by microorganisms followed by estimation of type and quantity of microorganisms present there. Students will be able to appraise the nutritional requirement of different microorganisms. Microbial interactions will also be clarified. The knowledge acquired will also help to assess potability of water samples. All the experiments will be based on hands-on training in laboratory setup along with discussions of basic theories and advanced topics for practical implementation of knowledge. Classes will be conducted by hands-on lab training and/or audio visual virtual lab session as per requirement. Students will perceive the basic concepts of the subject via exercise and discussions with the coordinator.

Course Content

Environmental Microbiology Lab (MIB22514)

1**. Analysis of soil –**

pH, moisture content, water holding capacity, percolation, capillary action. (7 h)

2. **Enumeration of microbes –**
Isolation of microbes (bacteria & fungi) from soil (28ºC & 45ºC) -by serial dilution and pour-plate/spread plate method. (8 h)
3. Isolation of microbes (bacteria & fungi) from rhizosphere and rhizoplane. (8 h)
4. Assessment of microbiological quality of water (a) Presumptive test b) Confirmatory test c) Completed test for coliform d) IMViC reactions. (12 h)
5. Determination of BOD of waste water sample. (8 h)
6. Study the presence of microbial activity by detecting (qualitatively) enzymes dehydrogenase, amylase, urease) in soil. (8 h)
7. Isolation of Rhizobium from root nodules. (9 h)

Text Book(s)
T1. Pepper IL, Gerba CP, Gentry TJ (2014). Environmental Microbiology, 3rdedition, Academic Press

Reference books
R1. Atlas RM and Bartha R (2000). Microbial Ecology: Fundamentals & Applications. 4th edition, Benjamin Cummings
R2. Madigan MT, Martinko JM and Parker J. (2014). Brock Biology of Microorganisms, 14th edition, Pearson

Modes of Examination: Assignment/Quiz/Project/Presentation/Written Exam

Examination Scheme:

Components	Class Assessment	End Term
Weightage (%)	50	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	3	2	3	3	3	3	3	1	3	3	3
CO2	3	3	2	3	3	3	3	3	1	3	3	3
CO3	3	3	2	3	3	3	3	3	1	3	3	3
CO4	3	3	2	3	3	3	3	3	1	3	3	3
CO5	3	3	2	3	3	3	3	3	1	3	3	3
Avg	3	3	2	3	3	3	3	3	1	3	3	3

1=weakly mapped
2= moderately mapped
3=strongly mapped

Model Question Paper

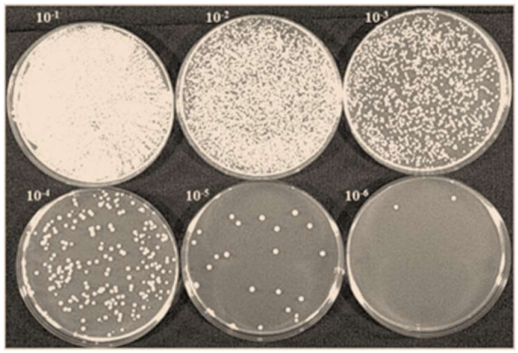
Name: **Enrolment No:**	

Course: MIB22514 – ENVIRONMENTAL MICROBIOLOGY LAB (PRACTICAL)
Program: M.Sc. Microbiology **Time: 03 Hrs.**
Semester: Even 2022-22 **Max. Marks: 50**

Instructions:
Answer the following questions"

SECTION A

1.	Elaborate your observations obtained from sample A with emphasis on following points: a) Description of microbial growth, type of media (R, An) b) Probable conclusion from the observation. (An)	**7.5+7.5**	**CO1**
2.	You have been provided with mother stock of a soil sample (1gm soil dissolved in 10ml sterile 0.9(N) NaCl solution). a) How will you prepare serial dilutions 10-1 to 10-6? (U) b) Which dilution is best for determining the microbial load? Justify with reference to the picture provided. (An) c) 200ul of each dilution was used for plating by spread plate method. Determine the microbial load in 20gm of this soil sample. (U)	**4+4+7**	**CO1, CO2**



	SECTION B		
6.	Lab note book (U, An)	**10**	**CO1, CO2, CO3, CO4. CO5**
7.	Viva (R, An)	**10**	**CO1, CO2, CO3, CO4. CO5**

MIB22516	Bioinformatics and Computational Biology Lab (PRACTICAL)	L	T	P	C
Version 1.0	**Contact Hours - 60**	0	0	4	2
Pre-requisites/Exposure	UG LEVEL BIOLOGY and Concepts of Computer application				
Co-requisites	--				

Course Objectives

1. To provide students with hands-on activities designed to encourage interest in the field of Bioinformatics, as well as promote greater understanding of the concepts presented in lecture.
2. Students will need to become proficient with terms, techniques, and applications.

Course Outcomes

On completion of this course, the students will be able to

1. **Identify** different databases used in bioinformatics and computational biology for storing biological information.
2. **Compare** and contrast different genome annotation tools and their capabilities.
3. **Construct** phylogenetic trees based on molecular data to infer evolutionary relationships.
4. **Analyze** RNA and protein structure prediction results to understand molecular structure-function relationships.
5. **Design** and **implement** a bioinformatics and computational biology project using appropriate tools and methods.

Catalogue Description

Bioinformatics Lab is the overall Learn and apply the knowledge of using different modern tools and techniques in the field of Bioinformatics. This course covers laboratory techniques describes different modern practical methods related to Bioinformatics such as genes and genomes, sequence alignment of DNA and proteins, basic programming using python, predict protein structure-function and phylogenetic tree. All the lectures will be devoted on discussions of basic theories and advanced topics, focusing on practical implementation of knowledge. Classes will be conducted by lecture as well as power point presentation, audio visual virtual lab session as per requirement. The tutorials will familiarize the students with practical problem-solving techniques led by the course coordinator. Students will strongly grab the basic concepts of the subject via exercise and discussions with the coordinator.

Course Content

1. Retrieving genomes, identifying of and annotating genes (10h)
2. Sequence Alignment of DNA and Proteins. (8 h)
2. Applying UNIX, basic programming using python: (12 h)
3. Predicting protein structure-function (10h)
4. Building phylogenetic tree (10h)
5. Protein structure- homology modelling and docking (10h)

Suggested reading:

1. Essentials of Bioinformatics, Xin Xiong, Cambridge
2. Bioinformatics: Sequence and Genome Analysis by David W. Mount, 2004.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

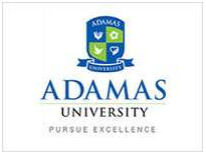
Components	Class Assessment	End Term
Weightage (%)	50	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	3	2	3	3	3	3	3	1	3	3	3
CO2	3	3	2	3	3	3	3	3	1	3	3	3
CO3	3	3	2	3	3	3	3	3	1	3	3	3
CO4	3	3	2	3	3	3	3	3	1	3	3	3
CO5	3	3	2	3	3	3	3	3	1	3	3	3
Avg	3	3	2	3	3	3	3	3	1	3	3	3

1=weakly mapped
2= moderately mapped
3=strongly mapped

Model Question Paper

Name: **Enrolment No:**	

Course: MIB22516– BIOINFORMATICS AND COMPUTATIONAL BIOLOGYLAB
Program: M.Sc. Microbiology **Time: 03 Hrs.**
Semester: Even 2022-23 **Max. Marks: 50**
Instructions:
Attempt any **three** questions from **Section A** (each carrying 10 marks); **Section B** is Compulsory (each carrying 10 marks)**.**

	Section A (Attempt any Three)		
1.	a) Retrieving one gene from different five species. **Write** about the method (U) b) Design a table using species name, gene accession no and gene length.(Ap)	**5** **5**	**CO1, CO5**
2.	a) Retrieving Five Proteins structure of SARS-CoV-2 from PDB with PDB ID as a basic step for homology modeling. **Write** about the method b) Design a table using Protein name, PDB ID and description structure (Ap, An)	**6** **4**	**CO4, CO5**
3.	a)Perform Sequence Alignment of one Proteins from different five species.b) **Write** about the method and its importance. (An)	**6** **4**	**CO2**
4.	a) **Draw** a phylogenetic tree of CRP protein from different six species. b) Explain its methodology and result. (U, Ap)	**4** **3** **3**	**CO4, CO5**
	SECTION B is compulsory		
5.	**Viva-voce** (R, U, Ap, An)	**10**	**CO1, CO2, CO3,CO4 CO5**
6.	**Practical copy (R, U, Ap, An, C)**	**10**	**CO1, CO2, CO3, CO4**

MIB21517	Enzyme and Enzyme Technology	L	T	P	C
Version 1.0	Contact Hours - 45	3	0	0	3
Pre-requisites/Exposure	UG LEVEL BIOLOGY				
Co-requisites	--				

Course Objectives

1. To provide basic concepts of Enzymology.
2. To provide basic understanding on enzyme immobilization for various applications.
3. Elaborating the cutting-edge uses of modern biosensors.

Course Outcomes

On completion of this course, the students will be able to

CO1 Students will be able to **describe** the basic principles of enzyme structure, activation energy, and transition states in enzyme catalysis.
CO2 Students will **interpret** and calculate key parameters of single substrate enzyme kinetics, such as Michaelis-Menten constant, using kinetic models to explain how enzymes lower activation energy.
CO3 Students will **differentiate** between free and immobilized enzyme techniques and evaluate their effectiveness in various industrial applications.
CO4 Students will **assess** different enzyme reactors (batch, continuous, etc.) based on reaction kinetics and propose solutions for maximizing reaction efficiency.
CO5 Students will **design** enzyme-based processes using both free and immobilized enzymes for **inventing** novel applications in biocatalysis, drug production, and waste management.

Catalogue Description:
Upon completion of this module, the students are able to design strategies to purify enzymes. Further, the students can evaluate the purification based on yield, purification factor and electrophoretic methods. After this module the students can determine the enzyme activity of different enzymes using different methods (e.g. spectrometric, HPLC). Students have knowledge about different immobilization methods of enzymes after this module and can perform and evaluate covalent immobilization methods. Upon this module, the students can perform and evaluate biotransformation processes. Classroom activities will be designed to encourage students to play an active role in the construction of their own knowledge and in the design of their own learning strategies. We will combine traditional lectures with other active teaching methodologies, Class participation is a fundamental aspect of this course. Students will be encouraged to actively take part in all group activities and to give an oral group presentation on various topics of this course. Students will be expected to interact with media resources, such as, web sites, videos, research papers etc.

Course Content

Unit 1: Introduction: (9 h)

Classification, mechanism of enzyme action, active site determination,

identification of binding and catalytic sites, specificity of enzyme action, activation energy and transition state theory, role of entropy in catalysis. Applications of enzymes.

Unit 2 Kinetics: (12 h)

Kinetics of single substrate enzyme catalyzed reactions, Michaelis-Menten equation, turnover number, enzyme inhibition- competitive, non-competitive, and uncompetitive, allosteric enzymes and metabolic regulation.

Unit 3 The technology of enzyme production: (10 h)

Types of reactors used for enzyme catalysis for free and immobilized enzymes, immobilized enzymes, preparation and properties.

Unit 4 Immobilized enzyme catalysis: (15 h)

Effects of external mass transfer resistance, analysis of Intra-particle diffusion and reaction. Simultaneous film and intra-particle mass transfer resistances, effects of inhibitors, temperature and pH on immobilized enzyme catalysis and deactivation.Design of enzyme electrodes & their applications as biosensors; health care & environment; Design of Immobilized Enzyme Reactors; Packed-bed, Fluidized-bed Membrane reactors; Bioconversion calculations in free- enzyme CSTRs & immobilized enzyme reactors.

Suggested Reading:

1. T. Palmer, Wnzymes: Biochemistry, Biotechnology, Clinical Chemistry (2008)

2. Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2ndedition. Panima Publishing Co. New Delhi.

3. Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. Elsevier Science: 2013.

4. Enzymes: Biochemistry, Biotechnology, Clinical Chemistry (2 nd Edition), by T Palmer, P L Bonner. Publisher: Woodhead Publishing; 2007.

5. Biochemistry by Jeremy M. Berg, John L. Tymozko, Lubert Stryer, Fifth edition, W. H. Freemanand Company.

6. Enzymes And Enzyme Technology 1 st Edition by Anil Kumar, Sarika Garg. ISBN-13: 978-1905740871.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination Examination Scheme:

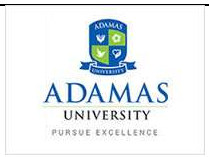
Components	Class Assessment	End Term
Weightage (%)	50	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	3	2	3	3	-	-	3	-	-	1	3
CO2	3	3	2	3	3	-	-	3	-	-	1	3
CO3	3	3	2	3	3	-	-	3	-	-	1	3
CO4	3	3	2	3	3	-	-	3	-	-	1	3
CO5	3	3	2	3	3	-	-	3	-	-	1	3
Avg	3	3	2	3	3	-	-	3	-	-	1	3

1=weakly mapped
2= moderately mapped
3=strongly mapped

Model Question Paper

Name: **Enrolment No:**	

Course: MIB21517 - ENZYME AND ENZYME TECHNOLOGY (THEORY)
Program: M.Sc Microbiology **Time: 03 Hrs.**
Semester: Even 2022-23 **Max. Marks: 50**

Instructions:
Attempt any **four** questions from **Section A** (each carrying 5 marks); any **three** questions from **Section B** (each carrying 10marks)**.**

SECTION A (Attempt **four questions)**

1.	**Define** constitutive and inducible enzymes and **explain** their role. (R, U)	**5**	**CO1**
2.	**Compare** and contrast endothermic and exothermic reactions. (U)	**5**	**CO2**
3.	**Classify** enzymes according to the enzyme commission (EC) numbers. Give one example of oxidoreductase class of enzyme with mechanism. Name one enzyme that hydrolyzes the bacterial cell wall. (M)	**3+1+1**	**CO2**
4.	**Define** K_m. Fetal hemoglobin has a higher binding affinity for oxygen than does adult hemoglobin. Which hemoglobin shows higher K_m value for Oxygen? **Comment** on it. (C)	**2+3**	**CO2**
5	**Catalogue** major strategies of enzyme immobilization processes. Why proteases are used as de-hairing agent in leather industries? **Explain** briefly. (U)	**3+2**	**CO3, CO4**
6.	**What** are the methods for preserving recombinant strain producing a thermostable enzyme? Explain	**5**	**CO5**
	SECTION B (Attempt any **Three questions)**		
7.	In a particular enzyme-catalyzed reaction, Vmax = 0.2 mol/sec and Km = 5 mM. Assume the enzyme shows standard Michaelis-Menten kinetics. What will be the rate of the reaction when [S] = 0.01 M? **Describe** the effect of pH and temperature on enzyme velocity. (U)	**6+2+2**	**CO1, CO2**
8.	**Distinguish** between "ping-pong" and "sequential random" modes of bisubstrate enzyme-catalyzed reactions with schematic representation. **Compare and contrast** between molarity, normality and molality.(U)	**5+5**	**CO1, CO2**
9.	Write short note on ATCase. Name the enzyme that does not obey typical Michaelis-Menten kinetics. In case, you need to plot [S] vs. V, then what type of curve you will get for this type of enzyme? **Explain. (An)**	**5+5**	**CO1, CO2**

10	Using the Lineweaver-Burk plot, describe the changes of K_m and V_{max} values in competitive, un-competitive and non-competitive inhibitions. Describe the operating principle of blood glucose monitoring biosensor. (An)	**5+5**	**CO2, CO5**

MIB21518	Food and Dairy: Safety and Quality Control	L	T	P	C
Version 1.0	**Contact Hours - 45**	3	0	0	3
Pre-requisites/Exposure	UG LEVEL BIOLOGY				
Co-requisites	--				

Course Objectives

1. To provide basic concepts of Food and Dairy Microbiology.
2. To provide basic understanding on Quality test and control.
3. Elaborating the food safety norms and their basis.

Course Outcomes

On completion of this course, the students will be able to

CO1 **Recall** the methods such as Most Probable Number (MPN) and Enrichment Culture Techniques used in microbial testing.
CO2 **Explain** the role of Good Laboratory Practices in ensuring the accuracy and reliability of safety and quality control tests.
CO3 **Implement** Good Laboratory Practices and biosafety protocols (BSL-1, BSL-2, BSL-3) during routine microbial testing of food and dairy products.
CO4 **Analyze** microbial test results obtained from MPN and Enrichment Culture techniques for compliance with HACCP and BIS standards in the food and dairy industry.
CO5 **Evaluate** and **improve** various quality control parameters.

Catalogue Description:
Upon completion of this module, the students are able to design strategies to analyse microbial quality in food and evaluate hazards associated with food. Alongside food processing, supplementation and basis of food spoilage will be discussed. Details of existing rules and regulations regarding food safety would also be elaborated.

Course Content

Unit 1 Microbiological Laboratory and Safe Practices (12 h)

Good laboratory practices - Good microbiological practices; Biosafety cabinets - Working of biosafety cabinets, use of protective clothing, specification for BSL-1, BSL-2, BSL-3. Discarding biohazardous waste - Methodology of Disinfection, Autoclaving &Incineration

Unit 2 Determining Microbes in Food and Pharmaceutical Samples (12 h)

Culture and microscopic methods - Standard plate count, Most probable numbers, Direct microscopic counts, Biochemical and immunological methods: Limulus lysate test for

endotoxin, gel diffusion, sterility testing for pharmaceutical products; Molecular methods - Nucleic acid probes, PCR based detection, biosensors.

Unit 3 Pathogenic Microorganisms of Importance in Food & Water (11 h)

Enrichment culture technique, Detection of specific microorganisms - on XLD agar, Salmonella-Shigella Agar, Mannitol salt agar, EMB agar, MacConkey Agar, Saboraud Agar; Ascertaining microbial quality of milk by MBRT, Rapid detection methods of microbiological quality of milk at milk collection centers (COB, 10 min Resazurin assay)

Unit 4 HACCP for Food Safety and Microbial Standards (10 h)

Hazard analysis of critical control point (HACCP) - Principles, flow diagrams, limitations; Microbial Standards for Different Foods and Water – BIS standards for common foods and drinking water

Suggested Reading:

1. Doyle MP, Buchanan RL (2012). Food Microbiology: Fundamentals and Frontiers, 4th edition, ASM

2. Jay JM, Loessner MJ, Golden DA (2005).Modern Food Microbiology, 7th edition, Springer

3. Baird RM, Hodges NA and Denyer SP (2005). Handbook of Microbiological Quality control in Pharmaceutical and Medical Devices, Taylor and Francis

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

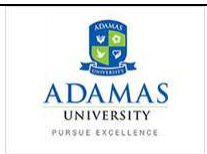
Components	Class Assessment	End Term
Weightage (%)	50	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	3	2	1	3	-	-	3	-	-	-	3
CO2	3	3	2	1	3	-	-	3	-	-	-	3
CO3	3	3	2	1	3	-	-	3	-	-	-	3
CO4	3	3	2	1	3	-	-	3	-	-	-	3
CO5	3	3	2	1	3	-	-	3	-	-	-	3
Avg	3	3	2	1	3	-	-	3	-	-	-	3

1=weakly mapped
2= moderately mapped
3=strongly mapped

Model Question Paper

Name: **Enrolment No:**	

Course: MIB21518 - FOOD AND DAIRY: SAFETY AND QUALITY CONTROL(THEORY)
Program: M.Sc Microbiology **Time: 03 Hrs.**
Semester: Even 2022-23 **Max. Marks: 50**

Instructions:
Attempt any **four** questions from **Section A** (each carrying 5 marks); all questions from **Section B** (each carrying 10marks)**.**

SECTION A (Attempt **any four questions)**

1.	**Define** food spoilage and impact of physical condition on it. (R, U)	**5**	**CO1**
2.	**Compare** andcontrastexotoxins and endotoxins from food pathogens citing mechanism. (U)	**5**	**CO2**
3.	**Elaborate** basis of probiotics and synbiotics. (M)	**3+1+1**	**CO2**
4.	**Design** strategy to identify a newly identified food pathogenic bacteria by differential media (C)	**2+3**	**CO2**
5	**Catalogue** major strategies of HACCP (U)	**3+2**	**CO3, CO4**
6.	**How** efficacy of a probiotic strain can be experimentally determined?	**5**	**CO2**
	SECTION B (Attempt all **questions)**		
7.	You have identified prompt putrification of a meat product that can be significantly controlled by canning. **Elaborate** the enzymatic action responsible of such observation. Predict the effect of pH and temperature on leavening backers yeast. (U)	**6+4**	**CO1, CO2**
8.	**Distinguish** between the action of botulinum toxin and tetanus toxin. **Compare** and contrast between BSL2 and BSL3 facility for QC.(U)	**5+5**	**CO1, CO4**
9.	Write short note on: MPN analysis; Biosensors for dairy industry. Regular consumption of fast foods often leads to dysbiosis-**Explain. (An)**	**3+4+3**	**CO1, CO2**

MIB21519	Drug Design and Development (THEORY)	L	T	P	C
Version 1.0	Contact Hours - 45	3	0	0	3
Pre-requisites/Exposure	UG LEVEL MICROBIOLOGY				
Co-requisites	--				

Course Objectives

1. Develop concepts of protein folding and modelling
2. Mechanistic perception of drug-receptor interaction
3. To develop concept of drug development from laboratory to application

.

