ADAMAS UNIVERSITY

SCHOOL OF LIFE SCIENCE AND BIOTECHNOLOGY

Department of Biological Sciences

B.Sc. Microbiology Program

Program Code: MIB3406

(2024-28)

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 centres and professional bodies to stay relevant and up-to-date

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

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.

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

Name of the Programme: B.Sc. Microbiology

PROGRAMME EDUCATIONAL OBJECTIVES (PEO)

PEO 01 : Acquire basic theoretical and practical domain knowledge.

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

PEO 03 : Ability to do identify research gaps, comprehend fundamentals and specialize in the domain.

PEO 04 : Develop as professional aspirants and sustainable learners.

PEO 05 : Global outlook with imbibed human values

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

Name of the Programme: B.Sc. in Microbiology

GRADUATE ATTRIBUTE / PROGRAMME OUTCOME (PO)

GA 01/ PO 01 : Strong fundamental knowledge in basic and applied field of microbiology.
GA 02/ PO 02 : Ability to correlate between courses and develop critical/logical thinking.
GA 03/ PO 03 : Develop skill set related to microbiology and allied fields.
GA 04/ PO 04 : Familiarized with classical as well as modern tools and techniques in microbiology.
GA 05/ PO 05 : Ability to identify scientific research gaps and problems pertaining to microbiology and allied fields.
GA 06/ PO 06 : Explore the acquired knowledge and skills of microbiology to identify approaches for suitable solution.
GA 07/ PO 07 : Ability to retrieve biological data for a meaningful solution.
GA 08/ PO 08 : Decide upon career path, force the challenges and develop professional aspirations.
GA 09/ PO 09 : Uphold integrity and collaborative approach in workplace.
GA 10/ PO 10 : To accept and implement learning towards sustainable development.
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.

HOD **DEAN / SCHOOL CONCERNED**

SCHOOL OF LIFE SCIENCE AND BIOTECHNOLOGY								
UNDERGRADUATE COURSE STRUCTURE								
B.Sc. MICROBIOLOGY								
BATCH 2024-28								
SEMESTER I								
S.No	**Type of Course**	**Code**	**Title of the Course**	**Contact Hours Per Week**				**Remarks**
				L	**T**	**P**	**C**	
1	CC	BIC101	Molecules of Life	2	1	1	4	CC-1
2	CC	MIB102	Fundamentals of Microbiology	2	1	1	4	CC-2
3	MDC	BIT105	Renewable energy resources	2	0	1	3	MDC1
4	AEC	AEC101	Communicative English-I	2	1	0	3	AEC1
5	Minor	100-199	To be chosen from a pool of minors	2	1	1	4	Minor1
6	VAC	VAC101	Environmental Education-I	2	0	0	2	VAC1
Semester Credits							**20**	
SEMESTER II								
7	CC	MIB103	Cell biology	2	1	1	4	CC-3
8	CC	MIB104	Bacteriology and Virology	2	1	1	4	CC-4
9	MDC	MIB108	Microbes for sustainable development	2	0	1	3	MDC2
10	SEC	SEC139	Applied Biophysics1	1	0	1	2	SEC-1
11	VAC	VAC105	Community engagement and Social responsibility	1	0	0	2	VAC2
12	AEC	AEC102	Communicative English-II	2	1	0	3	AEC2
13	Minor	100-199	To be chosen from a pool of minors	2	1	1	4	Minor2
Semester Credits							**22**	
SEMESTER III								
14	CC	MIB201	Microbial Metabolism	2	1	1	4	CC-5
15	CC	BIC202	Basics of Plant and Animal Sciences	2	1	1	4	CC-6
16	MDC	BIT206	Introduction to Biomaterials	2	0	1	3	MDC3
17	Minor	200-299	To be chosen from a pool of minors	3	1	0	4	Minor3
18	AEC	AEC106	Professional Communication Skills	2	0	0	2	AEC3
19	SEC	SEC140	Applied Biophysics2	1	0	1	2	SEC-2
20	VAC	VAC102	Human Values and Ethics	2	0	0	2	VAC3
21	PDC	PDC201	Professional development course-1	0	0	1	1	
Semester Credits							**22**	
SEMESTER IV								
22	CC	MIB203	Environmental Microbiology	2	1	1	4	CC-7

23	CC	MIB204	Microbial Genetics	2	1	1	4	CC-8
24	CC	MIB205	Molecular Biology	2	1	1	4	CC-9
25	SEC	SEC141	Microbial and Molecular diagnostics	1	0	1	2	SEC-3
26	Minor	200-299	To be chosen from a pool of minors	2	1	1	4	Minor4
27	VAC		To be chosen from subjects offered from University	2	0	0	2	VAC4
28	PDC	PDC202	Professional development course-2	0	0	1	1	
Semester Credits							**21**	
SEMESTER V								
29	CC	MIB301	Immunology	2	1	1	4	CC-10
30	CC	MIB302	Recombinant DNA Technology	2	1	1	4	CC-11
31	CC	MIB303	Pharmaceutical Microbiology	2	1	1	4	CC-12
32	Minor	300-399	To be chosen from a pool of minors	2	1	1	4	Minor5
33	SEC	SEC142	IPR and Biosafety	1	1	0	2	SEC-4
34	INT	MIB304	Internship	0	0	4	4	
35	PDC	PDC301	Professional development course-3	0	0	1	1	
Semester Credits							**23**	
SEMESTER VI								
36	CC	MIB305	Bioinformatics	2	1	1	4	CC-13
37	CC	MIB306	Industrial Microbiology	2	1	1	4	CC-14
38	CC	BIC307	Nutrition and toxicology	2	1	1	4	CC-15
39	Minor	300-399	To be chosen from a pool of minors	2	1	1	4	Minor6
40	SEC	SEC143	Quality control and quality assurance	1	0	1	2	SEC-5
41	Project	MIB308	Project Work on Microbiology	0	0	4	4	
42	PDC	PDC302	Professional development course-4	0	0	1	1	
Semester Credits							**23**	
Total Credits of the Program after 3rd Year							**131**	
			SEMESTER VII					
43	CC	MIB401	Food Microbiology	2	1	1	4	CC-16
44	CC	MIB402	Medical Microbiology	2	1	1	4	CC-17
45	CC	MIB403	Microbial Genomics and proteomics	2	1	1	4	CC-18
46	CC (For With	MIB404	Research Methodology for	3	1	0	4	CC-19 (Research)

	research)		Microbiology (should start working on dissertation topic)					
47	CC (For Without research)	MIB405	Modern techniques and bioinstrumentation	3	1	0	4	CC-19(without Research)
48	Minor	400-499	To be chosen from a pool of minors	2	1	1	4	Minor7
49	PDC	PDC401	Professional development course-5	0	0	1	1	
Total Semester Credit							**21**	
			Semester VIII					
49	CC	MIB406	Biostatistics and biomathematics	2	1	1	4	CC-20
50	CC (For Without research)	MIB407	Clinical trial management	2	1	1	4	CC-21 (without Research)
51	CC (For Without Research)	MIB408	Biomedical Nanotechnology	2	1	1	4	CC-22(without Research)
52	Minor (For without research)	400-499	To be chosen from a pool of minors				4	Minor8
53	Minor (For With /without research)	400-499	To be chosen from a pool of minors				4	Minor8
54	Dissertation (For With research)	MIB409	Dissertation on Microbiology	0	0	12	12	
Total Semester Credit							**20**	
Total Credits of the Program after 4th Year							**172**	

*NOTE: With research is only allowed for Students ***who secure 75% marks and above in the first six semesters***

Minors to be offered by Department of Biological Sciences

Semester	Course Code	Courses	L	T	P	C
1	BIC151	Biomolecules	2	1	1	4
2	MIB152	Elementary cell science	2	1	1	4
3	BIC251	Basic metabolism	2	1	1	4
4	MIB252	Microbial Ecology	2	1	1	4
5	MIB351	Genetic engineering	2	1	1	4

6	BIC352	Basics of Nutrition and toxicology	2	1	1	4
7	BIC451	Introduction to Genomics and proteomics	2	1	1	4
8	MIB452	Fundamentals of Nanobiotechnology	2	1	1	4
9	BIC453	Drug Design and Development	2	1	1	4

List of Multi-disciplinary courses to be offered by Department of Biological Sciences

Semester	Course Code	Courses	L	T	P	C
2	MIB108	Microbes for sustainable development	2	0	1	3
3	MIB203	Biomaterial Sciences	2	0	1	3

ADAMAS UNIVERSITY

B.Sc. Microbiology (Hons.)

SEMESTER-I

MIB 101	MOLECULES OF LIFE (THEORY)	L	T	P	C
Version 1.0	**Contact Hours - 60**	2	1	1	4
Pre-requisites/Exposure	PLUS TWO (12th) LEVEL BIOLOGY				
Co-requisites	--				

Course Objectives

1. To provide students with a thorough knowledge on bio-macromolecules like carbohydrates, proteins and lipids.
2. It will also provide in-depth knowledge of structural and functional diversity of carbohydrates, proteins and lipid.
3. Elaborating properties of enzymes and vitamins along with their importance.
4. Comprehend laws of thermodynamics and ionic equilibrium in relation to biochemical pathways.

Course Outcomes

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

CO 1: Knowledge: Define the basic principles of Bioenergetics and explain the energy flow in living systems.
CO 2: Comprehension: Explain how carbohydrates, proteins, lipids, and nucleic acids are synthesized and broken down in living organisms.
CO 3: Applying: - Apply the knowledge of bioenergetics to analyze metabolic pathways involved in energy production.
CO 4: Analyzing: Analyze the structure-function relationships of molecules of life in different biological systems.
CO 5: Synthesis and Evaluation: Generate hypotheses and critically assess on the interplay between different molecules of life in maintaining cellular homeostasis and demonstrate proficiency in using laboratory instruments and performing essential biochemical techniques.

Catalog Description

The core-course of 'molecules of life' will help to understand the structure and function of bio-macromolecules like carbohydrates, proteins and lipids. The syllabus include all the properties of enzymes and vitamins which provide ample scope for their future utilization. The course also relate laws of thermodynamics and ionic equilibrium in biochemical pathways. 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

MOLECULES OF LIFE

Unit 1

Basic laws of Bioenergetics: Idea of thermodynamic functions (U, H, S, G).First law, second law. Acid, Base and Salt. pH concept. Buffer concept. Determination of pH of a buffer solution.

Unit 2

Families of monosaccharides: aldoses and ketoses, trioses, tetroses, pentoses, and hexoses. Stereo isomerism of monosaccharides, epimers, Mutarotation and anomers of glucose. Furanose and pyranose forms of glucose and fructose, Haworth projection formulae for glucose; chair and boat forms of glucose, Sugar derivatives, glucosamine, galactosamine, muramic acid, N- acetyl neuraminic acid, Disaccharides; concept of reducing and non-reducing sugars, occurrence and Haworth projections of maltose, lactose, and sucrose, Polysaccharides, storage polysaccharides, starch and glycogen. Structural Polysaccharides, cellulose, peptidoglycan and chitin

Unit 3

Structure and functions of proteins; Amino acids, the building blocks of proteins. General formula of amino acid and concept of zwitterion. Titration curve of amino acid and its Significance, Classification, biochemical structure and notation of standard protein amino acids Ninhydrin reaction. Natural modifications of amino acids in proteins hydrolysine, cystine and hydroxyproline, Structure and functions of naturally occurring glutathione and insulin and synthetic aspartame, Secondary structure of proteins: Peptide unit and its salient features. The alpha helix, the beta pleated sheet and their occurrence in proteins, Tertiary and quaternary structures of proteins. Forces holding the polypeptide together. Human haemoglobin structure, Quaternary structures of proteins, Ramachandran Plot. Enzymes: Definition, classification, active site, co-factors etc.

Unit 4

Definition and major classes of storage and structural lipids. Storage lipids. Fatty acids structure and functions. Essential fatty acids. Triacylglycerols structure, functions and properties. Saponification Structural lipids. Phosphoglycerides: Building blocks, General structure, functions and properties. Structure of phosphatidylethanolamine and phosphatidylcholine, Sphingolipids: building blocks, structure of sphingosine, ceramide. Special mention of sphingomyelins, cerebrosides and gangliosides, Lipid functions: cell signals, cofactors, prostaglandins, Introduction of lipid micelles, monolayers, bilayers, structure of cholesterol and steroids.