Course Outcomes

On completion of this course, the students will be able to

CO1. **Identify** different stages of drug development process.
CO2. **Explain** the principles and techniques of drug design and development.
CO3. **Utilize** computational tools and software for drug design.
CO4. **Evaluate** the efficacy and safety of potential drug candidates.
CO5. **Assess** strategies for optimizing drug design process and **design** a comprehensive drug development plan for a specific target.

Catalog Description

The course of '**Drug Design and Development'** would primarily aim identifying drug targets and candidate molecules. Also the course would deal with details of gene expression regulation. Classes will be conducted by lecture as well as power point presentation, audio visual virtual lab session as per requirement. The tutorials will enable the students with problem-solving ability led by the course coordinator. Students will perceive the basic concepts of the subject via exercise and discussions with the coordinator.

Course Content

Unit 1 Protein folding (9h): Weak interactions, Basic concept of protein structural elements, Concept of force field and energy minimization, Chaperon action, Post translational modifications.
Unit 2 Determining protein structure (9h): X-ray crystallography, Cryo EM, NMR in structural determination. Various formats of structure depiction: SDF, PDB and mmCIF etc. Structure visualization.
Unit 3 Homology modelling (9h): Concept and approaches. Model building using HM softwares. Model refinement, model validation
Unit 4 Molecular docking (9h): Ligands and its preparation. Molcular docking softwares, Visualizing interactions, validating docking. Concept of molecular dynamic simulation.
Unit 5 CADD (9h): computer aided drug designing –basic concepts. QSAR, 3D QSAR ADMET profiling, Analysing clinical data on drug trial. Building STROBE Checklist.

Text Book:

1. Textbook of Drug Design and Discovery, by Kristian Stromgaard (Editor), Povl Krogsgaard-Larsen (Editor), Ulf Madsen (Editor) CBC press

Reference Book:

2. Introduction to Protein Structure 2nd Edition by Carl Branden (Author), John Tooze (Author)

3. Biomolecular Crystallography: Principles, Practice, and Application to Structural Biology 1st Edition by Bernhard Rupp

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

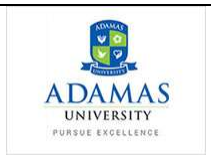
Components	Class Assessment	End Term
Weightage (%)	50	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	3	2	3	3	-	-	3	-	-	1	3
CO2	3	3	2	3	3	-	-	3	-	-	1	3
CO3	3	3	2	3	3	-	-	3	-	-	1	3
CO4	3	3	2	3	3	-	-	3	-	-	1	3
CO5	3	3	2	3	3	-	-	3	-	-	1	3
Avg	3	3	2	3	3	-	-	3	-	-	1	3

1=weakly mapped; 2= moderately mapped; 3=strongly mapped

Model Question Paper

Name: **Enrolment No:**	

Course: MIB21519- DRUG DESIGN AND DEVELOPMENT (THEORY)
Program: M.Sc. Microbiology **Time: 03 Hrs.**
Semester: ODD 2022-23 **Max. Marks: 50**

Instructions:
Attempt any **four** questions from **Section A** (each carrying 5 marks); any **three** questions from **Section B** (each carrying 10 marks)**.**

SECTION A (Attempt any Four questions)			
1.	**What** is a lead in drug discovery? **How** a good lead can be screened out from scratch? (Ap)	**2+3**	**CO1**
2.	**What** are the coordinates in PDB file? How energy minimization is performed for homology modeling? (U, Ap)	**2+3**	**CO2**
3.	**What** are forward and reverse chemical genetics? What is target deconvolution? (U)	**5**	**CO3**
4.	**Name** major chaperons in eukaryotic cells. Can posttranslational modification affect drug targeting? (R, U)	**2+3**	**CO4**
5.	**How** whole genome sequencing can accentuate drug target discovery? (Ap)	**5**	**CO5**
6.	**Mention** the significance of ADME profiling	**5**	**CO5**
	SECTION B (Attempt any **Three questions)**		
7.	**What** are Isosters? **Explain** the concept of Bio-isoterism with suitable examples. (R, U)	**3+7**	**CO3**
8.	**Explain** various scoring techniques in Molecular docking. How virtual library can be screened against a receptor? (Ap)	**5+5**	**CO1** **CO2**
9.	**How** Topliss decision tree can help in rational drug designing? **Outline** the principle of 3D QSAR. (U, Ap)	**5+5**	**CO1** **CO2**
10.	**What** is the significance of ADMET profiling? **Mention** the necessity of various phases of drug trial. (M, U)	**5+5**	**CO5**

MIB21520	Host-pathogen interaction (THEORY)	L	T	P	C
Version 1.0	Contact Hours - 45	3	0	0	3
Pre-requisites/Exposure	UG LEVEL MICROBIOLOGY				
Co-requisites	--				

Course Objectives

1. To provide the students with apt understanding of disease causing ability of pathogenic microorganisms.
2. It will also provide in depth knowledge of effect of pathogens on host defense mechanism and normal cellular machineries.
3. Elaborating role of infection cycle of pathogens in interference with the host signaling events.
4. Outlining the evolution of pathogen along with its susceptible host.

Course Outcomes

On completion of this course, the students will be able to

1. **Recall** the fundamental concepts of virulence in various pathogenic organisms and their impact on host health.
2. **Describe** how pathogen interference with host immune signaling disrupts normal cellular processes.
3. **Apply** knowledge of molecular mimicry to analyze how pathogens evade immune detection by resembling host molecules.
4. **Analyze** the signal transduction pathways hijacked by pathogens to interfere with host immunity, focusing on specific molecular interactions.
5. **Evaluate** and **elaborate** immunological aspects of host pathogen interaction.

Catalogue Description

The core-course of 'host-pathogen interaction' will help to understand the difference between normal microflora of human body and pathogenic microorganisms. This course will enable the students to elaborate the mechanism of interaction of host with pathogens. This course includes comprehensive approach through studying effects of virulence factors on various components of immune system and host cell cycle machinery. Furthermore, the evolution of disease causing ability in various types of microbes and co-evolution of respective hosts would also be illuminated. All the lectures will be devoted on discussions of basic theories and advanced topics, focusing on practical implementation of knowledge. Classes will be conducted by lecture as well as power point presentation, audio visual virtual lab session as per requirement. The tutorials will enable the students with problem-solving ability led by the course coordinator. Students will perceive the basic concepts of the subject via exercise and discussions with the coordinator.

Course Content

Unit 1 **(15 hours)**

Concepts of Virulence: microbial pathogenesis as the outcome of an interaction between a host and a microorganism, the damage-response framework, classes of pathogenic microorganisms according to the damage-response framework.Evolutionary analysis of pathogenicity. Host as pathogen co-evolution. Evolution of parasitism: theories and experiments.

Unit 2 **(10 hours)**

Interference of pathogens with cytokine/chemokine networks, interference with apoptosis, cytoskeletal remodeling.

Unit 3 **(9 hours)**

Molecular mimicry/Antigenic variation, interference with humoral immunity, Interference with cell-mediated immunity, protective vs. non-protective immunity

Unit 4 **(12 hours)**

Signal transduction pathways for pathogen sensing and pathogen triggered subversion/Interference with host cell signaling events. TLR signalling, Ca2+, PI, cNMP and c-di-NMP medisted signaling, RIG1-MAVS pathway. Inflammosome, Autophagy: Possible association with bacterial pathogenesis, strategies for intracellular survival of bacteria and parasites.

Text book:

T1. Kuby Immunology by Judy Owen, Jenni Punt, Sharon Stranford, 2013

T2. Review of Medical Microbiology & Immunology (Lange) by Warren Levinson, 2004

Reference Books:

R1. Mim's Medical Microbiology &Immunology by W.H. Smith, 6th Edition, Elsevier, 2018

R2. Brooks G.F., Carroll K.C., Butel J.S., Morse S.A. and Mietzner, T.A. (2013) Jawetz, Melnick and Adelberg's Medical Microbiology. 26th edition. McGraw Hill Publication.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Class Assessment	End Term
Weightage (%)	50	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	3	2	1	3	-	-	3	-	-	-	3
CO2	3	3	2	1	3	-	-	3	-	-	-	3
CO3	3	3	2	1	3	-	-	3	-	-	-	3
CO4	3	3	2	1	3	-	-	3	-	-	-	3
CO5	3	3	2	1	3	-	-	3	-	-	-	3
Avg	3	3	2	1	3	-	-	3	-	-	-	3

1=weakly mapped
2= moderately mapped
3=strongly mapped

Name: **Enrolment No:**	

Course: MIB21520– HOST PATHOGEN INTERACTION (THEORY)
Program: M.Sc. Microbiology **Time: 03 Hrs.**
Semester: Even 2022-23 **Max. Marks: 50**

Instructions:
Attempt any **four** questions from **Section A** (each carrying 5 marks); and **all questions** from **Section B** (each carrying 10 marks)**.**

SECTION A (Attempt any Four questions)

1.	**What** is virulence? (U) **Explain** how interaction of a microorganism with host contributes to pathogenesis. (U)	**1+4**	**CO1**
2.	**Classify** pathogenic microorganisms according to the damage-response framework®.	**5**	**CO2**
3.	**Differentiate** between protective and non-protective immunity. (U)	**5**	**CO3**
4.	**Mention** the role of molecular mimicry in virulence of a microbe. (U) Enlist the targets of TLR pathway that can be modulated by interaction with pathogens. ®	**3+2**	**CO4**
5	**What** is the association of autophagy with disease causing ability? (An)	**5**	**CO5**
6.	**What** is latency of a virus? Why protective immune response is not induced during latent period?	**5**	**CO3**
	SECTION B (Attempt all **questions)**		
7.	**Design** an experiment to demonstrate the evolution of parasitism. (An) Add a note on inflammosome.(U)	**6+4**	**CO3**
8.	**What** is the basis of cytoskeletal remodeling? (U) Illustrate how pathogens can interfere with cell-mediated immunity. (U)	**4+6**	**CO1** **CO2**
9.	**How** microorganisms can interfere with the cNMP and c-di-NMP mediated signaling? (U) What will be the outcome? (An) How can this effect be combated? (An)	**5+3+2**	**CO1** **CO2, CO4**

MIB21521	Recent Advances in Vaccine Technology	L	T	P	C
Version 1.0	Contact hour- 45	3	0	0	3
Pre-requisites/Exposure	**UG level knowledge in Microbiology or allied life sciences**				
Co-requisites					

Course Objectives

1. To provide the knowledge on conventional to recent technology of vaccine production.
2. Todiscusstheroleofvaccinesincontrollinginfectiousdiseaseswithexamples
3. Toprovidethe concept of variousstrategiesfor vaccinedevelopment.
4. Tooutlinechallengesof vaccinedevelopment
5. Toformulateavaccineagainstaparticularinfectiousdiseasebasedonbiology, epidemiology and immuneresponse.

Course Outcomes

On completion of this course, the students will be able to

CO1. **Differentiate** between the methods and applications of active and passive immunization in disease prevention.
CO2. **Assess** the importance of adjuvants in modern vaccines and their impact on immune responses.
CO3. **Evaluate** recent techniques in antibody engineering, including humanization and affinity maturation.
CO4. **Formulate** a strategy for designing a vaccine based on reverse vaccinology concepts for a specific pathogen.
CO5. **Explore** how AI is utilized for target identification, **prediction** of antigenic regions, and optimization in vaccine research.

Catalogue Description

This course introduces students to the field of vaccinology and aspects of the bioscience industry related to vaccine discovery, production, and testing. Students will learn about the history of vaccines, the production of vaccines in a regulated environment and the benefits and concerns with vaccine use.

Course Content (9 hurs/unit)

Unit 1: Active and passive immunization; Live, killed, attenuated, sub unit vaccines;

Unit 2: Role and properties of adjuvants, recombinant DNA and protein-based vaccines, plant-based vaccines, reverse vaccinology; Peptide vaccines, conjugate vaccines;

Unit 3: Antibody genes and antibody engineering- chimeric and hybrid monoclonal antibodies;

Unit 4: Monoclonal and Polyclonal antibodies, their applications; HAT selection; Catalytic antibodies and generation of immunoglobulin gene libraries. Abzymes.

Unit 5: Reverse vaccinology, algorithms for epitope prediction. MHC and antigenic peptide interaction and haplotype dependency, Allergenicity prediction, Application of AI in vaccine development.

Text books:

1. Janeway, C.A. *et al*., ": The Immune Systems in Health and Diseases", 6th Edition,GarlandScience, 2005.
2. Kuby, RA Goldsby, Thomas J. Kindt, Barbara, A. Osborne Immunology, 6th Edition, Freeman, 2002.
3. Brostoff J, Seaddin JK, Male D, Roitt IM., Clinical Immunology, 6th Edition, Gower Medical Publishing, 2002.
4. Janeway et al., Immunobiology, 4th Edition, Current Biology publications., 1999.

Reference books:

1. Stanley A. Plotkin & Walter Orenstein & Paul A. Offit, Vaccines, 6th Edition 2013 BMA Medical Book Awards Highly Commended in Public Health! Elsevier Publication.
2. Roitt's Essential Immunology. 11th ed. P. Delves, et al., ed., Blackwell Publishing, 2006.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Class Assessment	End Term
Weightage (%)	50	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	3	2	3	3	-	-	3	-	-	1	3
CO2	3	3	2	3	3	-	-	3	-	-	1	3
CO3	3	3	2	3	3	-	-	3	-	-	1	3
CO4	3	3	2	3	3	-	-	3	-	-	1	3
CO5	3	3	2	3	3	-	-	3	-	-	1	3
Avg	3	3	2	3	3	-	-	3	-	-	1	3

1=weakly mapped
2= moderately mapped
3=strongly mapped

Model Question Paper

Name: **Enrolment No:**	

Course: MIB21521 –RECENT ADVANCES IN VACCINE TECHNOLOGY (THEORY)

Program: M.Sc. Microbiology **Time: 03 Hrs.**
Semester: Even 2022-23 **Max. Marks: 50**

Instructions:
Attempt any **four questions** from **Section A** (each carrying 5 marks); and **any three** questions from **Section B** (each carrying 10 marks).

SECTION A (Attempt any Four questions)			
1.	**What** are the challenges for vaccine development against common bacterial diseases? Give examples (U).	**4+1**	**CO1 CO3**
2.	**What** is subunit vaccine? Write down the advantages and disadvantages of subunit vaccine.(U).	**1+4**	**CO4**
3.	**How** does DNA vaccine prevent future disease? What are the advantages of DNA vaccines?	**3+2**	**CO1 CO2 CO4**
4.	**Discuss** two techniques in proteomics that are routinely used in identification of potential vaccine candidates (Ap).	**5**	**CO2 C04**
5.	**How** do Peptide vaccines work?	**5**	
SECTION B (Attempt any three questions)			
6.	**What** are the considerations for developing an ideal dengue virus vaccine? Discuss the challenges in developing animal model for testing dengue vaccine (U).	**5+5**	**CO3 CO4**
7.	**Discuss** the advantages and limitations of live	**5+5**	**CO2**

	attenuated vaccines. Discuss strategies to develop live attenuated vaccines against dengue virus (M, C).		
8.	**What** is reverse vaccinology? Discuss the role of reverse vaccinology in developing vaccine candidates for *N. meningitidis* serogroup B (U, Ap).	**2+8**	**C01 CO2 CO5**
9.	Write down the mechanism of anti-idiotype vaccine. How do you make a hybridoma? Explain the steps	**5+5**	**CO5 CO6**

MIB22572	Professional Development Course-2 (Practical)	L	T	P	C
Version 1.0	Contact Hours - 30	0	0	1	1
Pre-requisites/Exposure	PLUS B.SC LEVEL SCIENCE				
Co-requisites	--				

Catalog Description: This professional development course aims to help you discover and achieve your goals by focusing on organization and action. You'll learn techniques to enhance goal-setting, communication, self-motivation, and a positive attitude, empowering you to maximize your performance both academically and professionally.

Course Syllabus:

The syllabus for Professional Development Course-I for senior students (1st Semester- 3rd Semester for P.G students)

1. Introduction to Pre-Placement Training.
2. Resume Building & Cover Letter Writing.
3. Interview Skills.
4. Aptitude and Technical Skills.
5. Group Discussion and Communication Skills.
6. Personal Branding and Online Presence.
7. Professional Skills.
8. Industry Insights and Company Presentations.
9. Career Guidance for competitive entrance exams and Job Search Strategies
10. Mock Tests and Assessments.

Course learning outcomes:

CO1: **Identify** the components of an effective resume and cover letter for job applications

CO2: **Explain** the importance of developing aptitude skills for placement tests..

CO3: **Interpret** the results of aptitude tests and identify areas for improvement.

CO4: **Participate** in mock interviews to improve interview skills and confidence.

CO5: **Critically** assess personal interview performance and identify areas for development.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	CA	End Term
Weightage (%)	50	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	-	3	3	1	3	3	3	3	-	3	2	2
CO2	-	3	3	1	3	3	3	3	-	3	2	2
CO3	-	3	3	1	3	3	3	3	-	3	2	2
CO4	-	3	3	1	3	3	3	3	-	3	2	2
CO5	-	3	3	1	3	3	3	3	-	3	2	2
Avg	-	3	3	1	3	3	3	3	-	3	2	2

MIB21549	IMMUNOLOGY and MEDICAL MICROBIOLOGY (THEORY)	L	T	P	C
Version 1.0	**Contact Hours - 45**	3	0	0	3
Pre-requisites/Exposure	Basic concept of Immunology from undergraduate level.				
Co-requisites	--				

Course Objectives

1. It will also provide in depth knowledge about antigen-antibody interaction and their effects.
2. Students will be able to elaborate organization and expression pattern of components of immune system and the medical conditions that may arise due to anomaly in expression of components of immune system.
3. Students will be proficient in application of various immunologic techniques in the field of research and medical science.

Course Outcomes

On completion of this course, the students will be able to

1. **Define** the basic principles of innate and adaptive immunity, including key components like antigens and antibodies.
2. **Summarize** the processes of immunoelectrophoresis and its applications in diagnosing immune-related conditions.
3. **Apply** knowledge of innate and adaptive immune responses to explain the body's defense mechanisms against infections.
4. **Distinguish** between the different immune cells (e.g., T cells, B cells, macrophages) and their roles in coordinating innate and adaptive immune responses.
5. **Assess** the effectiveness of vaccines based on the roles of adjuvants and **improve** immune responses.

Catalogue Description

The core-course of 'Immunology and Medical Microbiology' will help to understand the classification, components and organization of components of immune system. This course comprehends the function of all components of immune system and effect of different form of interactions of antibodies, complement components, cytokines in response to invasion of antigen. Furthermore, the application of immune system in carcinogenesis, therapeutics and gene delivery would also be illuminated. Medical conditions arising from malfunctioning of

one or more component of immune system would also be illustrated. All the lectures will be devoted on discussions of basic theories and advanced topics, focusing on practical implementation of knowledge. Classes will be conducted by lecture as well as power point presentation, audio visual virtual lab session as per requirement. The tutorials will enable the students with problem-solving ability led by the course coordinator. Students will perceive the basic concepts of the subject via exercise and discussions with the coordinator.

Course Content

Unit 1 Introduction (9 hours)

Concept of Innate and Adaptive immunity;

Primary and Secondary Immune Response; Generation of Humoral Immune Response (Plasma and Memory cells); Generation of Cell Mediated Immune Response (Self MHC restriction, T cell activation, Co- stimulatory signals); Killing Mechanisms by CTL and NK cells, Immune to tolerance, graft rejection. Microbial flora of healthy human body. Fundamentals of host pathogen interaction. Opportunistic infections, Nosocomial infections. Transmission of infection, PAMP and Pathophysiologic effects of LPS and exotoxins.

Unit 2 Immune Cells and Organs (5 hours)

Structure, Functions and Properties of: Immune Cells – Stem cell, T cell, B cell, NK cell, Macrophage, Neutrophil, Eosinophil, Basophil, Mast cell, Dendritic cell; and Immune Organs – Bone Marrow, Thymus, Lymph Node, Spleen, GALT, MALT, CALT, hematopoietic stem cells

Unit 3 Antigens-antibody and their interaction
(12 hours)

Characteristics of an antigen (Foreignness, Molecular size and Heterogeneity); Haptens; Epitopes (T & B cell epitopes); T-dependent and T-independent antigens; Adjuvants – complete and incomplete.

Structure, Types, Functions and Properties of antibodies; Antigenic determinants on antibodies (Isotypic, allotypic, idiotypic); VDJ rearrangements; Monoclonal and Chimeric antibodies. Immunological assays: Principles of Precipitation, Agglutination, Immunodiffusion, Immunoelectrophoresis, ELISA, ELISPOT, Western blotting, Immunofluoresence, Flow cytometry, Immunoelectron microscopy.

Organization of MHC locus (Mice & Human); Structure and Functions of MHC I & II molecules; Antigen processing and presentation (Cytosolic and Endocytic pathways), isotype switching, affinity maturation

Unit 4 Complement System (4 hours)

Components of the Complement system; Activation pathways (Classical, Alternative and Lectin pathways); Biological consequences of complement Activation

Unit. 5. Infection biology (5 hrs): Bacterial pathogens and virulence determinants. Majir bacterial disease Tuberculosis, typhoid, and Cholerae. Virus infection – HIV, HSV, and Hepatitis B. Protozoan parasites- Malaria and Leishmania, Fungal dises- Candidiasis and Histoplasmosis. Antimicrobial chemotherapy and drug resistance.

Unit 6 Immunological Disorders and Tumor Immunity (5 hours)

Types of Autoimmunity and Hypersensitivity with examples; Immunodeficiencies - Animal models (Nude and SCID mice), SCID, DiGeorge syndrome, Chediak- Higashi syndrome, Leukocyte adhesion deficiency, CGD; Types of tumors, tumor Antigens, causes and therapy for cancers.

Text Book:

Goldsby RA, Kindt TJ, Osborne BA. (2007). Kuby's Immunology.6th edition W.H. Freeman and Company, New York.

Reference books:

1. Abbas AK, Lichtman AH, Pillai S. (2007). Cellular and Molecular Immunology.6th edition Saunders Publication, Philadelphia.
2. Delves P, Martin S, Burton D, Roitt IM. (2006). Roitt's Essential Immunology.11th edition Wiley-Blackwell Scientific Publication, Oxford.
3. Murphy K, Travers P, Walport M. (2008). Janeway'sImmunobiology.7th edition Garland Science Publishers, New York.
4. Peakman M, and Vergani D. (2009).Basic and Clinical Immunology.2nd edition Churchill Livingstone Publishers, Edinberg.
5. Richard C and Geiffrey S. (2009). Immunology.6th edition. Wiley Blackwell Publication.
6. Owen, J.A.; Punt, J.; Kuby, J.; Stranford, S.A. Kuby immunology. W.H. Freeman: 2013.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Class Assessment	End Term
Weightage (%)	50	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	3	2	3	3	-	-	3	-	-	1	3
CO2	3	3	2	3	3	-	-	3	-	-	1	3
CO3	3	3	2	3	3	-	-	3	-	-	1	3
CO4	3	3	2	3	3	-	-	3	-	-	1	3
CO5	3	3	2	3	3	-	-	3	-	-	1	3
Avg	3	3	2	3	3	-	-	3	-	-	1	3

1=weakly mapped,

2= moderately mapped,

3=strongly mapped

Model Question Paper

Name: **Enrolment No:**	

Course: MIB21549– IMMUNOLOGY AND MEDICAL MICROBIOOGY (THEORY)
Program: M.Sc. Microbiology **Time: 03 Hrs.**
Semester: III (Odd 2022-23) **Max. Marks: 50**

Instructions:

Attempt any **four** questions from **Section A** (each carrying 5 marks); all questions from **Section B** (each carrying 10 marks)**.**

SECTION A (Attempt **all questions)**			
1.	**How** is the secondary immune response different from the primary immune response? (U) Give a comparative statement on innate and adaptive immunity.(An)	**2+3**	**CO1**
2.	Draw the precipitation curve and explain different zones of it. (U)	**5**	**CO2**
3.	Schematically **illustrate** the structure of T-cell receptor. (R)"Diversity of TCR genes is significantly greater than Immunoglobulin genes"- Why? (U)	**2+3**	**CO3**
4.	**Write** a note on application of agglutination reaction in diagnostic tests. (U)	**5**	**CO4**
5	**What** is meant by anaphylaxis? (R)What is hay fever? (R)	**3+2**	**CO5**
6.	Schematically **illustrate** the structure of MHC class I molecules. Why does it present endogenous antigens? (U)	**2+3**	**CO3**
7.	**Write** a note on application of ELISA and its application. (U)	**5**	**CO4**
	SECTION B (Attempt all **questions)**		
6.	**What** is the working principle of the home pregnancy kit? (U) An athlete who won gold in 1000metre race was	**5+5**	**CO2**

	suspected of taking an illegal drug and the honour conferred to him was confiscated. How can the runner prove his innocence? (An)		
7.	Write a note on the pros and cons of Sabin polio virus vaccine. (U) **How** do we overcome the drawbacks of this vaccine in order to eradicate Polio completely from the world? (U) **Explain** how autoimmune diseases can be mediated by stimulating auto-antibodies taking the example of Grave's disease (U).	**4+2+4**	**CO4** **CO2**
8.	**Which** antibody is known as maternal antibody and why? (U) **How** secretory IgA is generated- Show schematically. (R) Give the schematic diagram of Class II MHC molecule. (U) **Which** region of human genome encodes for Class II MHC molecule? (R)	**2+3+3+2**	**CO1** **CO3**

MIB21550	Epidemiology and Diagnostics	L	T	P	C
Version 1.0	Contact Hours - 45	3	0	0	3
Pre-requisites/Exposure	BASIC KNOWLEDGE OF MICROBIOLOGY and STATISTICS				
Co-requisites	--				

Course Objectives

To provide students the basic understanding of epidemiology and diagnostics. It will also provide in depth knowledge of epidemiological analysis. The course would elaborating relevant methods of biostatistics. General overview of diagnostics from traditional to cutting edge will be offered.

Course Outcomes

On completion of this course, the students will be able to

1. **Recall** basic diagnostics fundamentals used in identifying communicable diseases. Students will be able to design epidemiological studies.
2. **Explain** the differences between an epidemic and a pandemic, and how prevalence and incidence rates impact disease spread.
3. **Apply** diagnostic techniques to interpret clinical data in identifying patterns of morbidity in an outbreak.
4. **Analyze** morbidity rates and the epidemiology of communicable diseases using real-world data.
5. **Critically** assess the impact of prevalence and incidence rates on public health and **plan** interventions during an epidemic or pandemic.

Catalog Description

The core-course of '**Epidemiology and Diagnostics**' will help to understand the the science of epidemiology and diagnostics. It includes elaborated discussion on epidemiology alongside and overview of diagnostics is provided.

COURSE CONTENT

UNIT-I: Natural history of disease, Chain of infection, Mode and route of transmission of diseases, incubation period, latency period, clinical case, subclinical case, carrier, infectivity,

pathogenicity and virulence,Concepts of – Epidemic, Pandemic, Prevalence, incidence, morbidity rates, attack rates etc. Tools of Epidemiology: measuring disease Frequency, Survey methodology. Difference between infectious and communicable diseases vs. noncommunicable diseases, theories and principles of causation- epidemiological triad, web of causation, Bradford Hill criteria and Rothman's Causal pies, levels of prevention and modes of intervention.

UNIT-II: Epidemiological analysis: - Types of measures, Reliability, Validity, accuracy. Questionnaire and Index construction and scaling, variation, evaluating source data). Observational Studies (Cross Sectional, Descriptive, Cohort, Case Control, Before – after, Historical Prospective, international comparisons). Experimental studies- (Randomized Control trial, Allocation alternative, Maneuver, Compliance, contamination, co intervention, Adverse event). Qualitative research- (Mixed designs,Ecological Studies, Space time cluster studies, Familial aggregation studies). Research methodology- - The measurement loop and the Critical Appraisal cube. Defining the problem, Sample selection, Sample size, Events, outcome measures, dropouts, Analysis and reporting, Ethics, Strobe check list. Definitions: morbidity: Prevalence, Incidence proportion (Attack rate), Incidence rate (person-time), Relationship between incidence and prevalence. Measures of Mortality: Mortality rates, Crude death rate, Specific death rates, Case fatality rate, Infant and 12 child mortality rates, proportional mortality rate, survival rate, calculation of adjusted and standardized prevalence and death rates, concept of DALYs. Measures of association – Absolute risk, Relative risk, prevalence ratios, odds ratio, Measures of impact – Attributable risk, Population-attributable risk with real data examples. Kappa statistics, ROC curves, evaluation of screening tests, multiphasic screening tests.

Steps in conducting a systematic review - Develop an answerable question using the "Participants Interventions Comparisons Outcomes" (PICO) framework - Describe the process used to collect and extract data, Describe and interpret the results of meta-analyses Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) checklist and RevMan software for meta-analysis.

UNIT-III: Biostatistics Fundamentals of biostatistics: Introduction, types of data, tabular and graphical presentation of data. Measures of location, dispersion and correlation: Measures of central tendency. Mean, mode, median, GM, HM, quartiles Measures of dispersion— standard deviation, variance, coefficient of variation. Probability and statistical inference: Concept and probability distribution. Normal distribution— density curves, applications and statistical tables. Concept of significance tests, parametric and nonparametric tests, standard error and confidence intervals. Inferential statistics: Probability and distributions – Poisson, Binomial a nd Normal distribution – Chi-square test – Hypothesis test - Student's t-tes t – Correlation and Regression – ANOVA.

Unit-IV: Epidemiology of Communicable diseases (CD) Concept, CD typology, Risk factors for CDs, Epidemiology of CDs in India, burden of CD in India, Public health interventions for CDs. Introduction to tropical diseases, Neglected tropical diseases, Emerging and re-emerging tropical diseases. Epidemiology of major diseases of public health importance :

Small pox, Chicken pox, AIDS & other sexually transmitted diseases Acute respiratory infections, SARS Acute diarrhoeal disease, TB, Cholera, Typhoid, Leprosy, Food poisoning, Amoebiasis, Ascariasis, Hookworm.

Epidemiology of non-communicable diseases & injuries NCD typology, Risk factors for NCDs, Epidemiology of NCDs in India, Epidemiology of intentional and unintentional injuries, Congenital diseases in India, Public health interventions for NCDs. Epidemiology of major NCDs of public health importance: Cardiovascular diseases, Coronary heart disease, Hypertension, Stroke, Rheumatic heart disease, Cancer, and Diabetes.

UNIT-V: Diagnostics fundamentals: Introduction and History of diagnostics, Diseases-infectious, and genetic basis of diseases, inherited diseases. Traditional diagnostics approaches- microscopy, histology, biochemical analysis, and chromatography. Molecular diagnostics and concept of biomarkers. Diagnosis of congenital defects. Immunodiagnostics, Microfluidics- basic concept. Use of nanotechnology in diagnostics.

Textbook:

Textbook of Epidemiology, 2nd EditionLex Bouter, Maurice Zeegers, Tianjing Li, WILEY, 2023

Jekel's Epidemiology, Biostatistics, Preventive Medicine, and Public Health, Joann G. Elmore, ELSEVIER, 2020

A Textbook of Medical Diagnostics, Dr. Rajneesh Prajapat, NOTION press

Molecular Diagnostics: Fundamentals, Methods and Clinical Applications, Lela Buckingham, Kkruender Publications

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Class Assessment	End Term
Weightage (%)	50	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	3	2	1	3	-	-	3	-	-	-	3
CO2	3	3	2	1	3	-	-	3	-	-	-	3
CO3	3	3	2	1	3	-	-	3	-	-	-	3
CO4	3	3	2	1	3	-	-	3	-	-	-	3
CO5	3	3	2	1	3	-	-	3	-	-	-	3
Avg	3	3	2	1	3	-	-	3	-	-	-	3

1=weakly mapped
2= moderately mapped
3=strongly mapped

Model Question Paper

Name: **Enrolment No:**	

Course: MIB21550- Epidemiology and Diagnostics (THEORY)
Program: M.Sc. Microbiology **Time: 03 Hrs.**
Semester: III (ODD 2022-23) **Max. Marks: 50**

Instructions:

Attempt any **four** questions from **Section A** (each carrying 5 marks); any **three** questions from **Section B** (each carrying 10 marks)**.**

SECTION A (Attempt **all questions)**			
1.	**What** is dysbiosis? What are the approaches to treat dysbiosis? (R,U)	**5**	**CO1**
2.	**What** is the principle of LAMP? **How** it can be exploited for rapid detection of a pathogen? (R, Ap)	**2+3**	**CO2**
3.	Write short note on: HAART and TSST. (U)	**2+3**	**CO4**
4.	**What** are macrolids? **Outline** the basic mode of action for macrolids. (R, U)	**5**	**CO5**
5	**Discuss** the principle of a non-invasive diagnostic protocol for a viable but non-culturable pathogen. (U)	**5**	**CO3**
6.	**How** does resistance against tetracycline emerge? **Outline** the basic of identifying resistant mutants. (R, U)	**5**	**CO5**
	SECTION B (Attempt any **Three questions)**		
7.	**What** are PAMPs? Name major PAMPs for an enteropathogen and **discuss** how each of those affects host response against the pathogen. (U)	**2+3+5**	**CO3**
8.	**Outline** with the help of a flow diagram to depict possible implementation of PCR and CRISPR technology (U, An)	**5+5**	**CO1** **CO5**

9.	**Outline** the chemotherapeutic intervention for Mtb. What are MDR and XDR Tb? How does XDR Tb emerge?- discuss the mechanism. (R,U, An)	**3+4+3**	**CO5**
10	**Outline** a major signaling cascade acting in sensing viral infection and eliciting protective response. Why it is difficult to design vaccine against RNA virus in general? (R, An)	**6+4**	**CO2**

MIB21551	NATURAL PRODUCTS AND TOXICOLOGY	L	T	P	C
Version 1.0	**Contact Hours - 45**	3	0	0	3
Pre-requisites/Exposure	BASIC KNOWLEDGE OF BIOCHEMISTRY				
Co-requisites	--				

Course Objectives

1. To provide students the basic understanding of natural products.
2. It will also provide in depth knowledge of sources and functional aspects of natural products.
3. Elaborating extraction method of natural products.
4. General overview of natural products with toxicological assessment.

Course Outcomes

On completion of this course, the students will be able to

1. **Recall** key concepts related to plant-derived drugs, natural products, and microbial phytotoxins, along with their basic properties and sources.
2. **Explain** the methods for extraction and characterization of natural products, as well as the biotechnological processes used in developing biotechnology-derived products.
3. **Demonstrate** practical skills in extracting novel drug templates from natural sources and describe the process of genetically engineering natural products to enhance bioactivity.
4. **Analyze** the mode of action of different natural products and microbial phytotoxins, differentiating their effects on various biological systems.
5. **Evaluate** the potential of genetically engineered natural products and **formulate** plant-derived drugs for pharmaceutical development, considering safety, efficacy, and explain environmental impact.

Catalog Description

The core-course of 'Natural products and toxicology' will help to understand the classification, structure and properties of natural products. Natural products are small molecules produced naturally by any organism including primary and secondary metabolites. It includes study of mode of action, symptoms, detection and treatments of toxic agent in biological system.

COURSE CONTENT

Unit 1: Approaches available for drug development, role of natural products in new drug development. Plant-derived drugs, novel drug templates, chemical diversity, and structure-based drug design. Bioactive compounds from microorganisms: Antibiotics, non-antibiotic drugs from fungal and other microbial sources, microbial phytotoxins. Some typical structure elucidation insights for natural products by combination of classical, spectroscopic, synthetic and degradative methods depicting examples. Natural products as a guide (leads) to the future design of new drugs with case histories : statin drugs with anti-hyperlipidemic activity to be included. Case Studies of Plant-derived Natural products drugs: Discovery of statins, taxol, cardiac glycosides, vinca alkaloids, morphine, quinine, and podophyllotoxin

Unit 2: Methods for extraction, isolation, molecular separation and purification of biomolecules from natural sources. Bioassay-directed fractionation of natural products depicting examples. Disease pattern where use of natural products is preferred, recent developments on adaptogens, immunomodulators, memory enhancers, anti-inflammatory agents, antiparasitics along with screening methods for isolation guidance. Genetically engineered natural products, naturally occurring proteins, biotechnology-derived products.

Unit 3: Food, Drug interactions, Nutriceuticals : Nutrient interactions affecting ADME of drugs, Alcohol and nutrient deficiency, Anti-depressants, psychoactive drugs and nutrient interactions, Appetite changes with drug intakes and malnutrition.

Unit 4 Toxicology: Classification of Food Toxicants. Food, Law and Safety. Principles of Toxicology I: Exposure, the Dose-Response Curve. Absorption, Distribution and Elimination of Toxicants. Biotransformation Reactions (Phase I & Phase II).Carcinogenesis, Mutagenesis, Teratogenesis. Organ Toxicity.Natural Toxins in Foods of Plant Origin I. Risk Assessment. Pesticides in Foods. Marine,Toxinns Poisonous Mushrooms , Mycotoxins ,Toxicants Resulting from Food Processing I , Food Additives I , Food Adulteration Pesticides .