Nucleoside and Nucleotide; DNA, RNA, Chargaffs rule. Types and Functions of DNA-RNA.

Unit 5

Experiential learning through different activities.

LAB

1. Basic understanding of different instruments in lab (microscopy, washing, autoclaving etc.).
2. Properties of water.
3. Buffer preparation.
4. Acid-Base Titrations.
5. Qualitative analysis of Carbohydrates.
6. Qualitative analysis of proteins.
7. Qualitative analysis of Lipids.
8. Assay of salivary amylase.

Text Book:

1. Nelson DL and Cox MM (2013) Lehninger principles of biochemistry, 6th edition, W.H. Freeman

Reference books

1. Campbell, MK (2012). Biochemistry, 7th edition, Cengage Learning
2. Berg JM, Tymoczko JL and Stryer L (2011). Biochemistry, 7th edition, WH Freeman
3. Voet D and Voet JG (2004). Biochemistry, 3rd edition, John Wiley and Sons

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

MIB102	Fundamentals of Microbiology	L	T	P	C
Version 1.0	**Contact Hours - 45**	2	0	1	3
Pre-requisites/Exposure	PLUS TWO LEVEL BIOLOGY				
Co-requisites	--				

Course Objectives

- To give an introduction to the microbial world- their distribution- morphology growth and the role of microorganisms in various fields of life sciences and Industry.
- Makes the student aware of the role of microbes in the daily life as well as in the various fields of science and how it can be controlled is also dealt with.

Course Outcome:

CO1. Explain the structure, function, and classification of microorganisms

CO2. Apply microbiological techniques to isolate, culture, and identify microorganisms in laboratory settings

CO3. Analyze the role of microorganisms in health, disease, and the environment

CO4. Evaluate the effectiveness of antimicrobial agents and the mechanisms of microbial resistance

CO5. Design basic experiments to explore microbial growth, metabolism, and genetics and apply laboratory techniques to isolate, identify, and characterize microorganisms, demonstrating skills in microbial culture and staining methods.

Syllabus

Unit-I

History of Microbial World: History, development, and scope of microbiology, the evolution of microbial life. Theory of Spontaneous generation. Prokaryotes, archaebacteria and eukaryotes. Germ theory of diseases and Classification of microbes-numerical and molecular taxonomy. Bergey's manual for identification of various microbes. Modern trends in nomenclature. Diversity of the microbial world.

Unit-II

Basic microbiological techniques: Laminar Air Flow, Autoclave, Oven, pH meter, Colony counter, Incubator-Shaker, Nephelometer, Conductivity bridge, Centrifuge, Cyclomixer. Microscopy: Brightfield, Darkfield, Phase contrast, Differential interference contrast, fluorescence, Confocal scanning laser, Scanning electron, Transmission electron, Scanning tunnel microscope, and Atomic force microscope.

Unit-III

Microbial nutrition: Nutritional requirements for microbes and important nutritionalgroups.Preparationofartificialmedia,differenttypesofmediausedformicrobialculture.Sterilizationanditstypes.Functionofdifferentnutrientsandtheirstressonmicrobes,mechanism of stress tolerance in microbes. Important groups of prokaryotes – photosynthetic bacteria, blue green algae, chemoautotrophic bacteria, spore forming bacteria, mycoplasma. Methods for isolation, purification and preservation of microbes. Variousculturalcharacteristicsofmicrobes:colonyappearance,forms,elevation,margin,colour,density,odourand consistency.

Unit-IV

Microbial control: Definition, application and examples of frequently used terms; Sterilization, disinfection, antiseptic, sanitizer, germicide, antimicrobial agent, bacteriostatic and bactericidal agents; Pattern / Rate of Microbial Death; Concept of sterilization, Conditions influencing the effectiveness of Antimicrobial Agents. Physical methods of microbial control: heat, temperature, pressure, filtration, desiccation, osmotic pressure, radiation. Chemical methods of microbial control: disinfectants, types, and mode of action

Unit-V

Microbial ecology: Microbe interactions: Mutualism, synergism, commensalism, competition, amensalism, parasitism, predation. Microbe-Plant interaction: Symbiotic and non-symbiotic interactions. Microbe-animal interaction: Microbes in ruminants, nematophagus fungi and symbiotic luminescent bacteria

Recommended textbooks

Tortora, G.J.; Funke, B.R.; Case, C.L. ***Microbiology: An introduction***. Pearson Education: 2015.

Willey, J.M.; Sherwood, L.; Woolverton, C.J. ***Prescott's microbiology***. McGraw-Hill: 2013.

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

Examination Scheme:

Components	Continuous 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

BIT105	Renewable Energy Resources	L	T	P	C
Version 1.0	**CONTACT HOURS-60**	2	0	1	3
Pre-requisites/Exposure	PLUS TWO (12^{th}) LEVEL BIOLOGY, PHYSICS, CHEMISTRY				
Co-requisites	--				

Course Objectives

1. Understand the various forms of conventional energy resources.

2. Learn the present energy scenario and the need for energy conservation

3. Explain the concept of various forms of renewable energy

4. Outline division aspects and utilization of renewable energy sources for both domestics and industrial application

5. Analyze the environmental aspects of renewable energy resources.

Course Outcomes

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

1. CO1: Students will be able to recall and identify various types of renewable energy resources, such as solar, wind, hydro, and biomass.
2. CO2: Students will demonstrate an understanding of the principles behind renewable energy generation technologies, including how solar panels convert sunlight into electricity and how wind turbines harness wind energy.
3. CO3: Students will critically analyze the advantages and disadvantages of different renewable energy technologies, considering factors such as cost, environmental impact, and scalability.
4. CO4: Students will evaluate the effectiveness of various renewable energy generation technologies in meeting energy demands and reducing greenhouse gas emissions, comparing and contrasting different approaches to sustainable energy production.
5. CO5: Students will design and propose innovative solutions for integrating renewable energy resources into existing energy systems, considering factors such as energy storage, grid integration, and policy incentives and integrate knowledge of renewable energy resources with environmental and sustainability concepts.

Catalog Description

Renewable energy being the most important application area of engineering and technology in the twenty first century, this graduate programme is designed for quality learning in that sector. RE sector needs manpower with design and engineering skills in RE systems and components – this programme targets to impart these. The curriculum has an emphasis on solar, biomass, geothermal and wind energy systems, in tune with the Indian national missions on these. The energy has become an important and one of the basic infrastructures for the economic development of the country. it is imperative for the sustained growth of the economy. This course envisages the new and renewable source of energy, available in nature and to expose the students on sources of energy crisis and the alternates available, also stress up on the application of non-conventional energy technologies.

Course Content:

UNIT-I (7hr):

Introduction to Energy: Definition and units of energy, power, Forms of energy, Conservation of energy, second law of thermodynamics, Energy flow diagram to the earth. Origin and time scale of fossil fuels, Conventional energy sources, Role of energy in economic development and social transformation. Global Energy Scenario: Energy consumption in various sectors, projected energy consumption for the next century, exponential increase in energy consumption, energy resources, coal, oil, natural gas, nuclear and hydroelectric power, impact of exponential rise in energy usage on global economy. Energy demand and Energy trilemma index, Classification of energy resources, Conventional-Nonconventional, Renewable-Non-renewable, Green energy, Clean energy (Definitions and examples), Green footprint, Carbon footprint, Ecological footprint concepts.

UNIT-II (6 hr):

Indian Energy Scene: Energy resources available in India, urban and rural energy consumption, energy consumption pattern and its variation as a function of time, nuclear energy - promise and future, energy as a factor limiting growth, need for use of new and renewable energy sources. National Green Tribunal (NGT) act, NGT activities. Environmental Effects : Environmental degradation due to energy production and utilization, air and water pollution, depletion of ozone layer, global warming, biological damage due to environmental degradation. Environmental effects of thermal power station, nuclear power generation, hydroelectric power, Geothermal power, Ocean energy harvesting, Wind energy harvesting, Solar energy harvesting.

UNIT-III (5hr):

Solar constant, Solar Radiation spectrum, Classification of Solar cells, Solar thermal systems types, applications of Solar PV and Solar Thermal systems. Wind Energy: Introduction, Principle of wind energy conversion, Advantages and disadvantages of wind mills, Applications of wind energy.

UNIT-IV (3hr):

Introduction Advantages and disadvantages of geothermal energy over other energy forms, Sources of geothermal energy, Characteristics of geothermal energy

UNIT V (9 h):

Bio-Energy Energy from biomass, Sources of biomass, Different species as biomass feedstock, Conversion of biomass into fuels, Energy through fermentation, Pyrolysis, gasification and combustion, Biogas plants, Properties and characteristics of biogas, Biofuel production, Characterization of Biofuel and property analysis.

Practicals on Renewable Energy (30 h)

1. Ethanol production from biomass feedstock
2. Biogas production from microorganism by dark fermentation
3. Biodiesel production from algal biomass'
4. Calculations of Fuel properties
5. Prototype development and model presentation of any renewable energy generation

References:

1. Solar Energy Principles, Thermal Collection &Storage, S.P.Sukhatme: Tata McGraw Hill Pub., NewDelhi.
2. Non-Conventional Energy Sources, G.D.Rai, NewDelhi.
3. Renewable Energy, power for a sustainable future, Godfrey Boyle,2004,
4. The Generation of electricity by wind, E.W.Golding.
7. Non-Conventional Energy Resources by B.H. Khan, Tata McGraw Hill Pub.,2009.
8. Fundamentals of Renewable Energy Resources by G.N.Tiwari, M.K.Ghosal, Narosa Pub., 2007.
9. Non-Conventional Energy Resources by B.H. Khan, Tata McGraw Hill Pub., 2009. (Ch:6)
10. Non-Conventional Energy Resources by ShobhNath Singh, Pearson India., 2016. (Ch:2, 4)
11. Solar Cells: From Materials to Device Technology edited by S. K. Sharma, Khuram Ali, Springer (2020)
12. Rational Design of Solar Cells for Efficient Solar Energy Conversion edited by AlagarsamyPandikumar, RamasamyRamaraj, Wiley (2018).
13. Energy fables, Edited by edited by Jenny Rinkinen, Elizabeth Shove, Jacopo Torriti, Routledge a T&F group, (2019).

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

Examination Scheme:

Components	Continuous	End Term

	Assessment	
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

AEC101	Communicative English I	L	T	P	C
Version1.0		2	1	0	3
Pre-requisites/Exposure	Basic Knowledge in English Language				
Co-requisites	-				

Course Description

The Communicative English course aims to equip the language learners with the knowledge of comprehension and production of English language. The course is designed to develop the primary aspects of any language learning: listening, speaking, reading, writing, grammar, and vocabulary. The modules indicate the gradual evolvement of the acquisition of English language and communication skills.

Course Outcomes:

Remember: **Identify** key vocabulary and phrases used in everyday conversations.

Understand: **Explain** the main ideas and supporting details in spoken and written texts.

Apply: **Demonstrate** effective listening and speaking skills in real-life situations.

Analyze: **Compare** different communication styles and their cultural implications.

Evaluate: **Assess** the effectiveness of various communication strategies in diverse contexts and a**pply** communication strategies to interact effectively in multicultural and professional environments, fostering collaboration and teamwork.

Program Outcomes:

1. To sensitize learners to the nuances of spoken and written forms of English
2. To enable them to produce grammatically correct language
3. To help them master writing techniques to meet academic and professional needs
4. To provide sufficient practice in Listening, Speaking, Grammar, Vocabulary, Reading and Writing.

Unit 1

- Listening: practice listening to short conversations and identifying the purpose of communication.
- Speaking: Exchanging greetings, introducing oneself and others, sharing personal and professional information.
- Grammar: parts of speech.
- Reading: Practice reading short passages. Reading words clearly with pause. Answering questions from the passage.
- Writing: Practice writing short meaningful sentences using different forms of tense.