Unit 5: Analytical toxicology: Qualitative Descriptions of Toxicity Exposure Limits Determination of LD50 and ED50, Units in Toxicology. Analysis of pesticides by Chromatography Method. Analysis of heavy metals by Spectrophotometric Methods. Determination of heavy metals by Atomic Absorption Spectrophotometer. Determination of heavy metals by Atomic Emission Spectrophotometer, Inductively Coupled Plasma Spectrophotometers, Determination of drug of abuse. Estimating genotoxicity: Immunoassay Techniques: ELISA.

Textbook:

1. Medical Toxicology of Natural Substances: Foods, Fungi, Medicinal Herbs, Plants, and Venomous Animals.Donald G. Barceloux MD, FAACT, FACMT, FACEP,First published:2 January 2008Print ISBN:9780471727613 |Online ISBN:9780470330319 |DOI:10.1002/9780470330319 Copyright © 2008 John Wiley & Sons, Inc.
2. Toxicology of Herbal Products: Olavi Pelkonen (Editor), Pierre Duez (Editor), Pia Maarit Vuorela (Editor), Heikki Vuorela (Editor).ISBN-10 :

3319829157.ISBN-13 : 978-3319829159.ISBN-10 : 3319829157. ISBN-13 : 978-3319829159.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Class Assessment	End Term
Weightage (%)	50	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	3	2	3	3	-	-	3	-	-	1	3
CO2	3	3	2	3	3	-	-	3	-	-	1	3
CO3	3	3	2	3	3	-	-	3	-	-	1	3
CO4	3	3	2	3	3	-	-	3	-	-	1	3
CO5	3	3	2	3	3	-	-	3	-	-	1	3
Avg	3	3	2	3	3	-	-	3	-	-	1	3

1=weakly mapped
2= moderately mapped
3=strongly mapped

Name: Enrolment No:	

Course: MIB21551 – NATURAL PRODUCT AND TOXICOLOGY (THEORY)
Program: M.Sc. (Biochemistry) **Time: 03Hrs.**
Semester: Odd (2022-23) **Max. Marks:50**

Instructions:
Attempt any **four** questions from **Section A** (each carrying 5 marks); any **two** questions from **Section B** (each carrying 10 marks)**.**

SECTION A (Attempt any Four questions) (5×4=20) (5×4=20)

1.	**Analyze** the role of water in biological processes.	**An**	**CO1**
2.	**Explain** why is cellulose insoluble, while starch, which appears to have a very similar structure, is soluble? **Identify** the tools used to characterize the glycome.	**U**	**CO2**
3.	**Illustrate** why does plats produce secondary metabolites? What is peptide mass fingerprinting?	**R**	**CO3**
4.	**Describe** the principle of toxicity by aflatoxin	**U**	**CO4**
5	**Develop** a mass spectrometry-based analysis protocol for bacterial exotoxins	**AP**	**CO5**
	SECTION B (Attempt any Two questions) (10X2=20)		
6.	What is the role of CytP450 in toxicity? How do animoglycosdies function? **Illustrate** one of the pipelines for structure based drug designing. **3+2+5**	**U**	**CO3**
7.	A sugar ($C_6H_{10}O_5$) was treated by a method that reduces aldehyde groups and gave a product that was optically inactive. Assuming the sugar was D, **identify** the two possible structures of the product? **Analyze** the role of non- covalent interactions for determining the folding rate of two- state proteins. **Explain** regulation of glucokinaseactivity by Glucokinase regulatory protein. **2+4+4**	**U,AN**	**CO1** **CO2**
8.	Define and classify poisons? How presence of a posison can be detected in a food sample? Elaborate heavy metal toxicity. **2+1+3+4**	**AN,AP, U**	**CO3**

MIB21526	Bioprocess Technology (THEORY)	L	T	P	C
Version 1.0	Contact Hours - 45	3	0	0	3
Pre-requisites/Exposure	UG level knowledge in Microbiology				
Co-requisites	--				

Course Objectives

The course deals with the various aspects of applied and industrial biotechnology. It broadly focuses on the applied biocatalysis in homogeneous and heterogeneous systems, solid-state and submerged culture fermentation, downstream processing and industrial effluent treatment. This course thus offers a broad-spectrum exposure to such a rapidly advancing field as biotechnology and hence includes various strategies for bioprocess development, control, optimization and scale-up, starting from the strain to the final marketable product / technology. Considering tremendous commercial potential of bioprocesses as cost-competitive and environment friendly alternatives to chemical processes, the course emphasizes on the bioreactor design, configuration and various operational strategies for microbial and animal cells and downstream processing of bioproducts using modern analytical and purification techniques and protocols for the commercial manufacture of industrial biochemicals, enzymes and recombinant therapeutic proteins and for enzyme based bioconversions of steroids and by-products.

Course Outcomes

On completion of this course,

CO1. Students will be able to **recall** the fundamental principles of bioprocess technology, including the operation and maintenance of bioreactors.

CO2. Students will be able to **explain** the kinetics of microbial growth and the factors influencing growth rates in bioprocesses.

CO3. Students will be able to **apply** advanced concepts in bioprocess technology to optimize process parameters and maximize productivity in bioreactors.

CO4. Students will be able to **analyze** the importance of downstream processing techniques in the purification and isolation of bio-products from fermentation broths.

CO5. Students will be able to **evaluate** different microbial strain improvement strategies and **maximize** their impact on bioprocess performance and product quality.

Catalogue Description

The course discusses the basic operations in bioprocess technology, unit, dimension, mass transfer at the equilibrium phase, stoichiometry of microbial growth and product formation. This course explicates the connection between microbial growth, product formation, mass transfer and environment. Likewise, this course gives an overview of the bioprocess from raw material to product. Upstream and downstream processing will be discussed. This course explains the processes and techniques used for extraction and purification of a product from a culture medium. Also, bioprocess consideration in using animal and plant cell cultures will discuss using different techniques.

Course Content

Unit 1 Bioreactors: (18h)

Design of a basic fermenter, bioreactor configuration, individual parts, baffles, impellers, foam separators, Spurger, culture vessel, cooling and heating devices, probes for online monitoring, measurement and control of process. Reactors for specialized applications: Tubular reactors, packed bed reactors, fluidized bed reactors, plug-flow reactors, cyclone reactors, trickle flow reactors, their basic construction.Transport phenomena in fermentation: Gas-liquid exchange and mass transfer, oxygen transfer, critical oxygen concentration, determination of K_La, Heat transfer, aeration/agitation, sterilization of bioreactors, nutrients, air supply, products and effluents, process variables and control, scale-up of bioreactors

Unit 2 Fermentation process: (9h)

Growth of cultures in the fermenter , formulation of culture mediaand modification, kinetics of growth in batch culture, continuous culture with respect to substrate utilization, specific growth rate, steady state in a chemostat, fed-batch fermentation, yield of biomass, product, calculation for productivity, substrate utilization kinetics, Substrate inhibition models, product formation kinetics, fermentation process: Inoculum development, storage of cultures for repeated fermentations, scaling up of process from shake flask to industrial fermentation, steady state fermentation

Unit 3 Downstream Processing: (9h)

Biomass separation by centrifugation, filtration, flocculation, Cell disintegration: Physical, chemical and enzymatic methods, Extraction: Solvent, distillation, two phase, liquid extraction, whole broth, aqueous multiphase extraction, Pervaporation, Purification by

different methods, Concentration by precipitation, ultra-filtration, reverse osmosis, Lyophilization, Drying and crystallization

Unit 4 Microbial Strain Improvement: (9h)

Isolation, selection and improvement of microbial cultures: Screening and isolation of microorganisms, enrichment, specific screening for the desired product, Strain improvement for the selected organism: mutation, random and strategic screening methods, strategies of strain improvement for primary, secondary metabolites with relevant examples. Use of recombinant DNA technology, protoplast fusion techniques for strain improvement of primary and secondary metabolites, production of recombinant molecules in heterologous system, problems associated with strain improvement programme, Preservation of cultures after strain improvement programme

Textbook:

10. Patel A.H. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited.
11. Prescott & Dunn's Industrial Microbiology by G Reed, 2004

Reference books:

1. Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. Elsevier Science: 2013.

2. Okafor N. (2007). Modern Industrial Microbiology and Biotechnology. 1st edition. Bios Scientific Publishers Limited. USA

3. Bioprocess Engineering: Basic Concepts by Kargi Fikret and Schuler, 2017

4. Process Biotechnology: Theory and Practice by S. N. Mukhopadhyay, 2012

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	Class Assessment	End Term
Weightage (%)	50	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	3	2	3	3	-	-	3	-	-	1	3
CO2	3	3	2	3	3	-	-	3	-	-	1	3
CO3	3	3	2	3	3	-	-	3	-	-	1	3
CO4	3	3	2	3	3	-	-	3	-	-	1	3
CO5	3	3	2	3	3	-	-	3	-	-	1	3
Avg	3	3	2	3	3	-	-	3	-	-	1	3

1=weakly mapped
2= moderately mapped
3=strongly mapped

Model Question Paper

Name: **Enrolment No:**	

Course: MIB21523 - BIOPROCESS TECHNOLOGY (THEORY)

Program: M.Sc. Microbiology **Time: 03 Hrs.**
Semester: III (Odd 2022-23) **Max. Marks: 50**

Instructions:

Attempt any **four** questions from **Section A** (each carrying 5 marks); any **three** questions from **Section B** (each carrying 10 marks)**.**

SECTION A (Attempt **any Four questions)**			
1.	Which type of reactor, aeration is generally accomplished in a separate vessel? What is the unit of influent flow rate? **Differentiate** in detail airlift loop reactors and fluidized bed reactors. (An, R, U)	**1+1+3**	**CO1**
2.	**Explain** the methods of on-line and off-line biomass estimation. (U)	**5**	**CO2**
3.	**Write** short notes on different chemical methods of cell disruption. (R)	**5**	**CO3**
4.	What is convective mass transfer? **Discuss** about film resistance to mass transfer between two immiscible liquids. (R, U)	**2+3**	**CO4**
5	**Evaluate** the criteria for the selection of microbes as cloning hosts. (An)	**3+2**	**CO5**
6.	**Outline** the touble shooting while an attempt of enzyme purification fails . (R)	**5**	**CO3**
	SECTION B (Attempt any **Three questions)**		
6.	**Explain** in brief about affinity chromatography and reverse phase chromatography. (U) **Write**	**10**	**CO3**

7.	**Distinguish** between primary and secondary metabolites. Give one example for each. List the industrially useful microorganisms. Explain in detail about the raw materials and medium requirements for the fermentation process. (U,R)	**2+2+3+3**	**CO1** **CO5**
8.	**Explain** the step-by-step physical transfer of oxygen molecules from the air bubble to the cytoplasm of the cell and identify the various mass transfer resistances in series. (U)	**10**	**CO4**
9	**Describe** in detail construction and working of Bioreactor. **Describe** flow injection analysis for measurement of substrates. (U)	**5+5**	**CO1** **CO2**

MIB21528	Microbial Metabolism (THEORY)	L	T	P	C
Version 1.0	**Contact Hours - 45**	3	0	0	3
Pre-requisites/Exposure	UG LEVEL MICROBIOLOGY				
Co-requisites	--				

Course Objectives

1. Develop concepts of molecular basis of energy metabolism
2. Mechanistic perception of metabolic reactions
3. To develop concept of transport and metabolic flux

Course Outcomes

On completion of this course:

1. **Recall** the key concepts and principles of microbial metabolism, including bioenergetics, photosynthesis, oxidative phosphorylation, carbohydrate metabolism, lipid metabolism, amino acid metabolism, and nucleic acid metabolism.

2. **Demonstrate** an understanding of the different metabolic pathways utilized by microorganisms to generate energy, synthesize macromolecules, and regulate metabolic processes.

3. **Apply** knowledge of microbial metabolism to analyze and interpret experimental data related to bioenergetics, photosynthesis, oxidative phosphorylation, carbohydrate metabolism, lipid metabolism, amino acid metabolism, and nucleic acid metabolism.

4. **Evaluate** the impact of different environmental factors on microbial metabolism and predict how changes in these conditions can affect metabolic pathways in microorganisms.

5. **Design** experiments to investigate specific aspects of microbial metabolism, formulate hypotheses, and **propose** innovative strategies for optimizing metabolic pathways in microorganisms for practical applications in the fields of biotechnology and medicine.

Catalogue Description

The course of '**Microbial Metabolism**' will help to understand the basic concept of metabolism. Also the course would deal with details of metabolic regulation. Classes will be conducted by lecture as well as power point presentation, audio visual virtual lab session as per requirement. The tutorials will enable the students with problem-solving ability led by the course coordinator. Students will perceive the basic concepts of the subject via exercise and discussions with the coordinator.

Course Content

Microbial Metabolism (MIB21528)

Unit 1 Photosynthesis: (9h)

Major groups of photosynthetic prokaryotic microbes. Ultrastructure of reaction centre, arrangements of light harvesting pigments, light reaction & electron flow in photosynthesis, photophosphorylation, and bioenergetics. CO2 fixation pathways, Microbial consortium.

Unit 2 Carbohydrate metabolism: (9h)

Regulation and energetics of hexose and pentose metabolism. Peptidoglycan synthesis. Specialized metabolic pathways like ED and Bifido.

Unit 3 Aerobic and anaerobic respiration: (9h)

Mitochondrial Electron Transport chain and bioenergetics of ETC and oxidative phosphorylation, mechanism of oxidative phosphorylation. Inhibitors of electron Transport chain. Anaerobic respiration: electron transport & bioenergetics, importance (NO3 respiration, SO4 respiration, Halorespiration) and fermentation, secondary fermentation, syntrophy. Chemolithotrophy: Iron, Carbon, Hydrogen and Sulphur oxidation, Methanotrophy Acetogenesis, Methanogenesis, Anammox, ATP synthesis in Halobacterium.

Unit 4 Amino acid and nucleic acid metabolism: (9h)

Biochemistry of biological nitrogen fixation, properties of nitrogenase and its regulation, alternate and oxygen insensitive nitrogenase, nitrogenase assay. Ammonia assimilation with respect to glutamine synthetase, glutamate dehydrogenase, glutamate synthetase, their properties and regulation. Shikimate family and degradation of amino Protein turn over. Biosynthesis of purine and pyrimidine bases. Biosynthesis and oxidation of saturated and unsaturated fatty acids.

Unit 5 Nutrient transport: (9h)

Transport of solutes across the membrane, Active and Passive transport, Group Translocation, Carrier mediated transport mechanism, thermodynamics of transport process.

Text Book:

1. Willey JM, Sherwood LM, and Woolverton CJ.(2013) Prescott, Harley and Klein's Microbiology.9thedition. McGraw Hill Higher Education

Reference Book:

2. Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). Brock Biology of Microorganisms.14th edition. Pearson International Edition

3. Moat, Foster, Spector. Microbial Physiology (4th Edition) (2004)

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Class Assessment	End Term
Weightage (%)	50	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	3	2	3	3	-	-	3	-	-	1	3
CO2	3	3	2	3	3	-	-	3	-	-	1	3
CO3	3	3	2	3	3	-	-	3	-	-	1	3
CO4	3	3	2	3	3	-	-	3	-	-	1	3
CO5	3	3	2	3	3	-	-	3	-	-	1	3
Avg	3	3	2	3	3	-	-	3	-	-	1	3

1=weakly mapped2= moderately mapped3=strongly mapped

Model Question Paper

Name: **Enrolment No:**	

Course: MIB21528- Microbial Metabolism (THEORY)
Program: M.Sc. Microbiology **Time: 03 Hrs.**
Semester: III (2022-23) **Max. Marks: 50**

Instructions:

Attempt any **four** questions from **Section A** (each carrying 5 marks); all questions from **Section B** (each carrying 10 marks)**.**

SECTION A (Attempt **ant four questions)**			
1.	Draw a purine nucleus and **indicate** precursor for various parts of it. (U)	**5**	**CO1**
2.	**What** are UCPs? **How** those are related to thermogeneisis? (R,U)	**2+3**	**CO2**
3.	**Compare** ion channels and ionophores. (An)	**5**	**CO3**
4.	**Mention** amino acid decarboxylation and deamination. What are the physiological significance of both? (R, U)	**3+2**	**CO4**
5	Can ETC uncouplers affect a. methnogeneisis and b. sulphate reduction? explain (U)	**2+3**	**CO5**
6.	**Outline** Bifido pathway. (R)	**5**	**CO4**
	SECTION B (Attempt all **questions)**		
7.	Write short note of the following: a. cross inoculation group b. phycobillisome c. sulfer disproportion (R,U)	**4+2+4**	**CO3**
8.	**Explain** the following: a. ED reaction is half energy efficiency yet significant for Zynomonous b. Revesre TCS cycle is typical for purple S-bacteria d. Leghaemoglobins are crucial for nitrogenase activity (An)	**3+4+3**	**CO1** **CO2**

9.	**Outline** the points of antibiotic action in peptidoglycan biosynthetic pathway. What si the significance of pentose phosphate pathway? Illustrate mechanism of transketolase reaction. (U, An)	**5+5**	**CO1** **CO2**
10.	**What** is partition co-efficient- explain? **What** are the structural feature of porins? Can you find porin proteins in eukaryotic cells?(U, R, An)	**4+4+2**	**CO5**

MIB22548	Immunology and Medical Microbiology LAB (PRACTICAL)	L	T	P	C
Version 1.0	Contact Hours - 60	0	0	4	2
Pre-requisites/Exposure	Concept of immunology from UG level				
Co-requisites	--				

Course Objectives

1. Students will be able to demonstrate and interpret different antigen-antibody interactions.

2. It will make the students well acquainted with various components of the immune system.

3. The concept will enable the students to apply various immunological techniques for clinical and research purpose.

4. Students will learn to quantify antigen/ antibody in different samples.

5. Students will be adept to identify the virulence factors in pathogens.

Course Outcomes

On completion of this course, the students will be able to

1. **Identify** and recall the principles and applications of immunological and microbiological diagnostic tests.
2. **Explain** the theoretical basis of immunological and microbiological assays used in clinical diagnostics.
3. **Apply** appropriate laboratory techniques to diagnose infectious diseases based on microbial identification and immunological assays.
4. **Differentiate** between various diagnostic tests based on their specific applications and sensitivity for detecting pathogens.
5. **Critically** evaluate and **explain** the effectiveness and limitations of immunological and microbiological tests in clinical and research settings.

Catalogue Description

The student will be able to use the knowledge obtained to perform and analyze different types of antigen-antibody interaction. Identification of different components of the immune system is possible with the concept obtained. Students will gain the ability to apply different immunological techniques for research and clinical purposes.. All the experiments will be based on hands-on training in laboratory setup along with discussions of basic theories and advanced topics for practical implementation of knowledge. Classes will be conducted by

hands-on lab training and/or audio visual virtual lab session as per requirement. Students will perceive the basic concepts of the subject via exercise and discussions with the coordinator.

Course Content

Immunology and Medical Microbiology Lab (MIB22548)

1. Identify bacteria (any three of E. coli, Salmonella, Pseudomonas, Staphylococcus, Bacillus) using laboratory strains on the basis of cultural, morphological and biochemical characteristics: IMViC, TSI, nitrate reduction, urease production and catalase tests (15 h)
2. Isolation and identification of microorganisms from clinical samples- urine (growth in alkaline peptone water, growth in blood agar, MacConkey agar). (10h)
3. Study of bacterial flora of skin by swab method (10h)
4. Perform antibacterial sensitivity by Kirby-Bauer method, Determination of minimal inhibitory concentration (MIC) of an antibiotic. (5h)
5. To perform immunoprecipitation test. (10 hours)
6. To perform immunodiffusion by Radial immunodiffusion method (10 hours)
7. To perform sandwich ELISA. (6 hours)
8. To perform Widal Test (8 hours)
9. To perform rocket immunoelectrophoresis (4hours)

Text Book(s)

T1. Owen, J.A.; Punt, J.; Kuby, J.; Stranford, S.A. Kuby immunology. W.H. Freeman: 2013.

Reference books

R1. Abbas AK, Lichtman AH, Pillai S. (2007). Cellular and Molecular Immunology.6th edition Saunders Publication, Philadelphia.
R2. Delves P, Martin S, Burton D, Roitt IM. (2006). Roitt's Essential Immunology.11th edition Wiley-Blackwell Scientific Publication, Oxford.
R3. Murphy K, Travers P, Walport M. (2008). Janeway'sImmunobiology.7th edition Garland Science Publishers, New York.

Modes of Examination: Assignment/Quiz/Project/Presentation/Written Exam
Examination Scheme:

Components	Internal	End Term
Weightage (%)	50	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	3	2	3	3	3	3	3	1	3	3	3
CO2	3	3	2	3	3	3	3	3	1	3	3	3
CO3	3	3	2	3	3	3	3	3	1	3	3	3
CO4	3	3	2	3	3	3	3	3	1	3	3	3
CO5	3	3	2	3	3	3	3	3	1	3	3	3
Avg	3	3	2	3	3	3	3	3	1	3	3	3

1=weakly mapped, 2= moderately mapped, 3=strongly mapped

Model Question Paper

Name: **Enrolment No:**	

Course: MIB22548– Immunology and Medical Microbiology LAB (PRACTICAL)
Program: M.Sc. Microbiology **Time: 03 Hrs.**
Semester: III (Odd 2021-22) **Max. Marks: 50**

Instructions:

Answer the following questions"

SECTION A			
1.	**Summarize** the working principle of DOT-ELISA. (U)	**15**	**CO1**
2.	**Perform** the procedure for rocket immunoelectrophoresis with four samples provided of an antigen discussing the expected result. (An) *(Practical skill- 5, Method accuracy -5)*	**15**	**CO1, CO2**
SECTION B			
6.	Lab note book	**10**	**CO1, CO2, CO3, CO4. CO5**
7.	Viva	**10**	**CO1, CO2, CO3, CO4. CO5**

Course Title	Bioprocess Technology Lab	L	T	P	C
Course Code	MIB22527	0	0	4	2
Contact Hours	60 hr				
Pre-requisites/Exposure	UG level knowledge in Microbiology or allied subjects				
Co-requisites	-				

Course Objectives

1. To gain a deeper understanding on how and why bioprocessing is employed to increase value of the feed stream

2. To gain a deeper knowledge of the main workflow and logic behind bioprocessing both in lab and industrial scale, and able to identify unit operations.

Course Outcomes

On completion of this course,

CO1 Students will be able to **describe** the basic principles of aeration and agitation in bioprocess technology lab, including the factors affecting the volumetric oxygen mass transfer coefficient.

CO2 Students will be able to **explain** the various immobilization techniques used in bioprocess technology lab and compare their advantages and disadvantages.

CO3 Students will be able to **demonstrate** the process of ethanol production using microbial fermentation.

CO4 Students will be able to **analyze** the production and purification processes of various enzymes, including the methods for enzyme extraction, purification, and characterization.

CO5 Students will be able to **evaluate** the production of microbial products in bioprocess technology lab, including the quantification of biomass concentration and **improve** product yield.

Catalogue Description

This course explains the processes and techniques used for extraction and purification of a product from a culture medium. Also, bioprocess consideration in using animal and plant cell cultures will discuss using different techniques. After completion of the course the students will gain a thorough knowledge of the underlying principles of main bioprocess unit

operations like fermentation, downstream processing, about genetic engineering for recombinant protein expression and production from various cell systems, and have advanced knowledge about design of experiments.

Course Content

Bioprocess Technology Lab (MIB22527)

1. Determination of oxygen transfer rate and volumetric oxygen mass transfer coefficient (K_La) under variety of operating conditions in shake flask and bioreactor(5h)

2. Determination of mixing time and fluid flow behavior in bioreactor under variety of operating conditions(5h)

3. Rheology of microbial cultures and determination of various rheological constants (5h)

4. Production of microbial products in bioreactors (10h)

5. Studying the kinetics of enzymatic reaction by microorganisms (5h)

6. Production and purification of various enzymes from microbes(7h)

7. Comparative studies of Ethanol production using different substrates (8h)

8. Microbial production and downstream processing of an enzyme, e.g. amylase (8h)

9. Various immobilization techniques of cells/enzymes, use of sodium alginate beads for cell (7h)

Books:

1. Laboratory Manual in Industrial Biotechnology by P. Chellapandi 2007
2. Bioreactors in Biotechnology: A Practical Approach by A.H. Scragg, 1991

Modes of Examination: Assignment/Quiz/Project/Presentation/Written Exam

Examination Scheme:

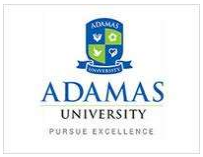
Components	Class Assessment	End Term
Weightage (%)	50	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	3	2	3	3	3	3	3	1	3	3	3
CO2	3	3	2	3	3	3	3	3	1	3	3	3
CO3	3	3	2	3	3	3	3	3	1	3	3	3
CO4	3	3	2	3	3	3	3	3	1	3	3	3
CO5	3	3	2	3	3	3	3	3	1	3	3	3
Avg	3	3	2	3	3	3	3	3	1	3	3	3

1=weakly mapped, 2= moderately mapped, 3=strongly mapped

Model Question Paper

Name: Enrolment No:			
Course: MIB22527 – Bioprocess Technology Lab (PRACTICAL) **Program: M.Sc. Microbiology** **Time: 03 Hrs.** **Semester: III (Odd 2021-22)** **Max. Marks: 50** **Instructions:** Attempt any **two** questions from **Section A** (each carrying 15 marks); **Section B** is Compulsory (carrying 10 marks)**.**			
Section A (Attempt **any Two)**			
1.	a) **Identify** onethe immobilization techniques of cells. (Ap)b) **Write** down the method and applications of this process for whole cell immobilization. (An)	**2 7 6**	**CO1**
2.	a) **Discuss** the applications ofalpha amylase. (Ap)b) **Write** down the procedure for production and partial purification of alpha amylase from *Bacillus subtilis.* (An)	**2 7 6**	**CO3**
3.	a) **Identify** the instrument shown in figure. (Ap)b) **Write** down the principle of operation and applications of this instrument. (An)	**5 5 5**	**CO3**
4.	You have synthesized two proteins via microbial production. Now you want to purify them. **Design** suitable chromatography technique to execute this process. **Interpret** the result. (An)	**10 5**	**CO2 CO5**
	SECTION B is compulsory		
5.	**Viva-voce** (U/An/Ap/R/Ev)	**10**	**CO1,CO2, CO3,CO4 CO5**
6.	**Practical copy** (U/Ap/Ev)	**10**	**CO1,CO2, CO3,CO4 CO5**

MIB22553	Epidemiology and Diagnostics Lab	L	T	P	C
Version 1.0	Contact Hours - 45	3	0	0	3
Pre-requisites/Exposure	BASIC KNOWLEDGE OF MICROBIOLOGY and STATISTICS				
Co-requisites	--				

Course Objectives

To provide students the basic understanding of epidemiology and diagnostics. It will also provide in depth knowledge of epidemiological analysis. Data analysis, case study, hands on practice on epidemiology. Experiments on molecular and conventional diagnostics.

Course Outcomes

On completion of this course, the students will be able to

1. **Recall** the fundamental principles of ELISA, PCR, qPCR, and their applications in diagnostics.
2. **Use** the EVM-calculator for vaccine coverage assessments in public health scenarios.
3. **Analyze** the output data from PEPITOOLS and EPIINFO to draw meaningful epidemiological conclusions.
4. **Assess** the utility of various epidemiological software tools like WINSPEPI and PEPITOOLS in public health research.
5. **Develop** and **design** diagnostic workflows integrating ELISA, PCR, and qPCR for the comprehensive detection of pathogens in clinical samples.

Catalog Description

The core-course of '**Epidemiology and Diagnostics Lab**' will help to understand the the science of epidemiology and diagnostics. It includes elaborated discussion on epidemiology alongside and overview of diagnostics is provided.

COURSE CONTENT

1. Exploring and understanding epidemiological database and designing epidemiological studies.

2. Use of PEPITOOLS, WINSPEPI, EPIINFO, EVM-calculator

3. Conventional diagnostics- biochemical, microbiological, and histological slides

4. Biomarker identification from sequence data, using and developing simple microfluidics based diagnostic kit.

5. Molecular diagnostics by PCR and qPCR.

6. Immunodiagnoistics: ELISA

Textbook:

Mosby's Manual of Diagnostic and Laboratory, Pragana and Pragana, 2017

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Class Assessment	End Term
Weightage (%)	50	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	3	2	3	3	3	3	3	1	3	3	3
CO2	3	3	2	3	3	3	3	3	1	3	3	3
CO3	3	3	2	3	3	3	3	3	1	3	3	3
CO4	3	3	2	3	3	3	3	3	1	3	3	3
CO5	3	3	2	3	3	3	3	3	1	3	3	3
Avg	3	3	2	3	3	3	3	3	1	3	3	3

1=weakly mapped
2= moderately mapped
3=strongly mapped

MIB22554	NATURAL PRODUCTS AND TOXICOLOGY LAB (PRACTICAL)	L	T	P	C
Version 1.0	**Contact Hours - 60**	0	0	4	2
Pre-requisites/Exposure	BASIC KNOWLEDGE OF BIOCHEMISTRY				
Co-requisites	--				

Course Objectives

1. To provide students with hands-on training in the field of nutritional biochemistry.
2. To provide in depth knowledge of modern research on nutrition and toxicology.
3. Students will become more proficient with different practical applications nutrition and toxicology.

Course Outcomes

On completion of this course, the students will be able to

CO1. **Recall** and identify various natural products used in traditional medicine
CO2. **Explain** the principles of natural product isolation and characterization techniques
CO3. **Demonstrate** proficiency in performing extraction, isolation, and purification of natural products
CO4. **Analyze** the chemical composition of natural products using spectroscopic techniques
CO5. **Formulate** and **propose** recommendations for the safe use of natural products based on toxicological assessments

Catalog Description

The discipline specific course "natural product and toxicology" is a practical paper which has been designed to provide the knowledge of different aspects of natural product and toxicology. It will provide biochemical & molecular understanding of important processes in toxicology. Students will be able to understand biochemical aspects of nutrition and toxicology.

Course Content

1. Estimation of vitamins, polyphenols, flavonoids etc.. (15 Lectures)
2. Estimation of minerals and heavy metals. (10 Lectures)
3. Estimation of adulterant in food stuffs. (10 Lectures)
4. Cell viability assay and vital staining. (15 Lectures)
5. Chemical mutagenesis analysis. (10 Lectures)
6. Profiling genotoxicity by commet assay (5 lectures)

SUGGESTED READINGS

1. A Practical Handbook of Food and Nutrition (2019): ISBN-9789387195660; Shivalik Prakashan.Jayashree Mishra and Pravabati Guru.

2. Practical Forensic Medicine and Toxicology: ISBN: 9789388178846, KK Banerjee.CBS Publishers & Distributors.(2019)

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

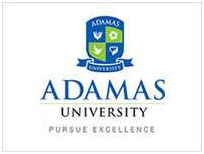
Components	Class Assessment	End Term
Weightage (%)	50	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	3	2	3	3	3	3	3	1	3	3	3
CO2	3	3	2	3	3	3	3	3	1	3	3	3
CO3	3	3	2	3	3	3	3	3	1	3	3	3
CO4	3	3	2	3	3	3	3	3	1	3	3	3
CO5	3	3	2	3	3	3	3	3	1	3	3	3
Avg	3	3	2	3	3	3	3	3	1	3	3	3

1=weakly mapped, 2= moderately mapped, 3=strongly mapped

Model Question Paper

Name: **Enrolment No:**	

Course: MIB22554- Natural products and toxicology LAB (PRACTICAL)
Program: M.Sc. Microbiology **Time: 03 Hrs.**
Semester: Even 2022-20 **Max. Marks: 50**

Instructions:
Attempt any **two** questions from **Section A** (each carrying 10 marks); **Section B** is Compulsory (carrying 10 marks)**.**

	Section A (Attempt **any Two)**		
1.	Write the principle of estimation of ascorbic acid. Perform the experiment.	**10**	**CO1** **CO2**
2.	Determine different adulterant in food stuffs.	**10**	**CO3** **CO4**
3.	a) Write the principle behind column chromatography. b)Demonstrate comet assay.	**4** **6**	**CO3** **CO2**
	SECTION B is compulsory		
4.	**Viva-voce** (U/An/Ap/R/Ev)	**10**	**CO1** **CO2** **CO3** **CO4** **CO5**
5.	**Practical copy**(U/Ap/Ev)	**10**	**CO1** **CO2** **CO3**

MIB21531	RESEARCH METHODOLOGY, BIOSTATISTICS AND GLP (THEORY)	L	T	P	C
Version 1.0	**Contact Hours - 45**	3	0	0	3
Pre-requisites/Exposure	Basic Knowledge of Biology, application of biotechnology in industry and concept of basic and applied research.				
Co-requisites	--				

Course Objectives

1. To provide the students with understanding of research and its types along with identification of problem for conducting research.
2. It will also deal with the research methodology and work plan to be adopted for conducting research.
3. To study the scope of Good Laboratory Practice as an integral part of research and industrial laboratory.
4. To get introduced to various forms of quality management system (QMS) applied for biotechnological research as well as allied industries.

Course Outcomes

On completion of this course,

1. **Recall** key terminologies and principles of research methodologies, biostatistics, and Good Laboratory Practice.
2. **Interpret** the role of study population, variables, and sampling in designing research.
3. **Use** biostatistical methods to determine the relationship between variables in a given dataset.
4. **Analyze** complex problems in a given research area and formulate a clear problem statement.
5. **Critically evaluate** statistical tests and **formulate** their applications

Catalogue Description

This course is designed to introduce the concept of research methodology to the students and provide them with understanding of research and its types along with identification of problem for conducting research. The concept of GLP will be dealt at par with international guidelines that is followed in various industries. The course will also introduce various forms

of quality management system (QMS) applied for biotechnological research as well as allied industries.

Course Content

RESEARCH METHODOLOGY, BIOSTATISTICS AND GLP (MIB21531)

Unit I **(3h)**
Introduction to research; Definitions and characteristics of research; Types of research; Main components of any research work.

Unit II **(2h)**
Problem identification; Criteria for prioritizing problems for research.

UNIT III **(5h)**
Analyzing the problem; Formulating the problem statement. Literature review: Uses of literature review; Definitions and Formulation of the research objectives**.**

UNIT IV **(5h)**
Research methodologies: Study population; Variables; Sampling; Sample size determination; Plan for data collection; Methods of data collection; Plan for data processing and analysis; Ethical considerations**.**

UNIT: V **(5h)**
Work Plan; Major components and outline of the different phases in a research process;
Summary of the major components of a research proposal; Fieldwork; Writing a research report.

UNIT: VI **(5h)**
Introduction to the WHO/TDR Handbook on GLP; Current Good Manufacturing Practices:
Introduction, US Cgmp Part 210 and Part 211.EC Principles of GMP (Directive 91/356/EEC) Article 6 to Article 14 and WHO cGMP guidelines GAMP-5; Medical device and IVDs Global Harmonization Task Force(GHTF) Guidance docs.

UNIT: VII **(5h)**
Introduction, USFDA GLP Regulations (Subpart A to Subpart K), Controlling the GLP inspection process, Documentation, Audit, goals of Laboratory Quality Audit, Audit tools, Future of GLP regulations, **relevant ISO and Quality Council of India(QCI) Standards,**

UNIT: VIII **(5h)**
Good Automated Laboratory Practices:
Introduction to GALP, Principles of GALP, GALP Requirements, SOPs of GALP, Training Documentation,21 CFR Part 11, General check list of 21CFR Part 11, Software Evaluation checklist, relevant ISO and QCI Standards.

UNIT: IX **(5h)**
Good Distribution Practices:
Introduction to GDP, Legal GDP requirements put worldwide, Principles,
Personnel, Documentation, Premises and Equipment, Deliveries to Customers, Returns, Self-Inspection, Provision of information, Stability testing principles, WHO GDP, USP GDP (Supply chain integrity), elevant CDSCO guidance and ISO standards

UNIT: X **(5h)**

Quality management systems:

Concept of Quality, Total Quality Management, Quality by design, Six Sigma concept, Out of Specifications (OOS), Change control. Validation: Types of Validation, Types of Qualification, Validation master plan (VMP), Analytical Method Validation. Validation of utilities, [Compressed air, steam, water systems, Heat Ventilation and Air conditioning (HVAC)]and Cleaning Validation. The International Conference on Harmonization (ICH) process, ICH guidelines to establish quality, safety and efficacy of drug substances and products, ISO 13485, Sch MIII and other relevant CDSCO regulatory guidance documents.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Class Assessment	End Term
Weightage (%)	50	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	3	2	3	3	-	-	3	-	-	1	3
CO2	3	3	2	3	3	-	-	3	-	-	1	3
CO3	3	3	2	3	3	-	-	3	-	-	1	3
CO4	3	3	2	3	3	-	-	3	-	-	1	3
CO5	3	3	2	3	3	-	-	3	-	-	1	3
Avg	3	3	2	3	3	-	-	3	-	-	1	3

1=weakly mapped, 2= moderately mapped, 3=strongly mapped

Model Question Paper

Name: **Enrolment No:**			
Course: MIB21531– DSE:II: RESEARCH METHODOLOGY, BIOSTATISTICS AND GLP **Program: M.Sc. Biotechnology** **Time: 03 Hrs.** **Semester: III (Odd 2021-22)** **Max. Marks: 50** **Instructions:** Attempt any **four** questions from **Section A** (each carrying 5 marks); all questions from **Section B** (each carrying 10 marks)**.**			
SECTION A (Attempt any **four questions)**			
1.	**Define** Research and Mention its types (R)	**2+3**	**CO1**
2.	**How** is a journal graded? Comment on its limitation. (U)	**3+2**	**CO2**
3.	Write a short note on PDCA (R)	**5**	**CO3**
4.	**Mention** the ISO applicable to a food industry. Justify (U)	**5**	**CO4**
5.	What is sampling in research? **Mention** the role of sample size in a survey. (R,U)	**5**	**CO1,CO2**
6.	**Mention** the steps of drug discovery. Justify each step (U)	**5**	**CO4**
	SECTION B (Attempt all **questions)**		
7.	**Comment** on the status if India in research. **Explain** the role of Literature Review in conducting research. Identify two problems of present time that require research: Justify (U, An)	**3+3+4**	**CO1, CO2**

8.	You wish to conduct a survey on the health condition of recovered COVID:19 patients. **Elaborate** your research plan. What are the ethical issues to be addressed while conducting research on human. Explain the role of GLP in a pharmaceutical industry. (U, An)	**4+3+3**	**CO2, CO3**
9.	Why is SOP necessary in a laboratory? **Classify** hazard. Design the HACCP chart of a food industry and as QC Microbiologist conduct analysis of any 2 steps. (U, Ap)	**2+2+6**	**CO3, CO4**

MIB21532	Pharmaceutical Microbiology	L	T	P	C
Version 1.0	Contact Hour: 45	3	0	0	3
Pre-requisites/Exposure	B.Sc. Microbiology or allied life sciences				
Co-requisites					

Course Objectives

Introduces students to the application of microbes in production of pharmaceutically active compounds. It discusses the role of microbiologists in pharmaceutical industries.