Unit 2

- Listening: practice listening to longer conversations and the theme/s of communication.
- Speaking: describing people, places and objects; comparing people, places and objects.
- Grammar: articles and prepositions
- Vocabulary: synonym and antonyms.
- Reading: Practice reading short passages. Identifying the known and the unknown words. Answering questions from the passage.
- Writing: Practice writing descriptive and comparative sentences.

Unit 3

- Listening: practice listening to jumbled fragmented parts of a text and working together to put the parts coherently.
- Speaking: Narration. Talking about past (immediate and distant)
- Grammar: tense
- Reading: practice reading passages and Answering questions from the passage.
- Writing: practice writing short paragraphs, describing people place objects, narrating events

Unit 4

- Listening: Practice following instructions and directions
- Speaking: practice conversation on the following situations- instruction, suggestion, enquiring, requesting, seeking permission, invitations, apologize and complaints.
- Grammar: verbs. Subject verb agreement. Active and passive voice.
- Reading: practice reading passages and elicit information from the passages by identifying topic so on. Answering questions from the passage.
- Writing: practice replacing the sentences from given passages by new sentences (but no meaning change). Correcting incorrect sentence.

Recommended Readings

1. Fluency in English-Part II, Oxford University Press, 2006.
2. Business English, Pearson, 2008.
3. Grammar and Composition, Wren and Martin.

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

1=weakly mapped

2= moderately mapped

3=strongly mapped

MIB152	Elementary Cell Science	L	T	P	C
Version1.0	**ContactHours -60**	2	1	1	**4**
Pre-requisites/Exposure	**12th level Biology**				
Co-requisites	**--**				

Course Objectives:

1. To correlate between the cellular organization and function
2. To categorize different ways of protein sorting and transport across membranes
3. To describe and illustrate cell signalling mechanisms
4. To investigate cell cycle, cell death, and cell renewal

Course Outcomes

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

1. Remembering:
- Recall key concepts in cell biology, such as the structure and function of different cell organelles.

2. Understanding:
- Understand the consequences of disrupted cell signalling pathways on cell function and disease development.

3. Applying:
- Apply knowledge of cell biology to analyze and interpret experimental data related to cell signalling pathways and cancer development. .

4. Analyzing:
- Analyze the interconnection between cell signalling, cancer progression, and the nuclear transport system.

5. Evaluating:
- Critically evaluate current research findings related to cell biology, cell signalling, cancer, and nuclear transport system and outline the components and regulation of the cell cycle, mechanisms of programmed cell death (apoptosis), and their implications in cancer, viral diseases, organ transplantation, and stem cell development, including embryonic and induced pluripotent stem cells.

Catalogue Description:

Cell biology is the study of eukaryotic cells. This course covers various aspects of structure and functions of cells and cellular processes such as cell division, cell transport, signalling, cell senescence among others.

Course Content: Theory (45 h)

Unit1: Basics of Cell Biology (structure & function)

Discovery of cell and Cell theory; Comparison between plant and animal cells; Cell wall; Plasma membrane; Modification of plasma membrane and intracellular junctions; Cytoskeleton; Protoplasm; Mitochondria; Chloroplast; ER; Golgi complex; Lysosome, endosome and microbodies; Ribosome; Centriole; Nucleus; Cell-Cell Interactions - adhesion junctions, tight junctions, gap junctions, and plasmodesmata (only structural aspects) Structure and organization of actin filaments, association of actin filaments with plasma membrane, inter mediate filaments, microtubules

Unit 2: Nucleus

Nuclear envelope, nuclear pore complex and nuclear Lamin; Chromatin – Molecular organization Nucleolus

Cytochemical staining of DNA – Feulgen, Identification and observation of mitochondria in human cheek epithelial cells using vital stain Janus Green B and Methylene Blue

Unit 3: Protein Sorting and Transport

Ribosomes, Endoplasmic Reticulum – Structure, targeting and insertion of proteins in the ER, protein folding, processing and quality control in ER, smooth ER and lipid synthesis, export of proteins and lipids; Golgi Apparatus – Organization, protein glycosylation, protein sorting and export from Golgi Apparatus; Lysosomes

Unit 4: Cell Signaling

Signaling molecules and their receptors; Function of cell surface receptors; Pathways of intra-cellular receptors – Cyclic AMP pathway, cyclic GMP and MAP kinase pathway

Unit 5: Cell cycle – An overview of cell cycle; Components of cell cycle control system

Intracellular and Extra-cellular control of cell division, Programmed cell death (Apoptosis), intrinsic & extrinsic pathways of cell death, Apoptosis in relation with Cancer, Viral disease (AIDS) & Organ transplant. Mitosis and Meiosis; Development of cancer, causes and types. Stem cells, embryonic stem cells, induced pluripotent stem cells

List of the practical (15 h)

1. Handling of compound microscope
2. Microscopic observation of animal cells and plant cells

a. Human Buccal epithelial cells
b. Human blood cells
c. Onion epidermal cells
d. Balsam leaf epidermal cell

3. Observation and Identification of different stages of Mitosis and Meiosis using root tip and flower bud of onion

Text Books

T1. Alberts B. Bray D, Hopkin K, Johnson A, Lewis J, Raff M, Roberts K, Walter P(2013).Essential cell biology, 4th edition,Taylor&Francis

Reference Books

R1. ardinJ,BertoniGandKleinsmithLJ.(2010).Becker'sworldofthecell,8thedition,Pearson
R2.KarpG.(2010)CellandMolecularBiology:ConceptsandExperiments.6thedition,JohnWiley

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

Components	Continuous 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

VAC101	Environmental Education I	L	T	P	C
Version1.1	**ContactHours –30**	2	0	0	**2**
Pre-requisites/Exposure	**None**				
Co-requisites	**--**				
Academicyear	**2023-2024**				

Course Objectives

- **Knowledge Acquisition**: Understand and articulate key concepts related to environmental science, including ecosystems, biodiversity, sustainability, and climate change.
- **Critical Thinking**: Analyze the relationships between human activities and environmental impacts, evaluating the consequences of different practices on ecosystems.
- **Practical Application**: Apply sustainable practices in daily life and community settings, demonstrating an understanding of resource conservation and waste reduction.
- **Community Engagement**: Develop skills to engage and educate others about environmental issues, fostering a sense of stewardship and responsibility.
- **Policy Awareness**: Evaluate various environmental policies and initiatives, understanding their implications for social and ecological systems.
- **Project Development**: Create and implement educational projects or campaigns aimed at raising awareness and promoting action on environmental issues within local communities.

Course Outcomes:

CO1	**Remember**: **List** key environmental concepts and terms, such as biodiversity, ecosystem, and sustainability.
CO2	**Understand**: **Explain** the interrelationships between humans and the environment.
CO3	**Apply**: **Implement** basic strategies for reducing waste and conserving resources in daily life.
CO4	**Analyze**: **Examine** the impact of human activities on local ecosystems and climate change.
CO5	**Evaluate**: **Assess** the effectiveness of various environmental policies and initiatives and **apply** critical thinking to propose innovative solutions and promote community involvement in environmental conservation and sustainable living practices.

Course Description:

This course provides an overview of fundamental concepts in environmental science and education, focusing on the interconnections between human activities and natural ecosystems. Students will explore key topics such as biodiversity, sustainability, climate change, and conservation efforts. Through a combination of lectures, hands-on activities, and field studies, participants will develop critical thinking skills and a deeper understanding of environmental issues.

The course emphasizes the importance of fostering environmental awareness and stewardship in individuals and communities. Students will engage in discussions about current environmental challenges and explore strategies for promoting sustainable practices. By the end of the course, participants will be equipped with the knowledge and skills to advocate for environmental responsibility and implement educational initiatives that inspire others to protect the planet.

Detailed Syllabus

Unit I: Humans and the Environment(2hours)

- Introduction to environmental education
- Relationship between humans and the environment
- Human impacts on the environment
- Environmental ethics and values

Unit II: Natural Resources and Sustainable Development(4hours)

- Concepts of natural resources and their types
- Sustainable development and its principles
- Conservation and management of natural resources
- Role of technology in sustainable development

Unit III: Environmental Issues: Local, Regional and Global(4hours)

- Identification and analysis of local, regional, and global environmental issues
- Environmental impacts of population growth and urbanization
- Environmental justice and equity
- Role of government, organizations, and individuals in addressing environmental issues

Unit IV: Conservation of Biodiversity and Ecosystems(3 hours)

- Importance of biodiversity and ecosystems
- Threats to biodiversity and ecosystem degradation
- Conservation strategies and approaches
- Role of protected areas and wildlife conservation

Unit V: Environmental Pollution and Health(4hours)

- Types and sources of environmental pollution
- Impacts of pollution on human health and ecosystems
- Pollution control measures and technologies
- Public health awareness and environmental pollution

Unit VI: Climate Change: Impacts, Adaptation, and Mitigation(3 hours)

- Understanding climate change and its causes
- Impacts of climate change on natural and human systems
- Adaptation strategies for dealing with climate change

- Mitigation measures and renewable energy alternatives

Unit VII: Environmental Management(3hours)

- Principles and concepts of environmental management
- Environmental impact assessment and sustainable development
- Environmental planning and policy-making
- Corporate social responsibility and environmental management

Unit VIII: Environmental Treaties and Legislation(2hours)

- Overview of international environmental treaties and agreements
- National and local environmental legislation and regulations
- Compliance and enforcement mechanisms
- Role of stake holders in environmental governance

Unit IX: Case Studies and Fieldwork(5hours)

- Analysis of case studies related to environmental issues and solutions.
- Discussionononenationalandoneinternationalcasestudyrelatedtotheenvironmentandsustainabledevelopment.
- Field visits to identify local/regional environmental issues, make observations including data collection and prepare a brief report.
- Documentation of campus biodiversity.
- Campus environmental management activities such as solid waste disposal, water management, and sewage treatment.
- Fieldvisitsandpracticalexercisestoobserveandassesslocalenvironmental conditions.
- Data collection and analysis techniques.
- Reporting and presentation of field work findings.

Suggested Reading:

1. Headrick, Daniel R.(2020)HumansversusNature-AGlobalEnvironmentalHistory,OxfordUniversityPress.
2. William P. Cunningham and Mary A.(2015)CunninghamEnvironmentalScience:AGlobalConcern,Publisher(Mc-Graw Hill, USA).
3. Harper, Charles L.(2017)EnvironmentandSociety,HumanPerspectivesonEnvironmentalIssues6thEdition. Routledge.
4. Bawa, K.S.,Oomen,M.A.andPrimack,R.(2011)ConservationBiology:APrimerforSouthAsia.UniversitiesPress.
5. Central Pollution Control Board Web page for various pollution standards.https://cpcb.nic.in/standards/
6. Ahluwalia, V.K.(2015).*EnvironmentalPollution,andHealth*.TheEnergyandResourcesInstitute(TERI).
7. Miller, G.T.,& Spoolman,S.(2015)Environmental Science. Cengage Learning.
8. Masters, G. M., &Ela, W. P. (2008). *Introduction to environmental engineering and science* (No.60457).Englewood Cliffs,NJ: Prentice Hall.
9. Pittock, Barrie(2009)ClimateChange:TheScience,ImpactsandSolutions.2ndEdition.Routledge.
10. Theodore, M. K. and Theodore, Louis (2021) Introduction to Environmental Management, 2nd Edition. CRCPress.
11. Richard A. Marcantonio, Marc Lame(2022).Environmental Management: Concepts and Practical Skills. Cambridge University Press.
12. Ministry of Environment, Forest and Climate Change(2019) A Handbook on International Environment

Conventions & Programmes. https://moef.gov.in/wp-content/uploads/2020/02/convention-V-16-CURVE-web.pdf

13. Kanchi Kohli and Manju Menon(2021)DevelopmentofEnvironmentLawsinIndia,CambridgeUniversity Press.

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

Examination Scheme:

Components	Continuous 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	-	1	3	-	-	-	-	3	-	3	3	3
CO2	-	1	3	-	-	-	-	3	-	3	3	3
CO3	-	1	3	-	-	-	-	3	-	3	3	3
CO4	-	1	3	-	-	-	-	3	-	3	3	3
CO5	-	1	3	-	-	-	-	3	-	3	3	3
Avg	-	1	3	-	-	-	-	3	-	3	3	3

1=weakly mapped

2= moderately mapped

3=strongly mapped

ADAMAS UNIVERSITY

B.Sc. Microbiology (Hons.)

SEMESTER-II

MIB**103**	**Cell Biology**	**L**	**T**	**P**	**C**
Version 1.0	Contact hours: 60	2	1	1	4
Pre-requisites/Exposure	Basic Knowledge in cell biology				
Co-requisites	-				

Course Objectives

1. To **recall** and **extend** the basic idea of structure and function of prokaryotic and eukaryotic cells
2. To **discuss** detailed perspective of cell including physiological properties, cell composition, growth, metabolic processes, signalling pathways, lifecycle.
3. To **interpret** the applications of different microscopy as tools for understanding cell biology.
4. To **discuss** about cell cycles, cell division and apoptosis
5. To **apply** and **assess** the cell biology in microscopic and molecular level to understand of human health and disease.

Course Outcomes

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

CO1: Remembering: Recall and describe the basic structure and function of the cell, including organelles such as the nucleus, mitochondria, and endoplasmic reticulum.

CO2: Understanding: Explain how cells communicate with each other and how signals are transmitted within and between cells.

CO3: Applying: Apply knowledge of cell biology to analyse and interpret experimental data related to cellular processes such as cell division, protein synthesis, and cell signalling.

CO4: Analysing: Critically evaluate the impact of mutations and dysregulation in cellular processes on human health and disease.

CO5: Evaluating: Assess and compare different models of cell biology and cellular processes, and explain their relevance in understanding biological phenomena and apply knowledge of cellular organization, chromosome dynamics, and molecular transport processes to understand cell function, growth, and development in both normal and experimental conditions.

Catalog Description

This course deals with the biology of cells of higher organisms: Thestructure, function, and biosynthesis of cellular membranes and organelles; cell growth and oncogenic transformation;

transport, receptors, and cell signaling; the cytoskeleton, the extracellular matrix, and cell movements; chromatin structure and RNA synthesis.

Course Content

Unit 1: Cell structure and Functions, Cell as basic unit of living organisms-bacterial, fungal, plant and animal cells. Ultrastructure of prokaryotic cell (cell membrane and plasmids, Nucleoid). Ultrastructure of eukaryotic cell (cell wall, cell membrane, nucleus, mitochondria, chloroplast, endoplasmic reticulum, Golgi apparatus, vacuoles) Fluid mosaic model, Sandwich model, Cell membrane permeability Structure and functions of cell organelles – Endoplasmic reticulum, Golgi complex, Mitochondria, Chloroplast, Ribosomes, Lysosomes, Peroxisomes, Nucleus (Nuclear envelope with nuclear pore complex, nucleolus, nucleoplasm, and chromatin). Vacuole, Cytoskeletal structures (Microtubules, Microfilaments and Intermediate filaments). Assembly, organization and movement of cilia and flagella.

Unit 2:Structure of chromosome-morphology, structural Organization - centromere, secondary construction, telomere, chromonema, euchromatin and heterochromatin, components of chromosomes (histones and nonhistone), specialized chromosomes (Polytene, Lamp brush), Chromosomal aberrations- structural and numerical chemical composition and karyotype. Ultrastructure: Single-stranded hypotheses, folded-fibre and nucleosome models.

Unit 3: Cell cycle. Bacterial cell division. Eukaryotic cell cycle –phases. Mitosis - Stages (spindle assembly)-significance. Meiosis- Stages (synaptonemal complex)-significance. Senescence and necrosis. Apoptosis.

Unit 4: Protein trafficking. Selective transport of proteins to and from the nucleus. Regulation of nuclear protein import and export. Targeting proteins to ER, smooth ER and lipid synthesis. Export of proteins and lipids from ER and into ER. Lipid and polysaccharide metabolism in Golgi. Protein sorting and export from Golgi. Mechanism of vesicular transport, cargo selection, coat proteins and vesicle budding, vesicle fusion. Protein import and mitochondrial assembly, protein export from mitochondrial matrix. Import and sorting of chloroplast proteins

Unit 5: Microscopic observation of cells: bacteria, fungi, plant and animal. Preparation of different stages of Mitosis (onion root tips) Preparation of different stages of Meiosis (grasshopper testis) Preparation of Polytene chromosome from Drosophila salivary gland. Demonstration of Plasmolysis. Demonstration of Osmosis.

Reference Books

1. The Cell: A Molecular Approach (2009) 5th ed., Cooper, G.M. and Hausman, R.E., ASM Press& Sunderland (Washington DC), Sinauer Associates, MA, ISBN:978-0- 87893-300-6.

2. Molecular Cell Biology (2012) 7th ed., Lodish, H., Berk, A., Zipursky, S.L., Matsudaira, P., Baltimore, D. and Darnell. J., W.H. Freeman & Company (New York), ISBN:13:978-1-4641-0981-2 / ISBN:10:1-4641-0981-8.

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

Components	Continuous 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

Course Id	MIB104
Course Title	Bacteriology and Virology
Credits	4
Contact Hours (L-T-P)	2-1-1

Course Objective

This course aims to provide a comprehensive understanding of bacteriology and virology, focusing on the structure, function, genetics, and pathogenicity of bacteria and viruses. The course will cover both theoretical concepts and practical techniques, aligning with the National Education Policy (NEP) goals of fostering critical thinking, interdisciplinary learning, and application-based education.

Course Outcomes:

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

CO1	Understand the fundamental concepts of bacteriology and virology.
CO2	Analyze the genetic and biochemical mechanisms in bacteria and viruses.
CO3	Explore the interactions between pathogens and host organisms.
CO4	Apply theoretical knowledge to address challenges in public health and disease management.
CO5	Gain practical experience in microbiological techniques and propose and evaluate public health strategies for controlling infectious diseases by integrating knowledge of microbiology, immunology, and therapeutic interventions.

COURSE CONTENT

Unit I: Fundamentals of Bacteriology
Overview of Microbial Life: Bacteria vs. Archaea, Bacterial Cell Structure and Function, Bacterial Growth, Reproduction, and Metabolism, Differentiate between bacterial and archaeal cells. Describe bacterial cell structures and their functions. Understand bacterial metabolic pathways and growth patterns.

Unit II: Bacterial Genetics and Pathogenesis
Bacterial Genome Structure and Gene Expression, Horizontal Gene Transfer: Conjugation, Transformation, Transduction, Mechanisms of Bacterial Pathogenicity, Host-Pathogen Interactions

Unit III: Fundamentals of Virology:
Structure and Classification of Viruses: Viral Life Cycles: Lytic vs. Lysogenic; Virus-Host Interactions; Viral Pathogenesis: Mechanisms and Outcomes

Unit IV: Viral Genetics and Evolution

Organization of Viral Genomes: Mutation, Recombination, and Evolution in Viruses; Emerging and Re-emerging Viral Diseases; Case Studies: Influenza, HIV, SARS-CoV-2

Unit V Immunology and Control of Microbial Infections
Immune System Responses to Bacterial and Viral Infections; Vaccines: Development, Types, and Mechanisms; Antibiotics and Antiviral Drugs: Mechanisms and Resistance; Public Health Strategies for Controlling Infectious Diseases

List of Practicals
Bacterial Culture Techniques
Microscopy
Bacterial Growth Curve Analysis
Antibiotic Susceptibility Testing (Kirby-Bauer Method)
Plaque Assay for Virus Quantification
Case Study Analysis: Emerging Infectious Diseases

Assessment and Grading:

Components	Continuous and Comprehensive Assessment	End Semester Examination
Weightage (%)	**50**	**50**

Recommended Readings

Books
Tortora, G. J., Funke, B. R., & Case, C. L. (2018). Microbiology: An Introduction (13th ed.). **Pearson.**
Madigan, M. T., Bender, K. S., Buckley, D. H., & Stahl, D. A. (2020). Brock Biology of Microorganisms (16th ed.). **Pearson.**
Flint, J., Racaniello, V. R., Rall, G. F., &Hatziioannou, T. (2020). Principles of Virology (5th ed.). **ASM Press.**

Other References
Brooks, G. F., Carroll, K. C., Butel, J. S., & Morse, S. A. (2019). Jawetz, Melnick, & Adelberg's Medical Microbiology (28th ed.). **McGraw-Hill Education**

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

Components	Continuous 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

Course Id	MIB108
Course Title	Microbes for Sustainable Development
Credits	3
Contact Hours (L-T-P)	2-0-1

Course Objective

This Multi-Disciplinary Course (MDC) examines the critical roles that microbes play in promoting sustainable development. The course covers microbial applications in environmental conservation, agriculture, waste management, and renewable energy production. It aligns with the National Education Policy (NEP) by integrating interdisciplinary knowledge, fostering critical thinking, and emphasizing hands-on practical experiences that address real-world challenges.

Course Outcomes:

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

CO1 **Remember**: **List** key types of microbes and their roles in ecosystems and human health.
CO2 **Understand**: **Explain** the significance of microbial processes in nutrient cycling and waste management.
CO3 **Apply**: **Demonstrate** the use of microbes in bioremediation and sustainable agriculture practices.
CO4 **Analyze**: **Examine** the impact of microbial diversity on ecosystem stability and resilience.
CO5 **Evaluate**: **Assess** the potential benefits and risks of using genetically modified microbes in environmental applications and apply laboratory techniques to isolate, identify and characterize microorganisms, demonstrating skills in microbial culture and staining methods

COURSE CONTENT

Unit I - Sustainable Development
Concept of Sustainable Development – Requirements for Sustainable Development – Concept of Linear and Circular Economy – Disadvantages of Linear Economy and hazards to the environment – Shifting from linear to circular economy – Circular economy (CE) leads to Sustainable Development - Sustainable Development Goals (SDG) by UN, 2015 – Bioconversion by microorganisms - Contribution of microbes to CE/SDG – Role of microorganisms in fulfilling goals 2, 3, 6, 7, 9, 12-15.

Unit II – Microbes in Sustainable Food Production and Good Health -
Concept of nutrient cycling - Bioconversion of industrial, agricultural and municipal wastes to biofertilisers – key microorganisms and their enzymatic activities involved – advantages and benefits of using waste derived biofertilisers – improvement of crop yield by microbial activity derived fertilisers –

probiotics in good health – fermented food as a low-cost alternative to sustainable nutrition – integration (effect on CE/SDG)

Unit III – Microbes in Sustaining Life on Land and Water
Brief overview of terrestrial and aquatic ecosystems – degradation of industrial effluents in terrestrial and aquatic ecosystems – biosorption and bioaccumulation - nutrient cycling – overview of mycorrhizal fungi and other beneficial microbial associations – biomass degradation – management of oil spills and microplastic pollution in oceans – restricting eutrophication – contribution to maintaining food chain in ecosystems – summary (effect on CE/SDG)

Unit IV – Microorganisms in Clean Energy and Climate Management
Production of clean energy and methanogenic bacteria – biofuel production by algae – production of bioplastics (PHA/PLA) – microbial fuel cells (MFCs) – overview of pollution management - methanotrophs and management of methane – carbon sequestration and greenhouse effect management – effect of microbial activity on agricultural practices and sustainable health – impact on development

List of Practicals

Isolation and Characterization of Soil Microbes
Microbial Bioremediation of Pollutants
Wastewater Treatment Using Microbial Consortia
Microbial Fuel Cells: Electricity Generation from Organic Waste
Case Study Analysis: Microbes for Sustainable Development

Assessment and Grading:

Components	Continuous and Comprehensive Assessment	End Semester Examination
Weightage (%)	**50**	**50**

Recommended Readings

Books
Bertrand, J. C., Caumette, P., Lebaron, P., Matheron, R., Normand, P., & Sime-Ngando, T. (2015). Environmental Microbiology: Fundamentals and Applications (2nd ed.). Springer.

Arora, P. K. (2021). Microbes and Sustainable Agriculture (1st ed.). Springer.