Course Outcomes

On completion of this course, the students will be able to

CO1. **Define** key terms related to antibiotics, synthetic antimicrobial agents, microbial resistance, and drug discovery in the context of pharmaceutical microbiology.

CO2. **Explain** the mechanisms of action of various antibiotics and synthetic antimicrobial agents, and describe how microbial resistance develops.

CO3. **Apply** knowledge of microbial resistance mechanisms to propose potential strategies for overcoming resistance in clinical or pharmaceutical settings.

CO4. **Analyze** case studies on the therapeutic effectiveness and limitations of antibiotics and synthetic antimicrobial agents in combating microbial infections.

CO5. **Critically evaluate** regulatory norms and **discuss** aspects for pharma.

Catalogue Description

This course will discuss strategies for cloning and expression of proteins, library construction, PCR strategies and troubleshooting, blotting techniques and recombinant gene expression systems. The course

Course Content

Pharmaceutical Microbiology (MIB21532)

Unit I Antibiotics and Synthetic antimicrobial agents (12 h)

Mechanism of action; microbial resistance; therapeutic, prophylactic usage and adverse reactions; Antibiotic and Synthetic antimicrobial agents: β- lactam, aminoglycosides, tetracyclines, macrolides. Antifungal antibiotics: Griseofulvin; Antiviral drugs: Amantidines; Nucleoside analogues, Interferons, Peptide antibiotics. Synthetic antibiotics: Sulphonamides;

Chloramphenicol; Quinolone.

Unit II Mechanism of action of antibiotics (12 h)

Inhibition of cell wall synthesis; nucleic acid and protein synthesis. Bacterial resistance to antibiotics; Penetration of antimicrobial agents (cellular permeability barrier, cellular transport system and drug diffusion). Mode of action of non–antibiotic antimicrobial agents; Mode of action of bacterial killing by quinolinones; Bacterial resistance to quionolinones; Molecular principles of drug targeting; Drug delivery system in gene therapy.

Unit III Drug Discovery and Development (12 h)

Microbial, Recombinant, Biochemical and Molecular level screening systems and their construction/ design strategies. Conventional Process; Bio-prospecting. Search of database/data mining for Drug designing; Preclinical and Clinical trials; Estimation of toxicity: LD50 and ED50; Rational Drug Design – Principle (Structure activity relationship -SAR) and

Tools (applications of High through Put Screening, Combinatorial synthesis, Pharmaco-genomics).

Unit IV Regulatory aspects in pharmaceuticals (9 h)

Introduction to pharmacopoeia; FDA regulation and IP, BP, USP; Reimbursement of drugs and biological; legislative perspectives; GMP in pharmaceuticals; Quality control through WHO; ICH process.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Class Assessment	End Term
Weightage (%)	50	50

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	3	2	3	3	-	-	3	-	-	1	3
CO2	3	3	2	3	3	-	-	3	-	-	1	3
CO3	3	3	2	3	3	-	-	3	-	-	1	3
CO4	3	3	2	3	3	-	-	3	-	-	1	3
CO5	3	3	2	3	3	-	-	3	-	-	1	3
Avg	3	3	2	3	3	-	-	3	-	-	1	3

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

1=weakly mapped, 2= moderately mapped, 3=strongly mapped

Model Question Paper

Name: **Enrolment No:**	

Course: MIB21532 –Pharmaceutical Microbiology
Program: M.Sc Microbiology **Time: 03 Hrs.**
Semester: III (Odd 2021-22) **Max. Marks: 40**

Instructions:

Attempt any four questions from **Section A** (each carrying 5 marks); all **Questions** from **Section B** (each carrying 10 marks)**.**

	Section A (Answer any four questions **)**		
1.	**Outline** the major targets of anti-HIV drugs. (U)	**5**	**CO1**
2.	**Why** physicians do not prescribe the antimicrobial agent with the largest zone of inhibition? Give two examples of side effects of antimicrobial agents. (An)	**5**	**CO1**
3.	**Contrast** between LD50 and ED50 (An)	**5**	**CO3**
4.	Briefly **explain** the role of SAR and QSAR in drug development. (U,An)	**5**	**CO2**
5.	Write short note on ADME profile (R)	**5**	**CO2**
6.	Can an antibiotic exhibit varied therapeutic potential in two populations?-explain (U)	**5**	**CO1**
	SECTION B (Attempt all **Questions)**		
7.	Schematically **outline** the major mechanisms of antimicrobial drugs with an example of each category. (R, U)	**10**	**CO1**
8.	Schematically **illustrate** the mechanisms by which antimicrobials target prokaryotic ribosomes to inhibit protein synthesis. (U)	**10**	**CO1**
9.	**Compare** and contrast between USP and IP. Outline the phases of clinical trials. (U, An)	**10**	**CO3**

MIB21555	Applied Toxicology (THEORY)	L	T	P	C
Version 1.0	Contact Hours - 45	3	0	0	3
Pre-requisites/Exposure	UG level knowledge of Biochemistry and Cell Biology				
Co-requisites	--				

Course Objectives

The study on toxic substances have clinical and environmental significance. From this course the students will identify various approaches of toxicity analysis and therapeutics.

Course Outcomes

On completion of this course, the students will be able to

CO1. **Recall** fundamental concepts of medical toxicology, including the mechanisms of toxicant action in human health.
CO2. **Explain** the clinical manifestations and treatment protocols for common toxic exposures.
CO3. **Utilize** medical toxicology principles to assess and manage real-life poisoning scenarios.
CO4. **Differentiate** between various toxicological responses based on exposure routes, dosage, and individual susceptibility.
CO5. **Critically evaluate** medical toxicology case studies to **develop** evidence-based decision-making in patient care.

Catalog Description

The elective course 'Applied Toxicology' will help to understand the scope and dimensions of toxicology. All the lectures will be devoted on discussions of basic theories and advanced topics, focusing on practical implementation of knowledge. Classes will be conducted by lecture as well as power point presentation, audio visual virtual lab session as per requirement. Students will perceive the basic concepts of the subject via exercise, case studies and discussions with the coordinator.

Course Content

UNIT-I Medical Toxicology: Mission of medical toxicology, Comparative toxicology, Human risk assessment, Toxicological database. Hepatic Toxicology Anatomy and physiology of the liver, Types of liver injury (acute and chronic), Hepatotoxic histological analysis of liver injury. Renal Toxicology Renal structure and functions, chemically induced renal, nephrotoxic potential of drugs and chemicals (with special reference to paraquat and amphotericin B) and their mechanism of action, histological analysis of renal injury.

Pulmonary Toxicology, Lung toxicants (silica, asbestos, acid fumes) and their effects (acute and chronic) in occupational toxicology, pulmonary diseases and dysfunction (Asthma, COPD, and Lung cancer) by inhaled toxicants, in vitro and in vivo assessment of pulmonary injury, histological characterization of pulmonary injury. Reproductive Toxicology- heavy metals and genotoxicity. Neuro-toxiity: Pesticide and heavy metal induced. Neurotoxic chemicals found in food, drugs and environment.

UNIT-II: Biochemical Toxicology: Fundamentals of Toxicology and Dose- Response Relationships , Factors Affecting Toxic Responses: Disposition , Factors Affecting Toxic Responses, Biochemical Mechanisms of Toxicity, Toxicokinetics- Absorption, distribution, and storage of toxic chemicals. Metabolism of a toxicant. Biotransformation and detoxification reactions- Phase l and Phase II. Genotoxicity: Mechanisms and Methods Introduction and Importance of genotoxicity studies, classification of carcinogens, Mechanism of genotoxicity, Standard test battery for genotoxicity, In-Vitro testing methods, Ames teat, Mammalian chromosome aberration test, In-Vivo genotoxicity testing methods: Laddering and tunnels assay, comet assay, micronuclei test.

UNIT III: Food and cosmetic toxicology: Food adulterants, contaminants and Food additives toxicity Agricultural and industrial contaminants in foods (pesticides residues in fruits and vegetables, metal contaminants such as lead, arsenic and mercury in foods), Food additives and its mode of action in packed food, classification and mechanism of toxicity of food additives with special reference to BHT (Butylated hydroxyl toluene) and BHA (Butylated hydroxyl anisole), Toxicants in food Enzyme inhibitors, antivitamins, glycoalkaloids, saponins, goitrogens, teratogens. Mycotoxins -Aflatoxin B1 and its metabolism, toxicity and preventive measures Food borne bacterial illness with reference to Staphylococcus aureus and Bacillus cerus. Cause, Treatment and prevention of food allergies- marine foods. Cosmetic toxicity Cosmetic induced disorders. Defense mechanism of skin against UV radiation, Agencies role in launching a cosmetic finish product, Toxicity of shampoos, conditioners, bleachers and dyes, Toxicities evaluation of cosmetic products.

UNIT- IV: Environmental toxicology: Pesticide Toxicity Classification and use of and toxicity of major groups of pesticides, Herbicide toxicity and toxicity of major groups of herbicides. Biomagnification of pesticides. Method of analysis. Heavy Metal Toxicity: Acute and Chronic Toxicity of Metals, Lead, Mercury, Arsenic, Cadmium, Chromium, Mechanism of heavy metal toxicity, Heavy Metal Toxicity Pathway, Oxidative damage by heavy metals, Genotoxicity of heavy metals, Ecotoxicology of Metals. Toxicology of Chemical Warfare Agents Chemical weapons, management of chemical warfare agents.

UNIT-V: Analytical toxicology: Qualitative Descriptions of Toxicity Exposure Limits Determination of LD50 and ED50, Units in Toxicology. Analysis of pesticides by Chromatography Method. Analysis of heavy metals by Spectrophotometric Methods. Determination of heavy metals by Atomic Absorption Spectrophotometer. Determination of heavy metals by Atomic Emission Spectrophotometer, Inductively Coupled Plasma Spectrophotometers, Determination of drug of abuse. Estimating genotoxicity: Immunoassay Techniques: ELISA.

Textbook:

P.K. Gupta, Fundamentals of toxicology, ELSEVIER 2016

Reference books:

Text book of modern toxicology, Ernest Hodgson, WILEY, 2004

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination Examination Scheme:

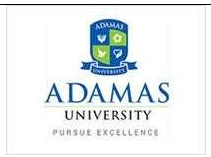
Components	Class Assessment	End Term
Weightage (%)	50	40

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	3	2	3	3	-	-	3	-	-	1	3
CO2	3	3	2	3	3	-	-	3	-	-	1	3
CO3	3	3	2	3	3	-	-	3	-	-	1	3
CO4	3	3	2	3	3	-	-	3	-	-	1	3
CO5	3	3	2	3	3	-	-	3	-	-	1	3
Avg	3	3	2	3	3	-	-	3	-	-	1	3

1=weakly mapped
2= moderately mapped
3=strongly mapped

Model Question Paper

Name: **Enrolment No:**	

Course: MIB22555 – APPLIED TOXICITY (THEORY)
Program: M. Sc. (Microbiology) **Time: 3Hrs.**
Semester: Odd **Max. Marks:50**

Instructions:
Attempt any **four** questions from **Section A** (each carrying 5 marks); any **two** questions from **Section B** (each carrying 10 marks)**.**

SECTION A (Attempt any Four questions) (5X4=20) (5X4=20)			
1.	**Analyze** arsenic toxicity.	**An**	**CO1**
2.	**Explain** why toxicological data base is required. .	**U**	**CO2**
3.	**Illustrate** why do proteins folding gets affected by heavy metals.	**R**	**CO3**
4.	**Describe** the use of Next Generation Sequencing (NGS) technology in determining genotoxicity	**U**	**CO4**
5	**Develop** a mass spectrometry-based toxin analysis protocol.	**AP**	**CO5**
	SECTION B (Attempt any Two questions) (10X2=20)		
6.	Elaborate major groups of pesticides and explain their toxicity? How do herbicide recognize affect crop quality? Comprehend herbicide resistance as potential environmental hazard. **3+2+5**	**U**	**CO3**
7.	Describe biomagnification and detoxification. Why amphotericin B elicits nephrotoxicity? Elaborate laws for chemical decontamination. **2+4+4**	**U,AN**	**CO1** **CO2**
8.	What is allowed region in Ramachandran plot? Which amino acid residue can occupy the greatest area in a Ramachandran plot? Identify the purpose of a Ramachandran plot. **Illustrate** the role of glycoprotein in cell membrane. **2+1+3+4**	**AN,AP, U**	**CO3**

9	Define and classify poisons? How presence of a posison can be detected in a food sample? Elaborate heavy metal oxicity. **2+1+3+4+1+5+3**	**AN,AP, U**	**CO4** **CO5**

MIB21556	Environmental Toxicology (THEORY)	L	T	P	C
Version 1.0	Contact Hours - 45	3	0	0	3
Pre-requisites/Exposure	UG level knowledge of Biochemistry and Cell Biology				
Co-requisites	--				

Course Objectives

The study on toxic substances environmental significance. From this course the students will identify various approaches of toxicity analysis and therapeutics.

Course Outcomes

On completion of this course, the students will be able to

CO1. **Recall** the definitions of bioaccumulation and biomagnification in the context of environmental pollutants.
CO 2. **Explain** how biotransformation and detoxification mechanisms protect organisms from pesticide toxicity.
CO 3. **Demonstrate** the application of biomagnification principles by evaluating toxin levels in aquatic food chains.
CO 4. **Analyze** the toxicological effects of pesticides, food additives, and cosmetics on human health and the environment.
CO 5. **Critically evaluate** the occupational exposure risks to toxic substances and **propose** safety measures for workers in industries.

Catalog Description

The elective course 'Environmental Toxicology' will help to understand the scope and dimensions of toxicological aspects of environmental studies. All the lectures will be devoted on discussions of basic theories and advanced topics, focusing on practical implementation of knowledge. Classes will be conducted by lecture as well as power point presentation, audio visual virtual lab session as per requirement. Students will perceive the basic concepts of the subject via exercise, case studies and discussions with the coordinator.

Course Content

Unit-I Introduction to environmental toxicology, Hazardous substances in environment sources. Properties of toxic chemical influencing their distribution and accumulation. Bioaccumulation and biomagnifications. Toxicokinetics- Absorption, distribution, and storage of toxic chemicals. Metabolism of a toxicant. Biotransformation and detoxification reactions- Phase l and Phase II.

UNIT- II Pesticide Toxicity- Pesticide management, Toxic effects of pesticides: Pyrethroids, DDT, Organophosphate pesticides, Cyclodienes, Lindane, Carbamate, Method of analysis. Herbicide Toxicity- Herbicide Selectivity, mode of action, Benzoic acids (dicamba), Pyridines (picloram), Paraquat, Triazines (atrazine, cyanazine), Sulfonylureas (chlorsulfuron, tribenuron), Aryloxyphenoxypropionates (diclofop), Isoxamolidinones (clomazone). Heavy Metal Toxicity Acute and Chronic Toxicity of Metals, Lead, Mercury, Arsenic, Cadmium, Chromium, Mechanism of heavy metal toxicity, Genotoxicity of heavy metals, Ecotoxicology of Metals . Heavy Metals in Medicine. Methods of analysis.

UNIT-III: Food toxicology: adulterants, contaminants and Food additives toxicity Agricultural and industrial contaminants in foods (pesticides residues in fruits and vegetables, metal contaminants such as lead, arsenic and mercury in foods), Food additives and its mode of action in packed food, classification and mechanism of toxicity of food additives with special reference to BHT (Butylated hydroxyl toluene) and BHA (Butylated hydroxyl anisole), Toxicants in food Enzyme inhibitors, antivitamins, glycoalkaloids, saponins, goitrogens, teratogens. Mycotoxins -Aflatoxin B1 and its metabolism, toxicity and preventive measures Food borne bacterial illness with reference to Staphylococcus aureus and Bacillus cerus.

UNIT-IV: Cosmetic toxicity: Cosmetic induced disorders such as acne, pruritis, nodules, papules etc. Defense mechanism of skin against UV radiation, Agencies role in launching a cosmetic finish product, Toxicity of shampoos, conditioners, bleachers and dyes, Toxicities evaluation of cosmetic products.

Unit- V Occupational toxicology: Occupational Hazards; Occupational Exposure, Occupational Disease; Occupational Dermatitis, Chloracne, Occupational Lung Diseases; COPD, Silicosis, Asbestosis, Asthama. Hazardous chemical substances and risk assessment of environmental chemical exposure. Rules and regulation governing release of hazardous chemicals into the environment.

Textbook:

P.K. Gupta, Fundamentals of toxicology, ELSEVIER 2016

Reference books:

Text book of modern toxicology, Ernest Hodgson, WILEY, 2004

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

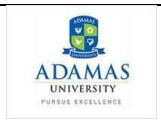
Components	Class Assessment	End Term
Weightage (%)	50	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	3	2	3	3	-	-	3	-	-	1	3
CO2	3	3	2	3	3	-	-	3	-	-	1	3
CO3	3	3	2	3	3	-	-	3	-	-	1	3
CO4	3	3	2	3	3	-	-	3	-	-	1	3
CO5	3	3	2	3	3	-	-	3	-	-	1	3
Avg	3	3	2	3	3	-	-	3	-	-	1	3

1=weakly mapped
2= moderately mapped
3=strongly mapped

Model Question Paper

Name: **Enrolment No:**	

Course: MIB21556 – ENVIRONMENTAL TOXICOLOGY (THEORY)
Program: M. Sc. (Microbiology) **Time: 03Hrs.**
Semester: Odd **Max. Marks:50**

Instructions:
Attempt any **four** questions from **Section A** (each carrying 5 marks); any **two** questions from **Section B** (each carrying 10 marks)**.**

SECTION A (Attempt any Four questions) (5×4=20) (5×4=20)

1.	**Analyze** arsenic toxicity.	**An**	**CO1**
2.	**Explain** why toxicological data base is required. .	**U**	**CO2**
3.	**Illustrate** why do proteins folding gets affected by heavy metals.	**R**	**CO3**
4.	**Describe** the use of Next Generation Sequencing (NGS) technology in determining genotoxicity	**U**	**CO4**
5	**Develop** a mass spectrometry-based toxin analysis protocol.	**AP**	**CO5**
	SECTION B (Attempt any Two questions) (10×2=20)		
6.	Elaborate major groups of pesticides and explain their toxicity? How do herbicide recognize affect crop quality? Comprehend herbicide resistance as potential environmental hazard. **3+2+5**	**U**	**CO3**
7.	Describe biomagnification and detoxification. Why amphotericin B elicits nephrotoxicity? Elaborate laws for chemical decontamination. **2+4+4**	**U,AN**	**CO1** **CO2**
8.	Define and classify poisons? How presence of a posison can be detected in a food sample? Elaborate heavy metal toxicity. Elaborate oxidative damage induced by heavy metals **2+1+3+4+1+5+3+1+3+4**	**AN,AP, U**	**CO3**

MIB21557	Advanced Laboratory Diagnostics (THEORY)	L	T	P	C
Version 1.0	**Contact Hours - 45**	3	0	0	3
Pre-requisites/Exposure	UNDERSTANDING OF BASIC LEVEL OF BIOLOGY				
Co-requisites	A Bachelor's degree in any branch of Life Sciences / Technology				

Course Objectives

1. To familiarize students with molecular diagnostic technologies,
2. To increase students' intuition and understanding of computational methods used to analyze molecular diagnostic data
3. To build students' abilities to interpret molecular diagnostic testing and to integrate results into clinical decision making
4. Build skills in appropriately choosing and evaluating diagnostic tests for patients

Course Outcomes

On completion of this course, the students will be able to

1. **Recall** the principles of biomarkers and their application in disease diagnostics.
2. **Explain** the relationship between chromosomal abnormalities and human disorders.
3. **Apply** cytogenetic analysis techniques to identify chromosomal mutations linked to specific genetic disorders.
4. **Differentiate** between various nucleic acid-based diagnostic methods (e.g., PCR, qPCR, sequencing) and evaluate their roles in disease detection.
5. Critically **assess** the use of omics technologies (genomics, proteomics, metabolomics) and **design** AI in the advancement of diagnostic tools.