Other References
Singh, H. (Ed.). (2017). Microbial Biotechnology: Applications in Agriculture and Environment (1st ed.). CAB International.

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

Components	Continuous 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

SEC139	Applied Biophysics I	L	T	P	C
Version 2.0	**Contact Hours - 45**	1	0	1	2
Pre-requisites/Exposure	Basic knowledge in Biology and Physics				
Co-requisites	--				

Course Objectives

This course provides an introduction to the practical applications of biophysics. Students will learn the fundamental principles and techniques of biophysics and explore their applications in fields such as medicine, bioengineering, and pharmaceuticals. Through lectures students will develop a solid understanding of the interdisciplinary nature of biophysics and its importance in solving real-world problems.

Course Outcomes

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

1. Remembering

- Outcome: Identify key concepts and terminology in biophysics.

2. Understanding

- Outcome: Explain the underlying physical principles that govern biological systems.

3. Explaining

- Outcome: Apply biophysical techniques to solve biological problems.

4. Analyzing

- Outcome: Analyze experimental data to draw conclusions about biophysical phenomena.

5. Evaluating

- Outcome: Critique biophysical models and their applicability to real-world scenarios and **a**pply biophysical methods and techniques in laboratory experiments to investigate biological phenomena, demonstrating skills in data analysis and interpretation.

Catalogue Description

Biophysics is an interdisciplinary subject. Students with a strong physical background require exposure to how their knowledge of physics can and has been used to solve important and frontier problems in biology. Thus, this course is aimed at those who possess a background in the physical sciences without any biological training. The approach is to both achieve a basic understanding of many of these topics and the critical experiments that have been done to lay the basis of our understanding of biophysical systems.

Course Content

Unit 1: General physico-chemical principles (5h)
Physico-chemical properties of water, nature and types of interactions, concept of pH and Buffer, Henderson–Hasselbalch equation, titration curve and pK values, examples of redox potential in biological system, numerical problems.

Unit 2: Physical Foundations of Biophysics (10h)
Thermodynamics of Biological system: first and second laws of thermodynamics, activation energy, concept of free energy, entropy, enthalpy, negative entropy as applicable to biological systems, thermodynamics of passive and active transport, concept of bioenergetics, applications of bioenergetics in biology.

Unit 3: Spectroscopic techniques (6h)
Colorimetry and UV-Vis spectroscopy, Data analysis and interpretation, recent developments in colorimetry and UV-Vis spectroscopy and industrial applications.

Unit 4: Chromatography techniques (8h)
Basic concept on paper chromatography, Thin layer chromatography, High-performance liquid chromatography (HPLC), sample preparation techniques for chromatographic analysis, data interpretation and analysis of chromatographic results, troubleshooting common issues in chromatography experiments.

Unit 5: Microscopy techniques (6h)
Bright field microscopy, Phase contrast microscopy, Fluorescence microscopy, fixation, staining, and mounting of samples for microscopy. Introduction to software for microscopy image processing.

List of Practicals (10h)
(a) Preparation of buffer.
(b) Operating instructions for colorimeter and UV-Visible spectrophotometer.
(c) Determination of sodium salicylate in face wash solutions by colorimetry.
(d) Demonstration of High-performance liquid chromatography (HPLC).
(e) Separation of amino acids by paper and thin layer chromatography.
(f) Operating instructions for bright field microscope.

Books
1. Biophysics: An Introduction by Rodney Cotterill.
2. Biophysics: Tools and Techniques edited by J. Andrew McCammon and Stephen C. Harvey.
3. Physical Biochemistry: Principles and Applications by David Sheehan.

Reference Books
1. Biophysical Chemistry by Peter Atkins and Julio De Paula.

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

Components	Continuous 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

VAC105	Community Engagement and Social Responsibilities	L	T	P	C
Version 1.0	**Contact Hours: 60**	1	0	1	**2**
Pre-requisites/Exposure	**Knowledge of Environment and Ecosystem at 10+2 level**				
Co-requisites	**-**				

Course Objectives

1. To gain a deeper understanding of community, social structure, social needs, ecological balance.

2. To acquire the knowledge of different community and their responsibilities for society development.

3. To acquire the knowledge about the importance of communication between communities and social work.
4. To gain the knowledge about social responsibilities and its importance.
5. To understand the need of social help (by human activities) for the benefit of entire lining beings (Human, animals, plants).

Course Outcomes

On completion of this course, the students will be able to
CO1: Recall the fundamental concepts of community engagement, social responsibility, and sustainable development.

CO2: Understand the social, cultural, and economic diversity within communities and the role of civic responsibility in fostering inclusivity.

CO3: Apply strategies for engaging with communities through participatory methods to identify and address local issues.

CO4: Analyze the impact of various social interventions and programs on community development and individual empowerment.

CO5: Evaluate the ethical dimensions and long-term sustainability of community engagement initiatives and create collaborative projects or action plans that address community challenges while promoting social equity and inclusivity.

Catalog Description

Social services can be both communal and individually based. This means that they may be implemented to provide assistance to the community broadly, such as economic support for unemployed citizens, environmental support (plantation), helping animals/birds to maintain ecological balance. This course also focus on specific need of an individual to support overall community and welfare. Ecological balance is also an important topic

that is required to support via various human activities. Classes will also be conducted focusing on community health workers that promote wellness by helping people adopt healthy behaviors. Various new ideas from young minds will always be encouraged that are related to any king of healthy community service and that could be utilized for overall welfare to the society that ensures social security and social support.

Course Content

Unit I: Introduction [12Lecture hours]

Introduction to Community Service, social structure, group, community /social work.Understanding the process of Urbanization-Urban Social Problems-Slums, Types of Slums-Urban Poor-Understanding Urban Power Structure and identifying the resources of the community (Community Mapping) and Modules for the community Service.

UnitII: Community & Groups [12 Lecture hours]

Identifying groups in the community such as women-children-youth-elders and persons with disabilities-Equipping with the skills to address issues such as Education, health, sanitation, Environment & livelihood issues. Special needs for environmental support, importance of plantation.

Unit III Community program

[12 Lecture hours]

Community Program Planning: Orientation on community program – Event process (Identifying the issues, Need based analysis on specific issues, Invitation, Pamphlets, Inviting participants, Content designing, identifying & Selection of tools, venue arrangements, tapping the resources and etc). Awareness / advocacy for an issue identified and build capacity to carry out that awareness and advocacy program. Importance of groupwise program for various types of community service for social /environmental support.

Unit IV Social Support [12 Lecture hours]

Importance of social support along with ecological balance, ecological balance, helping animals/birds. Relation between social support and social security, social help, social needs for specific animal species (like building nests for small birds). Campaign against alcoholism and substance addiction – Pros and cons of Social Media specially for young adults.

UnitV: Community Learning (Education) & social Help

[12 Lecturehours]

Importance of Education, Child rights ,Special Coaching (Easy English to all), Basic computer skill, Communication skill, Understanding various Govt. schemes related to urban poor - Creating livelihood opportunities – Basic App (in mobile). Rights of Women, children and others – marketing - Entrepreneurial skills & Schemes - Creating livelihood opportunities – Access to digital money (ATM, E-corner etc.,)

Reference Books

1. Community Service. by Frank Leroy Blanchard. Kessinger Pub. ISBN-10 : 1120180120, 2015

2. Managing Community Health Services byAllenMcNaught.
3. In Quest of Humane Development. By B. Dasgupta et.al.
4. Practicing Social Work in Deprived Comminities (Springer) by Ana Opacic.
5. Service Learning Through Community Engagement by Lori Gardinier

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

Components	Continuous 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	-	1	3	-	-	-	-	3	-	3	3	3
CO2	-	1	3	-	-	-	-	3	-	3	3	3
CO3	-	1	3	-	-	-	-	3	-	3	3	3
CO4	-	1	3	-	-	-	-	3	-	3	3	3
CO5	-	1	3	-	-	-	-	3	-	3	3	3
Avg	-	1	3	-	-	-	-	3	-	3	3	3

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

AEC102	Communicative English II	L	T	P	C
Version1.0		2	1	0	**3**
Pre-requisites/Exposure	**Basic Knowledge in English Language**				
Co-requisites	**-**				

Course Description

This course is the continuation of the Communicative English I course, which is offered in semester I. In this course, the learners will have repeated practice of what they have already acquired in the last course and will simultaneously develop news skills. The writing section of this course particularly focuses on academic writing and professional writing. The course intends to develop critical thinking ability of learners through various speaking tasks.

Course Outcomes:

CO1: Recall basic grammar rules and vocabulary to construct meaningful sentences in English.

CO2: Understand the structure and purpose of different forms of communication, including verbal and non-verbal modes.

CO3: Apply effective speaking and writing techniques in various contexts such as presentations, group discussions, and formal correspondence.

CO4: Analyze spoken and written texts to identify main ideas, supporting details, and implicit meanings.

CO5: Evaluate communication strategies for clarity, coherence, and appropriateness in different professional and social settings and **create** well-structured written documents and deliver engaging oral presentations tailored to specific audiences and purposes.

Program Outcomes:

1. Students can read and understand any text in English
2. Students imbibe the rule of English language unconsciously and can deduce language structure and usage
3. Students will be able to present arguments and observation through writing
4. Students will be able to decipher the mechanisms of language usage in different contexts and discourse.

Unit 1

- Listening: Practice listening to passages. practicing summarizing listening passages. Reading: practice reading and solving sample passages
- Speaking: Describing concepts and thoughts
- Grammar: practice tense practice types of sentences (declarative, negation, questions, active and passive voice)

- Writing: practice paraphrasing paragraphs from reading passages

Unit 2

- Speaking: asking for and giving opinion, agreeing and disagreeing with opinions, persuading and dissuading people. Describing concepts and thoughts
- Vocabulary: idioms
- Reading: practice reading and solving sample passages
- Writing: practice types of letter writing.

Unit 3

- Listening: Listen to passages and Speaking: expressing likes, dislikes, sympathy, emotions, hopes, wishes, regrets, and concerns. practice solving questions of listening passages
- Speaking: expressing likes, dislikes, sympathy, emotions, hopes, wishes, regrets, and concerns
- Grammar: practice different forms of conjunctions, disjunctions, and articles.
- Writing: practice report writing and other professional writing styles

Unit 4

- Listening: practice collaborative discussion of those passages
- Speaking: explaining words and actions with reasons.
- Writing: practice sessions on sample academic writing

Recommended Readings

4. Fluency in English-Part II, Oxford University Press, 2006.
5. Business English, Pearson, 2008.
6. Grammar and Composition, Wren and Martin.

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

Components	Continuous 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	-	1	3	-	-	-	-	3	2	3	-	3
CO2	-	1	3	-	-	-	-	3	2	3	-	3
CO3	-	1	3	-	-	-	-	3	2	3	-	3
CO4	-	1	3	-	-	-	-	3	2	3	-	3
CO5	-	1	3	-	-	-	-	3	2	3	-	3
Avg	-	1	3	-	-	-	-	3	2	3	-	3

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

ADAMAS UNIVERSITY

B.Sc. Microbiology (Hons.)

SEMESTER-III

MIB201	Microbial Metabolism	L	T	P	C
	Contact Hours - 60	2	1	1	4
Pre-requisites/Exposure	PLUS, TWO (12th) LEVEL BIOLOGY				
Co-requisites	--				

Course Objectives

1. Developing knowledge of microbial growth
2. To have general perception of microbial metabolism
3. To analyze roles of nutrients as carbon and nitrogen source and utilization
4. To identify photosynthesis and ETC as basis of energy metabolism
5.

Course Outcomes

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

CO1:Recall the fundamental concepts and terminologies of microbial metabolism, including catabolism, anabolism, and energy production.

CO2:Understand the biochemical pathways involved in microbial energy production, such as glycolysis, TCA cycle, oxidative phosphorylation, and fermentation.

CO3:Apply knowledge of metabolic pathways to explain the diversity of microbial metabolic processes under different environmental conditions.

CO4:Analyze the interconnections between various metabolic pathways and their regulation in microbial systems.

CO5:Evaluate the impact of environmental factors and genetic modifications on microbial metabolism and their implications for biotechnology and **design** experimental strategies to study microbial metabolic processes, including pathway analysis and enzyme activity assays.