Catalog Description

Diagnosis of disease has become a more precise science involving a combination of genetic, proteomic and biochemical tools. Understanding of these multi-disciplinary areas is essential for the diagnostic service industry. The course is designed to teach the technology, theory and practical approaches of molecular genetic methods to the diagnosis and understanding of human disease. Students would be taught scientific approaches to identify molecular biomarkers, develop and validate diagnostic assays.

Course Content

Advanced laboratory diagnostics (MIB22557)

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Unit 1: Biomarkers in disease diagnostics:(16 hours)
History of diagnostics, Age of molecular diagnostics, Significance, Scope, Rise of diagnostic industry in Indian and global scenario. FDA definition of disease markers, Role of markers in Disease diagnosis. Approaches and methods in the identification of disease markers, predictive value, diagnostic value, emerging blood markers for sepsis, tumor & cancer markers, markers in inflammation, and diagnosis of cytoskeletal disorders. Diagnostic pathology, immune pathology, and immunohistopathology. Detection & differentiation of pathogens – bacterial, viral, fungal, zoonotic, protozoan, Drug susceptibility testing, drug resistance testing, Point of care testing, Cellular and functional genomics in diagnostics. Routine blood & urine analysis, enzyme assays - liver function tests, cell-free biopsies, non-invasive testing.

Unit 2:Chromosomes, Human disorders, and Cytogenetic analysis:(10 hours)
Chromosome banding and nomenclature; GC and AT rich isochores. Structural and Numerical aberrations and their consequences. Sex determination Uniparental disomy, Genomic Imprinting and disorders. FISH, CGH, Flow cytometry techniques, and clinical diagnostics. Common fragile sites and methods of induction, Heritable fragile sites, and FXS. Pedigree analysis with genetic markers, and overview of the human genome project.

Unit 3: Immunodiagnostic techniques:(4 hours)
Introduction, Radioactive isotopes, DNA reporters, fluorogenic reporters, electro-chemiluminescent tags & label-free immunoassays. Immunoassays – precipitation, agglutination hemagglutination, RIA, ELISA, RIA, MELISA, and specific applications. Quantum dots. Immunohistochemistry – principle, and techniques.

Unit 4: Nucleic acids-based diagnostics (12 hours)
Nucleic acid analysis technologies: PCR Principle, procedure, types, and applications. cDNA synthesis and cloning, DNA primers, linkers, adapters, cDNA library construction, and screening. DNA fingerprinting, chromosome walking, and chromosome jumping. RFLP maps, RAPD, Microsatellites, SCAR (Sequence characterized amplified region), DNA sequencing methods, Next-generation sequencing (NGS). Hybridization techniques: Principle of hybridization. Southern, Northern, in-situ Hybridization. Whole Genome analysis, DNA microarray. Gene mapping and applications. Transcriptome and Proteome analysis. Protein microarrays. Advantages and disadvantages of DNA and protein microarrays.

Unit 5: Omics and AI in Diagnostics (3 hours)
Role of transcriptomic, proteomic, and metabolomic profiles as diagnostic markers. Use of AI in diagnostics.

Textbooks:
1. Principles of Biochemistry (Lehninger) (5th edition), MM Cox and DL Nelson, CBS Publishers.

2. Genomes (3rd edition) TA Brown, Wiley-Liss Publications.
3. Kuby Immunology (6th edition) Thomas J Kindt, Richard A Goldsby WH Freeman & Co.
4. Human Chromosomes by Miller & Tharman, Springer Publishing Company
5. Animal cell culture: Ian Freshney

Reference:

1. Biochemistry (4th edition): D Voet and JE Voet, 2011 John Wiley and Sons.

2. Principles of Immunology and Immunodiagnostics, Ralph Michael Aloisi. Lippincott Williams and Wilkins

3. Ringsrud, Karen Munson; Linné, Jean Jorgenson Linné & Ringsrud's Clinical laboratory science: the basics and routine techniques Turgeon, Mary L.5ISBN:0-323-03412-8

4. Molecular Cell Biology, (6th edition) Harvey Lodish, Arnold Berk, Paul Matsudaira, Chris A. Kaiser, Monty Krieger, Matthew P. Scott, Lawrence Zipursky, and James Darnell. WH Freeman Publication

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	Class Assessment	End Term
Weightage (%)	50	50

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	3	2	3	3	-	-	3	-	-	1	3
CO2	3	3	2	3	3	-	-	3	-	-	1	3
CO3	3	3	2	3	3	-	-	3	-	-	1	3
CO4	3	3	2	3	3	-	-	3	-	-	1	3
CO5	3	3	2	3	3	-	-	3	-	-	1	3
Avg	3	3	2	3	3	-	-	3	-	-	1	3

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

1=weakly mapped

2= moderately mapped

3=strongly mapped

Model Question Paper

	ADAMAS UNIVERSITY **END-SEMESTER EXAMINATION**		
Name of the Program:	M.Sc. (Microbiology)	**Semester:**	III
Course/Subject Name:	Advanced Laboratory Diagnostics	**Course/Subject Code:**	MIB21557
Maximum Marks:	50	**Time Duration:**	180 Minutes
Total No. of Questions:	**12**	**Total No of Pages:**	1
(Any other information for the student may be mentioned here)	**1.** At top sheet, clearly mention Univ. Roll No., Enrolment No., Course Name & Code, Date of Exam. **2.** All parts of a Question should be answered consecutively. Each Answer should start from a fresh page. **3.** Assumptions made if any, should be stated clearly at the beginning of your answer.		

Group A **Answer All 5 Questions (5 x 2 = 10)**			
		Knowledge Level (BL1-6)	**Course Outcome (CO1-5)**
1	Which one of the following is an enzyme that is considered the most tissue specific?A) Creatine kinase (CK).B) Alcohol dehydrogenase.C) Amylase.D) Alkaline phosphatase (ALP).E) Topoisomerase.	**L2**	**CO1**
2	Differentiate between linkers and adapters.	**L1**	**CO2**
3	What is Philadelphia chromosome?	**L3**	**CO3**
4	What is centromere?	**L4**	**CO4**
5	What is karyotyping?	**L5**	**CO4**
Group B **Answer All 5 Questions (5 x 4 = 20)**			
6	Discuss the roles of fluorogenic reporters in diagnostics.	**L1**	**CO1**
7	What is the role of annealing temperature in PCR?	**L2**	**CO2**
8	Briefly discuss about G bands.	**L3**	**CO1**

9	What is Multiplex Fish (M-FISH)?	**L3**	**CO2**
10(a)	What are the types of chromosomal changes related to cancer.	**L6**	**CO4**
10(b)	How can you sort chromosome using flow cytometry?	**L6**	**CO4**
Group C **Answer All 2 Questions (2 x 10 = 20)**			
11(a)	Discuss a method to detect chromosomal deletion. (5) What are the role of melting temperature of primers in PCR? (5)	**L3**	**CO3**
11(b)	What is the role of restriction enzymes in chromosomal analysis? (5) How can you detect aneuploidy? (5)	**L2**	**CO3**
12(a)	Describe a chromosome using ISCN Mapping System. (5) Differentiate between oncogenes and tumour suppressor genes. (5)	**L4/5**	**CO5**
12(b)	Discuss briefly about cytopathic effect. (5) Discuss the role of DNA probes in diagnostics. (5)	**L4/5**	**CO5**

MIB21558	Biomedical Nanotechnology (THEORY)	L	T	P	C
Version 1.0	Contact Hours - 45	3	0	0	3
Pre-requisites/Exposure	UG level knowledge of Chemistry and Biology				
Co-requisites	--				

Course Objectives

This course will focus on micro- and nanotechnology and its uses in the biomedical sciences. The future of nanomedicine and its significance in medical diagnostics, the development of molecular manufacturing, molecular transport, and nanosensors for use in the medical field like tissue engineering, medical implants, and many other topics will be explored. This course teaches that more advancement in this field is predicted to bloom in the years to come and aid in the creation of the most cutting-edge, life-saving medical treatments. Thus, the main objective of this course is to impart knowledge on biomedical applications of nanotechnology.

Course Outcomes

On completion of this course, the students will be able to

CO1 Students will be able to **identify** the principles of green synthesis in the context of biomedical nanotechnology.
CO2 Students will be able to **summarize** the principles and techniques involved in the characterization of nanomaterials.
CO3 Students will be able to **utilize** nanotoxicology assessments to evaluate the safety and efficacy of nanomaterials in biological systems.
CO4 Students will be able to critically **evaluate** the challenges and opportunities in using nanomaterials for cancer therapy.
CO5 Students will be able to **judge** the potential benefits and drawbacks of protein and glyco nanotechnology to **improve** drug delivery and therapeutics.

Catalogue Description

A broad range of disciplines are involved in the fast evolving field of biomedical nanotechnology. In practically every discipline, nanotechnology applications are receiving a resoundingly positive reaction. Significant advancements have been made, particularly in the healthcare industry. For instance, the detection and treatment of cancer, medical implants, tissue engineering, etc. The advancements in this discipline are anticipated to blossom in the upcoming years and result in a number of life-saving medical innovations and treatment approaches.

Therefore, each student who takes this course learns about nanotechnology and its application in the medical field.

Course Content

Unit 1: Introduction to nanoscience and nanotechnology, Cellular nanostructures, Nano biomimetic, Physical, chemical and greensynthesis of nanomaterials. (**5 hours**)

Unit 2: Characterization of nanomaterials: Transmission Electron Microscopy (TEM), Scanning Electron Microscopy (SEM), Dynamic Light Scattering (DLS), X-ray Diffraction (XRD), Fourier Transform Infrared Spectroscopy (FTIR), UV-Vis Spectroscopy (**10 hours**)

Unit 3: DNA nanotechnology, Protein & glyco nanotechnology, Lipid nanotechnology, Bio-nanomachines, Concept on carbon nanotubes, fullerenes, carbon dot, dendrimers and their bio-applications. (**10 hours**)

Unit 4: Nanomaterials for cancer diagnosis, Nanomaterials for cancer therapy, Nanotechnology in tissue engineering, Nano artificial cells, Nanotechnology in organ printing. (**10 hours**)

Unit 5: Nanotechnology in point-of-care diagnostics, Nanopharmacology & drug targeting, Cellular uptake mechanisms of nanomaterials, *In vitro* methods to study antibacterial and anticancer properties of nanomaterials, Nanotoxicology. (**10 hours**)

Text books:

1. Malsch, N.H., "Biomedical Nanotechnology", CRC Press. (2005).
2. Mirkin, C.A. and Niemeyer, C.M., "Nanobiotechnology II: More Concepts and Applications", Wiley-VCH. (2007).
3. Kumar, C. S. S. R., Hormes, J. and Leuschner C., "Nanofabrication towards Biomedical Applications: Techniques, Tools, Applications, and Impact", WILEY-VCH Verlag GmbH & Co. (2005).
4. Lamprecht, A., "Nanotherapeutics: Drug Delivery Concepts in Nanoscience", Pan Stanford Publishing Pte. Ltd. (2009).

Reference books:

1. Jain, K.K., "The Handbook of Nanomedicine", Humana press. (2008).
2. M. Ferrari, A. P. Lee, and J. Lee., Biological and Biomedical Nanotechnology, Springer, 2006.
3. Nanotechnology in Biomedical Engineering Abhinaya Nellerichale LAP-Lambert Academic Publishing,Mauritius. ISBN: 978-613-9-83115-9 2F0ir0s5t Edition, 2018.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Mid Term	Class Assessment	End Term
Weightage (%)	20	30	50

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	3	2	3	3	-	-	3	-	-	1	3
CO2	3	3	2	3	3	-	-	3	-	-	1	3
CO3	3	3	2	3	3	-	-	3	-	-	1	3
CO4	3	3	2	3	3	-	-	3	-	-	1	3
CO5	3	3	2	3	3	-	-	3	-	-	1	3
Avg	3	3	2	3	3	-	-	3	-	-	1	3

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

1=weakly mapped
2= moderately mapped
3=strongly mapped

Model Question Paper

Name: **Enrolment No:**	

Course: MIB21558 - BIOMEDICAL NANOTECHNOLOGY (THEORY)
Program: M.Sc. (Microbiology) **Time: 03 Hrs.**
Semester: Odd (2022-23) **Max. Marks: 50**
Instructions:
Attempt any **four** questions from **Section A** (each carrying 5 marks); any **three** questions from **Section B** (each carrying 10 marks)**.**

SECTION A (Attempt **any Four questions)**			
1.	How do nanoscale structures and interfaces affect the interactions between biomaterials and living systems, and how can this knowledge be leveraged to improve biocompatibility and performance in biomedical applications? (An)	**5**	**CO1**
2.	How can X-ray diffraction (XRD) analysis be used to determine the crystal structure, phase purity, and crystallite size of nanomaterials?(E)	**5**	**CO2**
3.	How can protein and glyco-nanomaterials be engineered to enhance drug delivery, targeting specific cells or tissues, and improve therapeutic efficacy?(U)	**5**	**CO3**
4.	How can nanomaterial-based imaging probes enable multimodal imaging, combining different imaging techniques for comprehensive cancer diagnosis?(An)	**5**	**CO4**
5.	How can carbon dots be employed as nanoscale sensors or biosensors for the detection and monitoring of biomolecules or disease markers?(E)	**5**	**CO5**
6.	What are the mechanisms by which nanomaterials can be used for targeted drug delivery to tumor sites, improving therapeutic efficacy while minimizing off-target effects?(U)	**5**	**CO5**
	SECTION B (Attempt any **Three questions)**		

7.	What are the strategies for utilizing nanomaterials to mimic the native extracellular matrix and create biomimetic microenvironments for tissue regeneration?s(R, An)	**5+5**	**CO3**
8.	What are the ethical considerations associated with the development and use of biomimetic nanotechnologies, particularly in areas such as nanomedicine or environmental applications? What are the advantages and limitations of electron microscopy techniques (TEM and SEM) in characterizing nanomaterials, and how can they provide information about particle size, shape, and crystal structure?(U, E)	**5+5**	**CO1** **CO2**
9.	What are the challenges and considerations in the large-scale production and purification of protein and glyco-nanomaterials for commercial and biomedical applications?What are the potential toxicological effects of carbon nanotubes, fullerenes, carbon dots, and dendrimers in biological systems, and how can these concerns be addressed for safe use in bio-applications?(U, An)	**5+5**	**CO3**
10.	How can nanotechnology be applied to develop smart, responsive scaffolds that interact with cells and the surrounding environment for improved tissue regeneration? What are the techniques and methodologies employed in nanotoxicology research to assess the cytotoxicity, genotoxicity, and immunotoxicity of nanomaterials?(E, An)	**5+5**	**CO4** **CO5**

MIB24535	Industry Internships	L	T	P	C
Version 1.0		0	0	0	2
Pre-requisites/Exposure	Basic skill of microbiology				
Co-requisites	-				

Course Objectives

1. To provide students the opportunity to test their interest in a particular career before permanent commitments are made.
2. To develop skills in the application of theory to practical work situations.
3. To develop skills and techniques directly applicable to their careers.
4. Internships will increase a student's sense of responsibility and good work habits.
5. To expose students to real work environment experience gain knowledge in writing report in technical works/projects.

Course Outcomes

On completion of this course, the students will be able to

CO1: **Demonstrate** a growing interest in industry-specific practices by actively engaging in workplace tasks and reflecting on career opportunities.
CO2: **Relate** academic knowledge to practical tasks in the workplace by applying theoretical concepts to solve industry-specific problems.
CO3: **Exhibit** proficiency in essential industry skills by performing tasks accurately under real-world conditions.
CO4: **Display** responsibility and professionalism by managing time effectively, adhering to workplace ethics, and completing assigned duties consistently.
CO5: **Apply** and **improve** effective communication techniques by delivering technical reports, presentations, and documentation to industry standards.

Catalogue Description

The purpose of Industrial Internship is to expose students to real industry experience and also to gain the knowledge through hands on observation and job execution. From the industrial training, the students will also develop skills in work ethics,

communication, management and others. Moreover, this practical training program allows students to relate theoretical knowledge with its application in the industry.

Course Content

Industry Internship (MIB24532)

1. Visit industry or labs or research institutes related to Microbiology or allied life sciences and gain hands on experience related to practical work.

Modes of Evaluation: Quiz/Assignment/ presentation/ Extempore/ Written Examination
Examination Scheme:

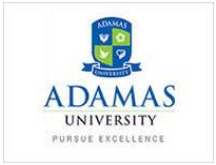
CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	3	3	1	3	3	3	3	3	-	-	3
CO2	3	3	3	1	3	3	3	3	3	-	-	3
CO3	3	3	3	1	3	3	3	3	3	-	-	3
CO4	3	3	3	1	3	3	3	3	3	-	-	3
CO5	3	3	3	1	3	3	3	3	3	-	-	3
Avg	3	3	3	1	3	3	3	3	3	-	-	3

Components	Report	Presentation
Weightage (%)	50	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

1=weakly mapped, 2= moderately mapped, 3=strongly mapped

Model Question Paper

Name: **Enrolment No:**	

Course: MIB245352–Industry Internship
Program: M.Sc Microbiology **Time: 01 Hrs.**
Semester: III (Odd 2021-22) **Max. Marks: 50**

Presentation on the industry/ Lab experience

MIB22572	Professional Development Course-3 (Practical)	L	T	P	C
Version 1.0	Contact Hours - 30	0	0	1	1
Pre-requisites/Exposure	PLUS B.SC LEVEL SCIENCE				
Co-requisites	--				

Catalog Description: This professional development course aims to help you discover and achieve your goals by focusing on organization and action. You'll learn techniques to enhance goal-setting, communication, self-motivation, and a positive attitude, empowering you to maximize your performance both academically and professionally.

Course Syllabus:

The syllabus for Professional Development Course-I for senior students (1st Semester- 3rd Semester for P.G students)

1. Introduction to Pre-Placement Training.
2. Resume Building & Cover Letter Writing.
3. Interview Skills.
4. Aptitude and Technical Skills.
5. Group Discussion and Communication Skills.
6. Personal Branding and Online Presence.
7. Professional Skills.
8. Industry Insights and Company Presentations.
9. Career Guidance for competitive entrance exams and Job Search Strategies
10. Mock Tests and Assessments.

Course learning outcomes:

CO1: **Identify** the components of an effective resume and cover letter for job applications

CO2: **Explain** the importance of developing aptitude skills for placement tests..

CO3: **Interpret** the results of aptitude tests and identify areas for improvement.

CO4: **Participate** in mock interviews to improve interview skills and confidence.