Catalogue Description

The core-course of 'Microbial Physiology and Metabolism' will help to understand the basic concept and application of microbial growth and metabolism. This course includes comprehensive approach through studying impact of conditions on growth and metabolism. Furthermore, students will be able to classify based on nutritional parameters and elaborate energy metabolism. 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 Contents
Theory (45 h)

Unit 1: Microbial growth, Nutrient uptake and transport in microbial metabolism

Microbial growth stages, generation time, specific growth rate, effect of temperature, pH and salt on microbial growth, Passive and facilitated diffusion, Active transport, Primary and secondary active transport, concept of uniport, symport and antiport, Group translocation, Iron uptake

Unit 2: Chemoheterotrophic Metabolism - Aerobic Respiration

Concept of aerobic respiration, Sugar degradation pathways, i.e., EMP, ED, Pentose phosphate pathway TCA cycle. Electron transport chain: components of respiratory chain, comparison of mitochondrial and bacterial ETC, electron transport phosphorylation, uncouplers and inhibitors.

Unit 3: Chemoheterotrophic Metabolism- Anaerobic respiration and fermentation

Anaerobic respiration with special reference to dissimilatory nitrate reduction (Denitrification; nitrate /nitrite and nitrate/ammonia respiration; fermentative nitrate reduction) Fermentation - Alcohol fermentation and Pasteur effect; Lactate fermentation (homofermentative and heterofermentative pathways), concept of linear and branched fermentation pathways

Unit 4: Chemolithotrophic and Phototrophic Metabolism

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

Unit 5: Nitrogen and Amino acid metabolism- An overview

Introduction to biological nitrogen fixation, Ammonia assimilation, Assimilatory nitrate reduction,

Lab (15 h):
List of the practical

1. Study and plot the growth curve of E. coli by turbidometric and standard plate count methods.
2. Calculations of generation time and specific growth rate of bacteria from the graph plotted with the given data
3. Effect of temperature on growth of *E. coli*
4. Effect of pH on growth of *E. coli*
5. Effect of carbon and nitrogen sources on growth of *E. coli*

6. Effect of salt on growth of *E. coli*
7. Growth of anaerobic bacteria and its characterization
8. Enrichment of phototrophic bacteria from natural sources

Experiential learning:

1. Consulting recent articles on microbial metabolism
2. Problem (numerical) solving
3. Video lectures:

Extra credit in offer:

NPTEL course:

Overview And Integration Of Cellular Metabolism, IIT Kharagpur
Dr. Arindam Ghosh, Dr. Aritri Bir

Or a relevant one (up on due approval)

https://nptel.ac.in/courses/104105139

SUGGESTED READING

Madigan MT, and Martinko JM (2014). Brock Biology of Microorganisms. 14th edition. Prentice Hall International Inc.

Moat AG and Foster JW. (2002). Microbial Physiology. 4th edition. John Wiley & Sons

Reddy SR and Reddy SM. (2005). Microbial Physiology. Scientific Publishers India

Gottschalk G. (1986). Bacterial Metabolism. 2nd edition. Springer Verlag

Stanier RY, Ingrahm JI, Wheelis ML and Painter PR. (1987). General Microbiology. 5th edition, McMillan Press.

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

Components	Class Assessment (including lab)				End Term
	Experiential learning	Quiz, etc	Regular evaluation	Attendance	
Weightage (%)	10	5	30	5	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

BIC202	Basics of Plant and Animal Sciences	L	T	P	C
Version 1.0	**Contact Hours - 60**	2	1	1	4
Pre-requisites/Exposure	BOTANY BASIC FROM CLASS XII				
Co-requisites	--				

Course Objectives

1. Understand fundamental concepts of plant and animal biology, including key terms and definitions.
2. Explain the roles of photosynthesis, cellular respiration, and reproduction in the life cycles of plants and animals.
3. Apply basic scientific techniques to conduct experiments related to plant growth and animal behaviour.
4. Analyze data from experiments to draw conclusions about the effects of environmental factors on plants and animals.
5. Evaluate different agricultural practices and their impacts on ecosystems and biodiversity.

Course Outcomes

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

1. Remembering

- **Identify** key concepts and terminology related to plant and animal biology.

2. Understanding

- **Explain** the processes of photosynthesis and cellular respiration in plants and animals.

3. Applying

- **Demonstrate** proper techniques for plant propagation and animal care.

4. Analyzing

- **Differentiate** between the various types of plant and animal classifications.

5. Evaluating

- **Assess** the effectiveness of different agricultural practices on crop yield and **create** practical solutions or projects using plant and animal science principles to address agricultural, environmental, or medicinal challenges.

Catalog Description

The core-course of 'Basics of Plant and Animal Sciences' is discipline specific elective subject which deals with the modern aspects of plant physiology and animal biochemistry. This course deals with plant and animal cellular structure with emphasis to special organelles related to plant and animal cells. It also includes topics related to plant specific biochemical pathways like photosynthesis, respiration and nitrogen fixation. Furthermore, it deals with the roles of phyto-hormones and secondary metabolites in plant growth and development.It also encompasses the very important industrially important plant tissue culture technique. 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

Plant Biochemistry (MIB202)

Basics of Plant and Animal Sciences

UNIT 1

Introduction to plant kingdom. Introduction to Plant cell structure: Plasma membrane, Vacuole and tonoplast membrane, cell wall, mitochondria, plastids and peroxisomes. Photosynthesis and Carbon assimilation: Structure of PSI and PSII complexes, Light reaction, Cyclic and non cyclic photophosphorylation, Calvin cycle and regulation; C4 cycle and Crassulacean acid metabolism (CAM), Photorespiration. Respiration.

UNIT 2

Nitrogen metabolism, Introduction to plant hormones and their effect on plant growth and development. Secondary metabolites representative examples from each class, biological functions. Plant tissue culture: Cell and tissue culture techniques, types of cultures: organ and explants culture, callus culture, cell suspension culture and protoplast culture. Plant regeneration pathways: organogenesis and somatic embryogenesis. Applications of cell and tissue culture and somaclonal variation.

UNIT 3

Outline of classification of non-chordates and chordates up to sub classes and general features of all the major phyla. Special topics on non-chordates and chordates (Water Canal system in Porifera & Water Vascular system in Starfish, Parental care in Fish, Neoteny and Paedogenesis, Flight adaptations in birds, Dentition in mammals).

UNIT 4

Digestive System: Functions of digestive organs, Modes of mechanical digestion, Chemical digestion (hormones, enzymes, pH), Absorption and elimination, Name parts of GI Tract and accessory organs, Nutrition and metabolism (production of ATP). Excretory System: Functions of urinary system, Kidney, ureter, bladder, urethra, Microanatomy and function of nephron, Formation of urine-steps involved.

Respiratory System: General structure of respiratory system and functions- Lungs and Trachea, Respiratory Pathways, Functional aspects and mechanics of respiration. Nervous System: Functions of nervous system, Organization of the Nervous System - Structural Classification, Functional Classification, and Nervous Tissue: Structure and Function –

UNIT 5

Basics of Plant and Animal Sciences Applications: **Analyse**, appraise and discuss the topic with different tools and techniques.

List of practical:

1. Identification and Classification of the following:

Non-chordate specimens: Scypha, Obelia, Sea-anaemone, Ascaris, Hirudinaria, Scorpion, Bombyx mori, Acatina, Loligo, Starfish, Balanoglossus.

Chordate specimens: Branchiostoma, Petromyzon, Scolidon, Lates, Axolotl larva, Tylototriton, Gekko; Hemidactylus, Turtle, Naja, Chiroptera.

Plant specimens.

2. Visit to any national park/museum/zoological garden and prepare an ecological Note.
3. Identification of Different mammalian tissue sections of digestive system, excretory system and respiratory system.
4. Study of seed germination and plant pigments.

SUGGESTED READING:

1. Barnes, R.D. (1992). Invertebrate Zoology. Saunders College Pub. USA.
2. Campbell & Reece (2005). Biology, Pearson Education, (Singapore) Pvt. Ltd.

3. Raven, P. H. and Johnson, G. B. (2004). Biology, 6th edition, Tata McGraw Hill Publications. New Delhi.

Textbooks:

(1) Plant Biochemistry (2008), Caroline Bowsher, Martin steer, Alyson Tobin, Garland science ISBN 978-0-8153-4121-5

[2] Ruppert, Fox and Barnes (2006) Invertebrate Zoology. A functional Evolutionary Approach 7th Edition, Thomson Books/Cole.

[3] Kardong, K. V. (2002). Vertebrates Comparative Anatomy. Function and Evolution. Tata McGraw Hill Publishing Company. New Delhi.

[3] Charles E. Tobin, Basic Human Anatomy, McGraw Hill Publication.

[4] J. H. Green An Introduction to Human Physiology.

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

Components	Quiz	Attendance	Class Assessment	End Term
Weightage (%)	10	10	30	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

MIB206	Introduction to Biomaterials	L	T	P	C
Version 1.0	**Contact Hours - 60**	2	0	1	3
Pre-requisites/Exposure	Basic knowledge of Biology				
Co-requisites	--				

Course Objectives

1. Understand common use of biomaterials as metals, ceramics and polymers and its chemical structure, properties, and morphology.
2. Understand and account for methods for categorization of biomaterials.
3. Explain methods to modify surfaces of biomaterials and choose material for desired biological response.
4. Describe interactions between biomaterials, proteins and cells.
5. Understand the interaction between biomaterial and tissue for short term and long term implantations, distinguish between reactions in blood and in tissue.
6. Explain the types of material used to replace different organs & tissues of human body.

Course Outcomes

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

CO1:Recall the basic concepts and terminologies related to biomaterials, including types, properties, and applications.

CO2:Understand the relationship between the structure, properties, and functions of biomaterials used in medical and biological applications.

CO3:Apply knowledge of material science to evaluate the suitability of biomaterials for specific biomedical applications, such as implants or tissue engineering.

CO4:Analyze the interactions between biomaterials and biological systems, including biocompatibility, degradation, and immune responses.

CO5:Evaluate the performance of biomaterials under various physiological conditions and their compliance with safety and regulatory standards and **design** innovative solutions or propose modifications to existing biomaterials for enhanced functionality in biomedical applications.

Catalogue Description

The purpose of this course is to acquaint each student with the field of material Science and the bio materials that are used in medical devices or in contact with biological systems. The effectiveness of the technology depends on the behaviour of the Bio materials and the Medical devices.

Course Content

Unit-1 Properties of Materials Bulk properties and Surface properties of Materials Characterization methods of surface properties of Biomaterials Materials Used In Medicine: Metals; Polymers; Hydrogels; Bioresorbable and Biodegradable Materials.

Unit-2 Materials Used in Medicine Fabrics
Biologically Functional Materials; Ceramics; Natural materials; Composites, thin films, grafts and coatings; Pyrolytic Carbon for long-term medical Implants; Porous materials; Nano biomaterials.

Unit-3 Host Reactions to Biomaterials Inflammation
Wound healing and the Foreign body response; Systemic toxicity and Hypersensitivity; Blood coagulation and Blood-materials Interactions; Tumorigenesis. Degradation of Materials in Biological Environment: Degradation of Polymers, Metals and Ceramics.

Unit-4 Application of Biomaterials
Cardiovascular Applications; Dental implants; Adhesives and Sealants; Opthalmologic Applications; Orthopedic Applications; Drug Delivery System; Sutures; Bioelectrodes; Biomedical Sensors and Biosensors.

List of Experiments: (Outlines)
1. Extraction of biopolymers from natural origins
2. Fabrication of 2D/3D biomaterials
3. Characterization of biomaterials: morphology, stability, solubility, degradibility.

Course Materials:
Required Text: Textbooks
1. Schoen, F. J., Ratner, B. D., Hoffman, A. S., Lemons, J. E. (2004). Biomaterials Science: An Introduction to Materials in Medicine. Netherlands: Elsevier Science.
2. Hench, L. L., Ethridge, E. C. (1982). Biomaterials: an interfacial approach. United Kingdom: Academic Press.