CO5: **Critically** assess personal interview performance and identify areas for development.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	CA	End Term

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	-	3	3	1	3	3	3	3	-	3	2	2
CO2	-	3	3	1	3	3	3	3	-	3	2	2
CO3	-	3	3	1	3	3	3	3	-	3	2	2
CO4	-	3	3	1	3	3	3	3	-	3	2	2
CO5	-	3	3	1	3	3	3	3	-	3	2	2
Avg	-	3	3	1	3	3	3	3	-	3	2	2

Weightage (%)	50	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

MIB25540	COMPREHENSIVE VIVA	L	T	P	C
Version 1.0		0	0	0	4
Pre-requisites/Exposure	Concept of Microbiology and allied subjects at UG and PG level				
Co-requisites	--				

Course Objectives

1. Defining and outlining a research area with a clear question
2. Identifying the leading issues
3. Sourcing the relevant information
4. Evaluating the evidence on all sides of a debate
5. Coming to a well-argued conclusion

Course Outcomes

On completion of this course, the students will be able to

CO1. **Explore** their knowledge during their interview for microbiology-related jobs.
CO2. **Interpret** their knowledge during their interview for microbiology-related research field.
CO3. **Develop** the skill to conclude a scientific fact.
CO4. **Discuss** about the biology data.
CO5. **Apply** and **improve** microbiological skills for societal development.

Catalogue Description

The objective of comprehensive viva-voce is to assess the overall knowledge of the student in the relevant field of Biotechnology acquired over 2 years of study in the postgraduate program

Course Content

1. Reading of Biotechnology Text books, very recent research papers from high impact journals containing biology research work and also performance of laboratory based research oriented experiments.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Viva
Weightage (%)	100

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	3	2	3	3	-	-	3	-	-	1	3
CO2	3	3	2	3	3	-	-	3	-	-	1	3
CO3	3	3	2	3	3	-	-	3	-	-	1	3
CO4	3	3	2	3	3	-	-	3	-	-	1	3
CO5	3	3	2	3	3	-	-	3	-	-	1	3
Avg	3	3	2	3	3	-	-	3	-	-	1	3

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

1=weakly mapped, 2= moderately mapped, 3=strongly map

Model Question Paper

Name: **Enrolment No:**	

Course: MIB25540 –Comprehensive Viva
Program: M.Sc Microbiology **Time: 01 Hrs.**
Semester: IV (Even 2022-22 **Max. Marks: 100**

Answer all asked questions

MIB25541	DISSERTATION	L	T	P	C
Version 1.0		0	0	6	15
Pre-requisites/Exposure	Concept of Microbiology and allied subjects at UG and PG level				
Co-requisites	--				

Course Objectives

1. This will enable students to design and evaluate scientific investigations

2. Students will learn to deduce evidence-based conclusions.

3. Skill of presentation and scientific content writing will be improved.

Course Outcomes

On completion of this course, the students will be able to

1. Students will be able to **compile** novel ideas to enrich their scientific interest, demonstrating innovation in formulating hypotheses and designing experiments in microbiology or biotechnology.
2. The students will be able to **use** their theoretical and practical knowledge to apply biotechnological and microbiological skills for the identification, culturing, and preservation of microorganisms important for industrial and research purposes.
3. Students will be able to **compare** different microbiological techniques and analyze experimental data, identifying patterns, correlations, and discrepancies in their results.
4. Students will **design** and evaluate scientific investigations, critically assessing the methodologies, results, and conclusions drawn from their experimental work.
5. Students will **learn to deduce** evidence-based conclusions, **discuss** their research findings and presenting them coherently in the context of current scientific literature.

Catalogue Description

The core-course of 'dissertation' will enable the students to nurture their research interest by compiling basic knowledge obtained in five years of their education together with novel ideas from contemporary research. An idea about appropriate application of microbiological and biotechnological skill for industrial and research purpose can be developed. With the potential to

design and evaluate scientific investigations the students will learn to comprehend conclusions based on experimental evidences. The entire literature review work and experimentation focuses on practical implementation of knowledge. Students will perceive the basic concepts of the subject via exercise and discussions with the mentor.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

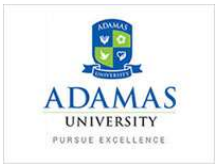
Components	**Report/Thesis submission**	**Presentation**

CO Number	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**
CO1	3	3	3	1	3	3	3	3	3	-	-	3
CO2	3	3	3	1	3	3	3	3	3	-	-	3
CO3	3	3	3	1	3	3	3	3	3	-	-	3
CO4	3	3	3	1	3	3	3	3	3	-	-	3
CO5	3	3	3	1	3	3	3	3	3	-	-	3
Avg	3	3	3	1	3	3	3	3	3	-	-	3

Weightage (%)	**50**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

1=weakly mapped, 2= moderately mapped, 3=strongly mapped

Name: **Enrolment No:**	
Course: MIB25541 –Comprehensive Viva **Program: M.Sc Microbiology** **Time: 01 Hrs.** **Semester: IV (Even 2022-22** **Max. Marks: 100**	
Attend the session and interact	

Composite CO-PO mapping M. Sc. (Microbiology) 2024-26

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
MIB21501												
CO1	3	3	2	3	3	-	-	3	-	-	1	3
CO2	3	3	2	3	3	-	-	3	-	-	1	3
CO3	3	3	2	3	3	-	-	3	-	-	1	3
CO4	3	3	2	3	3	-	-	3	-	-	1	3
CO5	3	3	2	3	3	-	-	3	-	-	1	3
MIB21503												
CO1	3	3	2	3	3	-	-	3	-	-	1	3
CO2	3	3	2	3	3	-	-	3	-	-	1	3
CO3	3	3	2	3	3	-	-	3	-	-	1	3
CO4	3	3	2	3	3	-	-	3	-	-	1	3
CO5	3	3	2	3	3	-	-	3	-	-	1	3
MIB21542												
CO1	3	3	2	1	3	-	-	3	-	-	-	3
CO2	3	3	2	1	3	-	-	3	-	-	-	3
CO3	3	3	2	1	3	-	-	3	-	-	-	3
CO4	3	3	2	1	3	-	-	3	-	-	-	3
CO5	3	3	2	1	3	-	-	3	-	-	-	3
MIB21543												
CO1	3	3	2	1	3	-	-	3	-	-	-	3
CO2	3	3	2	1	3	-	-	3	-	-	-	3
CO3	3	3	2	1	3	-	-	3	-	-	-	3
CO4	3	3	2	1	3	-	-	3	-	-	-	3
CO5	3	3	2	1	3	-	-	3	-	-	-	3
MIB22544												
CO1	3	3	2	3	3	3	3	3	1	3	3	-
CO2	3	3	2	3	3	3	3	3	1	3	3	-
CO3	3	3	2	3	3	3	3	3	1	3	3	-
CO4	3	3	2	3	3	3	3	3	1	3	3	-
CO5	3	3	2	3	3	3	3	3	1	3	3	-
MIB22545												
CO1	3	3	2	3	3	3	3	3	1	3	3	-
CO2	3	3	2	3	3	3	3	3	1	3	3	-
CO3	3	3	2	3	3	3	3	3	1	3	3	-
CO4	3	3	2	3	3	3	3	3	1	3	3	-
CO5	3	3	2	3	3	3	3	3	1	3	3	-
MIB21546												

CO1	3	3	2	1	3	-	-	3	-	-	-	3
CO2	3	3	2	1	3	-	-	3	-	-	-	3
CO3	3	3	2	1	3	-	-	3	-	-	-	3
CO4	3	3	2	1	3	-	-	3	-	-	-	3
CO5	3	3	2	1	3	-	-	3	-	-	-	3
MIB21509												
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CO2	3	3	2	3	3	-	-	3	-	-	1	3
CO3	3	3	2	3	3	-	-	3	-	-	1	3
CO4	3	3	2	3	3	-	-	3	-	-	1	3
CO5	3	3	2	3	3	-	-	3	-	-	1	3
MIB21511												
CO1	3	3	2	3	3	-	-	3	-	-	1	3
CO2	3	3	2	3	3	-	-	3	-	-	1	3
CO3	3	3	2	3	3	-	-	3	-	-	1	3
CO4	3	3	2	3	3	-	-	3	-	-	1	3
CO5	3	3	2	3	3	-	-	3	-	-	1	3
MIB21513												
CO1	3	3	2	3	3	-	-	3	-	-	1	3
CO2	3	3	2	3	3	-	-	3	-	-	1	3
CO3	3	3	2	3	3	-	-	3	-	-	1	3
CO4	3	3	2	3	3	-	-	3	-	-	1	3
CO5	3	3	2	3	3	-	-	3	-	-	1	3
MIB21515												
CO1	3	3	2	3	3	3	3	3	1	3	3	1
CO2	3	3	2	3	3	3	3	3	1	3	3	1
CO3	3	3	2	3	3	3	3	3	1	3	3	1
CO4	3	3	2	3	3	3	3	3	1	3	3	1
CO5	3	3	2	3	3	3	3	3	1	3	3	1
MIB22547												
CO1	3	3	2	3	3	3	3	3	1	3	3	-
CO2	3	3	2	3	3	3	3	3	1	3	3	-
CO3	3	3	2	3	3	3	3	3	1	3	3	-
CO4	3	3	2	3	3	3	3	3	1	3	3	-
CO5	3	3	2	3	3	3	3	3	1	3	3	-
MIB22514												
CO1	3	3	2	3	3	3	3	3	1	3	3	-
CO2	3	3	2	3	3	3	3	3	1	3	3	-
CO3	3	3	2	3	3	3	3	3	1	3	3	-
CO4	3	3	2	3	3	3	3	3	1	3	3	-
CO5	3	3	2	3	3	3	3	3	1	3	3	-

MIB22516												
CO1	3	3	2	3	3	3	3	3	1	3	3	-
CO2	3	3	2	3	3	3	3	3	1	3	3	-
CO3	3	3	2	3	3	3	3	3	1	3	3	-
CO4	3	3	2	3	3	3	3	3	1	3	3	-
CO5	3	3	2	3	3	3	3	3	1	3	3	-
MIB21517												
CO1	3	3	2	3	3	-	-	3	-	-	1	3
CO2	3	3	2	3	3	-	-	3	-	-	1	3
CO3	3	3	2	3	3	-	-	3	-	-	1	3
CO4	3	3	2	3	3	-	-	3	-	-	1	3
CO5	3	3	2	3	3	-	-	3	-	-	1	3
MIB21518												
CO1	3	3	2	1	3	-	-	3	-	-	-	3
CO2	3	3	2	1	3	-	-	3	-	-	-	3
CO3	3	3	2	1	3	-	-	3	-	-	-	3
CO4	3	3	2	1	3	-	-	3	-	-	-	3
CO5	3	3	2	1	3	-	-	3	-	-	-	3
MIB21519												
CO1	3	3	2	3	3	-	-	3	-	-	1	3
CO2	3	3	2	3	3	-	-	3	-	-	1	3
CO3	3	3	2	3	3	-	-	3	-	-	1	3
CO4	3	3	2	3	3	-	-	3	-	-	1	3
CO5	3	3	2	3	3	-	-	3	-	-	1	3
MIB21520												
CO1	3	3	2	1	3	-	-	3	-	-	-	3
CO2	3	3	2	1	3	-	-	3	-	-	-	3
CO3	3	3	2	1	3	-	-	3	-	-	-	3
CO4	3	3	2	1	3	-	-	3	-	-	-	3
CO5	3	3	2	1	3	-	-	3	-	-	-	3
MIB21521												
CO1	3	3	2	3	3	-	-	3	-	-	1	3
CO2	3	3	2	3	3	-	-	3	-	-	1	3
CO3	3	3	2	3	3	-	-	3	-	-	1	3
CO4	3	3	2	3	3	-	-	3	-	-	1	3
CO5	3	3	2	3	3	-	-	3	-	-	1	3
MIB21549												
CO1	3	3	2	3	3	-	-	3	-	-	1	3
CO2	3	3	2	3	3	-	-	3	-	-	1	3
CO3	3	3	2	3	3	-	-	3	-	-	1	3
CO4	3	3	2	3	3	-	-	3	-	-	1	3

CO5	3	3	2	3	3	-	-	3	-	-	1	3
MIB21550												
CO1	3	3	2	3	3	-	-	3	-	-	1	3
CO2	3	3	2	3	3	-	-	3	-	-	1	3
CO3	3	3	2	3	3	-	-	3	-	-	1	3
CO4	3	3	2	3	3	-	-	3	-	-	1	3
CO5	3	3	2	3	3	-	-	3	-	-	1	3
MIB21551												
CO1	3	3	2	3	3	-	-	3	-	-	1	3
CO2	3	3	2	3	3	-	-	3	-	-	1	3
CO3	3	3	2	3	3	-	-	3	-	-	1	3
CO4	3	3	2	3	3	-	-	3	-	-	1	3
CO5	3	3	2	3	3	-	-	3	-	-	1	3
MIB21526												
CO1	3	3	2	3	3	-	-	3	-	-	1	3
CO2	3	3	2	3	3	-	-	3	-	-	1	3
CO3	3	3	2	3	3	-	-	3	-	-	1	3
CO4	3	3	2	3	3	-	-	3	-	-	1	3
CO5	3	3	2	3	3	-	-	3	-	-	1	3
MIB21528												
CO1	3	3	2	3	3	-	-	3	-	-	1	3
CO2	3	3	2	3	3	-	-	3	-	-	1	3
CO3	3	3	2	3	3	-	-	3	-	-	1	3
CO4	3	3	2	3	3	-	-	3	-	-	1	3
CO5	3	3	2	3	3	-	-	3	-	-	1	3
MIB22548												
CO1	3	3	2	1	3	-	-	3	-	-	-	3
CO2	3	3	2	1	3	-	-	3	-	-	-	3
CO3	3	3	2	1	3	-	-	3	-	-	-	3
CO4	3	3	2	1	3	-	-	3	-	-	-	3
CO5	3	3	2	1	3	-	-	3	-	-	-	3
MIB22527												
CO1	3	3	2	3	3	3	3	3	1	3	3	-
CO2	3	3	2	3	3	3	3	3	1	3	3	-
CO3	3	3	2	3	3	3	3	3	1	3	3	-
CO4	3	3	2	3	3	3	3	3	1	3	3	-
CO5	3	3	2	3	3	3	3	3	1	3	3	-
MIB22553												
CO1	3	3	2	3	3	3	3	3	1	3	3	-
CO2	3	3	2	3	3	3	3	3	1	3	3	-
CO3	3	3	2	3	3	3	3	3	1	3	3	-

CO4	3	3	2	3	3	3	3	3	1	3	3	-
CO5	3	3	2	3	3	3	3	3	1	3	3	-
MIB22554												
CO1	3	3	2	3	3	3	3	3	1	3	3	-
CO2	3	3	2	3	3	3	3	3	1	3	3	-
CO3	3	3	2	3	3	3	3	3	1	3	3	-
CO4	3	3	2	3	3	3	3	3	1	3	3	-
CO5	3	3	2	3	3	3	3	3	1	3	3	-
MIB21531												
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CO2	3	3	2	3	3	-	-	3	-	-	1	3
CO3	3	3	2	3	3	-	-	3	-	-	1	3
CO4	3	3	2	3	3	-	-	3	-	-	1	3
CO5	3	3	2	3	3	-	-	3	-	-	1	3
MIB21532												
CO1	3	3	2	3	3	-	-	3	-	-	1	3
CO2	3	3	2	3	3	-	-	3	-	-	1	3
CO3	3	3	2	3	3	-	-	3	-	-	1	3
CO4	3	3	2	3	3	-	-	3	-	-	1	3
CO5	3	3	2	3	3	-	-	3	-	-	1	3
MIB21555												
CO1	3	3	2	3	3	-	-	3	-	-	1	3
CO2	3	3	2	3	3	-	-	3	-	-	1	3
CO3	3	3	2	3	3	-	-	3	-	-	1	3
CO4	3	3	2	3	3	-	-	3	-	-	1	3
CO5	3	3	2	3	3	-	-	3	-	-	1	3
MIB21556												
CO1	3	3	2	3	3	-	-	3	-	-	1	3
CO2	3	3	2	3	3	-	-	3	-	-	1	3
CO3	3	3	2	3	3	-	-	3	-	-	1	3
CO4	3	3	2	3	3	-	-	3	-	-	1	3
CO5	3	3	2	3	3	-	-	3	-	-	1	3
MIB21557												
CO1	3	3	2	3	3	-	-	3	-	-	1	3
CO2	3	3	2	3	3	-	-	3	-	-	1	3
CO3	3	3	2	3	3	-	-	3	-	-	1	3
CO4	3	3	2	3	3	-	-	3	-	-	1	3
CO5	3	3	2	3	3	-	-	3	-	-	1	3
MIB21558												
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CO2	3	3	2	3	3	-	-	3	-	-	1	3

CO3	3	3	2	3	3	-	-	3	-	-	1	3
CO4	3	3	2	3	3	-	-	3	-	-	1	3
CO5	3	3	2	3	3	-	-	3	-	-	1	3
MIB24535												
CO1	3	3	3	1	3	3	3	3	3	-	-	3
CO2	3	3	3	1	3	3	3	3	3	-	-	3
CO3	3	3	3	1	3	3	3	3	3	-	-	3
CO4	3	3	3	1	3	3	3	3	3	-	-	3
CO5	3	3	3	1	3	3	3	3	3	-	-	3
MIB21536												
CO1	3	3	3	2	3	3	3	3	2	3	3	2
CO2	3	3	3	2	3	3	3	3	2	3	3	3
CO3	3	3	3	2	3	3	3	3	2	3	3	2
CO4	3	3	3	2	3	3	3	3	2	3	3	2
CO5	3	3	3	2	3	3	3	3	2	3	3	2
MIB25540												
CO1	3	3	3	1	3	3	3	3	3	-	-	3
CO2	3	3	3	1	3	3	3	3	3	-	-	3
CO3	3	3	3	1	3	3	3	3	3	-	-	3
CO4	3	3	3	1	3	3	3	3	3	-	-	3
CO5	3	3	3	1	3	3	3	3	3	-	-	3
MIB25541												
CO1	3	3	3	1	3	3	3	3	3	-	-	3
CO2	3	3	3	1	3	3	3	3	3	-	-	3
CO3	3	3	3	1	3	3	3	3	3	-	-	3
CO4	3	3	3	1	3	3	3	3	3	-	-	3
CO5	3	3	3	1	3	3	3	3	3	-	-	3
MIB22571												
CO1	-	3	3	1	3	3	3	3	-	3	2	2
CO2	-	3	3	1	3	3	3	3	-	3	2	2
CO3	-	3	3	1	3	3	3	3	-	3	2	2
CO4	-	3	3	1	3	3	3	3	-	3	2	2
CO5	-	3	3	1	3	3	3	3	-	3	2	2
MIB22572												
CO1	-	3	3	1	3	3	3	3	-	3	2	2
CO2	-	3	3	1	3	3	3	3	-	3	2	2
CO3	-	3	3	1	3	3	3	3	-	3	2	2
CO4	-	3	3	1	3	3	3	3	-	3	2	2
CO5	-	3	3	1	3	3	3	3	-	3	2	2
MIB22573												
CO1	-	3	3	1	3	3	3	3	-	3	2	2

CO2	-	3	3	1	3	3	3	3	-	3	2	2
CO3	-	3	3	1	3	3	3	3	-	3	2	2
CO4	-	3	3	1	3	3	3	3	-	3	2	2
CO5	-	3	3	1	3	3	3	3	-	3	2	2
Total	570	615	445	490	615	240	240	615	100	195	275	466
No of Courses	41											
Average	2.780	3	2.170	2.390	3	1.170	1.170	3	0.487	0.951	1.341	2.273