Optional Materials: Reference Books
1. Bronzino, J. D. (2000). The Biomedical Engineering Handbook. Germany: CRC Press.

Experiential learning:

1. Flip classes
2. Presentation on relevant topics
3. Attending seminars and research talks

Extra credit in offer:

NPTEL course: Introduction to Biomaterials (https://nptel.ac.in/courses/113104009)
Or a relevant one (up on due approval)

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

Components	Class Assessment (including lab)				End Term
	Experiential learning	Quiz etc.	Regular evaluation	Attendance	
Weightage (%)	10	5	30	5	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

SEC140	Applied Biophysics II	L	T	P	C
Version 1.0	**Contact Hours - 45**	1	0	1	2
Pre-requisites/Exposure	Basic knowledge in Biology and Physics				
Co-requisites	--				

Course Objectives

The course focuses on applying the principles of physics to understand and analyze biological systems at various levels. Students learn how physical laws and techniques can be used to investigate biological processes and phenomena. Students develop skills in quantitative analysis and mathematical modeling of biological systems. They learn to use mathematical tools and computational techniques to describe and predict the behavior of biological systems, such as protein folding, ion channel function, or cell signaling.

Course Outcomes

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

CO1:Recall fundamental concepts and principles of biophysics, including the physical forces and processes influencing biological systems.

CO2:Understand the relationship between biophysical principles and the structure-function relationship in biological macromolecules.

CO3:Apply biophysical techniques such as spectroscopy, electrophoresis, and microscopy to study biological molecules and systems.

CO4:Analyze the dynamics of biomolecular interactions, such as ligand binding, enzyme kinetics, and membrane transport mechanisms.

CO5:Evaluate the role of biophysical methods in solving biological problems and their implications in research and healthcare and **design** experimental approaches using biophysical principles to investigate complex biological systems or solve specific research challenges.

Catalogue Description

The course aims to provide students with a solid foundation in the fundamental principles of biophysics. This includes concepts from physics, chemistry, biology, and mathematics that are relevant to the study of biological systems. The course may explore the applications of biophysics in biotechnology, medicine, and related fields. Students learn about the role of biophysics in areas such as drug discovery, medical imaging, biomaterials, and biophysical techniques used in diagnosis and therapy.

Course Content

Unit 1: Structural Biophysics (10h)
Methods for structural analysis (X-ray crystallography, NMR, Circular dichroism, mass spectrometry); Principles, methodologies and applications of Scanning Electron Microscopy (SEM) and Transmission Electron Microscopy (TEM).

Unit 2: Membrane Biophysics (7h)
Membrane structure and dynamics, membrane transport mechanisms (channels, carriers, pumps), electrical properties of membranes (ionic currents, membrane potential), Basic principles and applications of sensory perception and signal transduction.

Unit 3: Electrophoresis in Biophysics (5h)
Agarose gel electrophoresis and polyacrylamide gel electrophoresis (PAGE), immunoelectrophoresis, analysis of serum proteins and immunoglobulins.

Unit 4: Computational Biophysics (5h)
Introduction to computational biophysics, Molecular dynamics simulations, Applications of Molecular Dynamics Simulations in protein folding and protein-ligand interactions.

Unit 5: Biophysics in Drug Discovery and Development (8h)
Principles of drug discovery and development, Structure-based drug design, Applications of High-throughput screening techniques.

List of Practicals (10h)
(a) Demonstration of Scanning Electron Microscopy.
(b) Preparation of lipid vesicles using phospholipids such as phosphatidylcholine.
(c) Electrophoresis buffer preparation.
(d) Demonstration of use software packages such as GROMACS.
(e) Separation of proteins by polyacrylamide gel electrophoresis.
(f) DNA size determination by agarose gel electrophoresis.

Books
1. Biophysics: An Introduction by Rodney Cotterill.
2. Biophysics: Tools and Techniques edited by J. Andrew McCammon and Stephen C. Harvey.
3. Physical Biochemistry: Principles and Applications by David Sheehan.

Reference Books
1. Biophysical Chemistry by Peter Atkins and Julio De Paula.

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

Components	Continuous 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

MIB252	Microbial Ecology	L	T	P	C
Version 1.0	**Contact Hours - 60**	2	1	1	4
Pre-requisites/Exposure	Basic knowledge in Biology				
Co-requisites	--				

Course Objectives

Explore the classification and diversity of microorganisms, including bacteria, archaea, fungi, and protists, and their roles in different ecosystems.

Analyze the interactions between microorganisms and their environments, including competition, symbiosis, and predation, and how these relationships shape community dynamics.

Understand the role of microorganisms in biogeochemical cycles (carbon, nitrogen, sulfur, and phosphorus) and their importance in ecosystem functioning and nutrient cycling.

Evaluate the effects of human activities, such as pollution and climate change, on microbial communities and ecosystem health.

Develop skills in sampling, isolating, and characterizing microbial communities using laboratory techniques and molecular methods.

Explore applications of microbial ecology in environmental management, biotechnology, and agriculture, including bioremediation and sustainable practices.

Course Outcomes

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

CO1:Recall the fundamental concepts of microbial diversity, ecological roles, and environmental interactions.

CO2:Understand the relationships between microorganisms and their habitats, including their roles in biogeochemical cycles.

CO3:Apply ecological principles to study microbial communities and their responses to environmental changes.

CO4:Analyze the interactions between microorganisms and other organisms, such as symbiosis, competition, and predation, in ecological contexts.

CO5:Evaluate the impact of microbial activities on ecosystem processes, human health, and environmental sustainability and **design** strategies for the application of microbial ecology principles in areas such as bioremediation, agriculture, and climate change mitigation.

1. **Course Description**
   This course explores the interactions of microorganisms with each other and their environment. Topics include microbial diversity, community structure, biogeochemical cycles, and the role of microbes in ecosystem functioning. Emphasis will be placed on both theoretical concepts and practical applications in environmental management and biotechnology.

Course Content

Unit 1

Introduction to Microbial Ecology Overview and historical context, Key concepts and terminology; Microbial Diversity Taxonomy and phylogenetic relationships, Methods for studying diversity (e.g., culturing, molecular techniques); Microbial Habitats and Communities, Terrestrial, aquatic, and extreme environments, Microbial biofilms and community structure

Unit 2

Biogeochemical Cycles; The role of microbes in carbon, nitrogen, sulfur, and phosphorus cycles; Microbial Interactions Types of interactions: mutualism, commensalism, competition, and predation; Ecological significance of microbial interactions

Unit 3

Microbial Ecology in Ecosystem Functioning Contributions to primary production and decomposition; Microbial influences on soil health and plant growth; •Anthropogenic Influences on Microbial Communities; Pollution, climate change, and habitat loss; Microbial adaptation and resilience

Unit 4

Applications in Microbial Ecology; Bioremediation and environmental managementMicrobial ecology in agriculture and biotechnology; Research Methods in Microbial Ecology; Sampling techniques and experimental design; Data analysis and interpretation

Unit 5

Laboratory Experiments –

- Isolation and Characterization of Soil Microbial Communities
- Effects of Environmental Factors on Microbial Growth,
- Microbial Bioremediation
- Biofilm Formation and Characterization
- Plant-Microbe Interactions

Suggested Books:

1. Raven, P. H. and Johnson, G. B. (2004). Biology, 6th edition, Tata McGraw Hill Publications. New Delhi

2. Tortora, G.J.; Funke, B.R.; Case, C.L. ***Microbiology: An introduction***. Pearson Education: 2015.
3. Willey, J.M.; Sherwood, L.; Woolverton, C.J. ***Prescott's microbiology***. McGraw-Hill: 2013.

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

Components	**Continuous 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

Course Id	VAC102
Course Title	Human Values and Ethics
Credits	2
Contact Hours (L-T-P)	2-0-0

Course Objective

To facilitate the development of a Holistic perspective among students towards life and profession as well as towards happiness and prosperity based on a correct understanding of the Human reality and the rest of Existence. To achieve sustainable development goals by fostering a sense of responsibility and awareness among students about the impact of their actions on the world around them.

Course Outcomes:

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

CO1:Recall the fundamental principles of human values, ethics, and morality and their relevance in personal and professional life.

CO2:Understand the importance of ethical behavior and the role of values in fostering individual and societal well-being.

CO3:Apply ethical frameworks to analyze real-life scenarios and resolve moral dilemmas.

CO4:Analyze the interrelationship between human values, ethics, culture, and societal norms across different contexts.

CO5:Evaluate ethical issues and challenges in contemporary society, including environmental ethics, workplace ethics, and global justice and **create** actionable strategies or initiatives to promote ethical practices and value-based leadership in various spheres of life.

COURSE CONTENT

Unit I Value Education, Love, Compassion and Truth

Understanding value education. Love and its forms: love for self, parents, family, friend, spouse, community ,nation, humanity and other beings—living and non-living. Affect theory

Love and compassion and inter-relatedness**:** relationship between love and compassion and other related feelings and emotions like empathy, sympathy, and non-violence. Value education to achieve SDGs.

Individuals who are remembered in history or collective memory for practising compassion and love: (such as the Buddha, and Jesus Christ)

What is truth? A Universal truth, truth as value (a*rtha*), truth as fact (*satya*) (veracity, sincerity, honesty among others)

Individuals who are remembered in history for practising this value (Raja Harishchandra, Dharmaraja Yudhishthira, Gautama Buddha, Socrates, and Mahatma Gandhi, among others)

Unit II Non-Violence, Righteousness and Peace

Non-violence and its need. *Ahimsa* is non-violence and non-killing. Individuals and organizations that are known for their commitment to non-violence.

What is righteousness? Righteousness and *dharma*, righteousness and propriety. Individuals who are remembered in history for practising righteousness.

What is peace and its need? Peace, harmony and balance. Individuals and organizations that are known for their commitment to peace (Mahatma Gandhi, United Nations).

Unit III Harmony in the Family and Society

Harmony in the human being. Understanding harmony in the self.

Family: Meaning and constitution. Importance of family relationships. Characteristics of a strong family. Build strong family relationships

Trust and Respect as the foundational values of relationship. Understanding the meaning of Trust; Difference between intention and competence; The meaning of Respect; Difference between respect and differentiation; the other salient values in relationship.

Meaning of Society. Social roles — Meaning and various types. Individual as a Social Being. Responsibilities as Social Being. Role conflict versus role strain. Harmony in the society (society being an extension of family; Visualizing a universal harmonious order in society - from family to world family

Unit IV Love and Sensitivity for Nature and Environment

The harmony in the Nature. Interconnectedness and mutual fulfilment among the four orders of nature recyclability and self-regulation in nature. Understanding Existence as Co-existence of mutually interacting units in all-pervasive space

Unit V Ethics and Integrity

Ethics and its importance. Ethical decision making. Personal and professional moral codes of conduct. Competence in professional ethics. Ethical human conduct. Strategies for Transition towards Value-based Life and Profession. Creating a harmonious life.

What makes an individual great? Understanding the persona of a leader for deriving holistic inspiration.

Assessment and Grading:

Components	Continuous and Comprehensive Assessment	End Semester Examination
Weightage (%)	50	50

Recommended Readings

Books

1. R R Gaur, R Asthana, G P Bagaria, *A Foundation Course in Human Values and Professional Ethics*, 2nd Revised Edition, Excel Books, New Delhi, 2019.

Other References

1. B L Bajpai, 2004, Indian Ethos and Modern Management, New Royal Book Co., Lucknow.
2. A.N. Tripathy, 2003, Human Values, New Age International Publishers.
3. PL Dhar, RR Gaur, Science and Humanism, Commonwealth Publishers.

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

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

PDC201	Professional Development Course-I	L	T	P	C
Version 1.0	Contact Hours - 30	0	0	1	1
Pre-requisites/Exposure	Semester-wise course				
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 learning outcomes:

Remember Recall fundamental concepts of professional ethics, communication, and workplace dynamics.

Understand Interpret the principles of effective communication and teamwork in a professional setting.

Apply Implement strategies for personal branding, time management, and goal-setting to enhance career growth.

Analyze Examine real-world scenarios to identify challenges and propose solutions in professional contexts.

Evaluate **Assess** the effectiveness of leadership styles and decision-making approaches in diverse work environments and d**evelop** a comprehensive personal and professional development plan, incorporating skills, ethics, and growth strategies.

Course Syllabus:

The syllabus for Professional Development Course-I for senior students (preferably 3rd semester-7th semester of U.G)

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.

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

ADAMAS UNIVERSITY

B.Sc. Microbiology (Hons.)

SEMESTER-IV

MIB203	Environmental Microbiology	L	T	P	C
Version 1.0	**Contact Hours - 60**	2	1	1	4
Pre-requisites/Exposure	12th level Biology				
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 illustrate and appraise the regulations associated with waste management, and apply the knowledge to judge the potability of water samples.
5. Students will be able to identify different microbial community from different ecosystem and characterize them.

Course Outcomes

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

CO1:Recall the fundamental concepts of microbial ecology and the roles of microorganisms in environmental processes.

CO2:Understand the interactions between microorganisms and their environments, including their roles in nutrient cycling and pollutant degradation.

CO3:Apply microbiological techniques to assess and monitor microbial communities in diverse ecosystems.

CO4:Analyze the effects of environmental factors such as temperature, pH, and pollutants on microbial diversity and activity.

CO5:Evaluate the applications of environmental microbiology in bioremediation, wastewater treatment, and sustainable agriculture and **design** strategies utilizing microorganisms to address environmental challenges such as pollution control and climate change mitigation.

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 I: Air Soil and Water Microbiology (12 Hrs)

1. Diversity of microorganisms & their natural habitats

i). Terrestrial Environment: Soil characteristics, Soil profile, Soil formation, Soil as a natural habitat of microbes, Soil microflora, humus, composting

ii). Aquatic Environment: Stratification & Microflora of Freshwater & Marine habitats

iii). Atmosphere: Stratification of the Atmosphere, Aeromicroflora, Dispersal of Microbes

iv). Animal Environment: Microbes in/on human body (Microbiomics) & animal (ruminants) body.

v). Extreme Habitats: Extremophiles: Microbes thriving at high & low temperatures, pH, high hydrostatic & osmotic pressures, salinity, & low nutrient levels.

Techniques of studying Air and Soil Microflora.

Unit II: Microbial interaction in different ecosystem

(12Hrs) 1. Succession of microbial communities in the decomposition of plant organic matter

2. Biological Interactions: i). Microbe–Microbe Interactions; Mutualism, Synergism, Commensalism, Competition, Ammensalism, Parasitism, Predation, Biocontrol agents, microbial succession

Microbe–Plant Interactions; Roots, Aerial Plant surfaces, Biological Nitrogen fixation, Defense response, Pathogenicity in plants, Tools for infectious Phytotoxins. Mycorrhyza.

Microbe–Animal Interactions; Role of Microbes in Ruminants, Nematophagus fungi, Luminescent bacteria as Symbiont

Unit III: Role of microorganisms in biogeochemical cycles (12 Hrs)

Contribution of Microorganisms in C, N, P S cycle

Unit IV: Role of microorganisms in waste water management (12 Hrs)

Water purification & sanitary analysis. Waste water Microbiology, Measurement of waste water quality, Waste water treatment.

Unit V: Role of microorganisms in bioremediation (12 Hrs)

Bioremediation: Bioleaching, Biopesticides, cleaning of oil spills, biogas production

List of experiments to estimate of role of microorganisms in environment

1. Analysis of soil

pH, moisture content, water holding capacity, percolation, capillary action.

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

Text Books

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. Elsevier
T4.Pepper IL, Gerba CP, Gentry TJ (2014). Environmental Microbiology, 3rdedition, Academic Press

Reference Books

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	Continuous 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	-	1	3	-	-	-	-	3	-	3	3	3
CO2	-	1	3	-	-	-	-	3	-	3	3	3
CO3	-	1	3	-	-	-	-	3	-	3	3	3
CO4	-	1	3	-	-	-	-	3	-	3	3	3
CO5	-	1	3	-	-	-	-	3	-	3	3	3
Avg	-	1	3	-	-	-	-	3	-	3	3	3

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

MIB204	Microbial Genetics	L	T	P	C
Version 1.0	**Contact Hours - 60**	2	1	1	4
Pre-requisites/Exposure	12th level Biology				
Co-requisites	--				

Course Objectives

1. To provide the students with understanding of gene organization mutation and repair.
2. It will also provide in depth knowledge of plasmids and their properties.
3. To study the methods of genetic exchange in microorganisms.
4. To study the concept and application of transposons.

Course Outcomes

On completion of this course,

CO1:Recall the fundamental concepts and terminologies related to microbial genetics, including genome organization and gene regulation.

CO2:Understand the mechanisms of genetic variation in microorganisms, such as mutation, recombination, and horizontal gene transfer.

CO3:Apply knowledge of genetic principles to explain the inheritance patterns and molecular basis of microbial traits.

CO4:Analyze genetic mechanisms underlying microbial adaptation and evolution in response to environmental challenges.

CO5:Evaluate the role of microbial genetics in biotechnology, medicine, and industrial applications, including genetic engineering and drug resistance and **design** experimental approaches for studying microbial genetics and developing genetically modified microorganisms for specific purposes.

Catalogue Description

The core-course of 'microbial genetics is a fundamental course to develop knowledge about the genetic aspect of microorganisms. It discusses the aspects of gene organization, plasmids, genetic exchanges and transposons. The process of mutation and horizontal gene transfer are the major focus of this course. The repair mechanism is also dealt.

Course Content

Unit 1 Genome Organization, Mutations and repair

Genome organization: Eubacteria and Yeast

Spontaneous (Spontaneous mutation Luria - Delbruck's Fluctuation Test) and induced mutations, Mutagenic agents - Physical, Chemical and Biological (Phage-mu). Genetic Techniques to detect mutations in bacteria and

fungi (isolation and characterization of nutritional auxotrophic mutation); Different forms of mutations and how they arise (tautomeric shift, base analog, alkylating agent, apurinic lesions, UV radiation and thymine dimers, replicational error); Repair: reversal of UV damage in prokaryotes: photoreactivation, base excision and nucleotide excision repair, post replicational repair, mismatch repair, SOS repair, error prone repair.

Unit 2 Plasmids
Types of plasmids – F plasmid, R Plasmids, colicinogenic plasmids, yeast- 2 μ plasmid, Plasmid replication and partitioning, Host range, plasmid-incompatibility, plasmid amplification, Regulation of copy number, curing of plasmids

Unit 3 Mechanisms of Genetic Exchange
Transformation - Discovery, mechanism of natural competence; Conjugation - Discovery, mechanism, Hfr and F' strains, Interrupted mating technique and time of entry mapping; Transduction - Generalized transduction, specialized transduction, LFT & HFT lysates, Mapping by recombination and co-transduction of markers

Unit 4 Transposable elements
Discovery of transposition. Classes of bacterial transposons. Prokaryotic transposable elements – Insertion Sequences, composite and non-composite transposons, Replicative and Non replicative transposition, Mu transposon
Eukaryotic transposable elements - Yeast (Ty retrotransposon), Drosophila (P elements), Maize(Ac/Ds) Uses of transposons and transposition.

UNIT 5: Phage Genetics
Features of T4 genetics, Genetic basis of lytic versus lysogenic switch of phage lambda

List of Practicals:
Development of Replica and Master plate.
2. Understanding the effect of mutagens (UV and HNO_2)on bacterial cells
3. Observation of the survival curve of bacteria post UV exposure
4.Plasmid DNA isolation from *E.coli*
5. Plasmid DNA observation through Agarose Gel Electrophoresis
6. Study of Bacterial transformation, conjugation and transduction
7. AMES test.(**5h**)

Textbook:
Russell PJ. (2009). Genetics: A Molecular Approach, 3rd edition, Benjamin Cummings

Reference books:
1. Klug WS, Cummings MR, Spencer C, Palladino M (2011). Concepts of Genetics, 10th edition, Benjamin Cummings
2. Krebs J, Goldstein E, Kilpatrick S (2013). Lewin's Essential Genes, 3rd edition, Jones and BartlettLearning
3. Pierce BA (2011) Genetics: A Conceptual Approach, 4th edition, WH Freeman
4. Watson JD, Baker TA, Bell SP (2008). Molecular Biology of the Gene, 6th edition, Benjamin Cummings

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

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

MIB205	MOLECULAR BIOLOGY	L	T	P	C
Version 1.0	**Contact Hours - 60**	2	1	1	4
Pre-requisites/Exposure	Basic knowledge of Biology				
Co-requisites	--				

Course Objectives

1. Understand the basic concepts of central dogma of molecular biology and the structural aspects of DNA, RNA and Protein.
2. Study the process of replication transcription and translation.
3. Compare between the processes w.r.t. prokaryotes and eukaryotes

Course Outcomes

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

CO1:Recall the fundamental concepts of molecular biology, including DNA structure, replication, transcription, and translation.

CO2:Understand the molecular mechanisms that regulate gene expression and cellular processes.

CO3:Apply techniques such as PCR, gel electrophoresis, and cloning to manipulate and analyze DNA, RNA, and proteins.

CO4:Analyze the roles of various molecular components in cellular functions, including signal transduction pathways and regulatory networks.

CO5:Evaluate the impact of molecular biology techniques in research, medicine, and biotechnology, including gene therapy and diagnostic tools and **design** experiments to explore gene function, regulation, and interaction using molecular biology tools and technologies.

Catalogue Description

The core-course of molecular biology is a fundamental course that deals with the major molecules of life form i.e. DNA, RNA and protein. It also deals with the process of regulation of gene expression.

Course Content

Unit 1 Structures of DNA and RNA / Genetic Material (9 h)

DNA Structure: Miescher to Watson and Crick- historic perspective, DNA structure, Salient features of double helix, Types of DNA, Types of genetic material, denaturation and renaturation of DNA, cot curves. DNA topology - linking number, topoisomerases; Organization of DNA in Prokaryotes, Viruses, Eukaryotes; RNA Structure, Organelle DNA -- mitochondria and chloroplast DNA.

Unit 2 Replication of DNA (Prokaryotes and Eukaryotes) (9 h)

Bidirectional and unidirectional replication, semi- conservative, semi- discontinuous replication; Meselson-Stahl experiment, Mechanism of DNA replication: Enzymes and proteins involved in DNA replication –DNA

polymerases, Helicase, SSB protein, DNA ligase, primase, telomerase, RNA primers – for replication of linear ends, Okazaki fragments, Leading and Lagging strands, Various models of DNA replication including rolling circle, D- loop (mitochondrial), Θ(theta) mode of replication and other accessory protein, Mismatch and excision repairs, Photoreactivation

Unit 3 Transcription in Prokaryotes and Eukaryotes (9 h)
Transcription: Definition, difference from replication, promoter - concepts. Sigma factor, RNA Polymerase and the transcription unit. Transcription in Eukaryotes: RNA polymerases, general Transcription factors **Post-Transcriptional Processing** Split genes, concept of introns and exons, RNA splicing, spliceosome machinery, concept of alternative splicing, Polyadenylation and capping.

Unit 4 Translation (Prokaryotes and Eukaryotes) (9 h)
Translational machinery, Charging of tRNA, aminoacyl-tRNA synthetases, Mechanisms of initiation, elongation and termination of polypeptides in both prokaryotes and eukaryotes, Fidelity of translation, Inhibitors of protein synthesis in prokaryotes and eukaryote, clover leaf structure of tRNA, Genetic Code – Concept and Characteristics, Wobble hypothesis, Post-translational modifications

Unit 5 Regulation of gene Expression in Prokaryotes and Eukaryotes (9 h)
Principles of transcriptional regulation, regulation at initiation with examples from *lac* and *trp*-operons. Inducible and repressible operons. Outline of epigenetic regulation: histone modification.

Experiential learning:

1. Flip classes
2. Divulging experimental data
3. Presentation on relevant topics
4. Attending seminars and research talks

Extra credit in offer:

NPTEL course:

Molecular BiologyProf. Vishal Trivedi,IITG

Or a relevant one (up on due approval)

Text books:
T1. Weaver R. (2011). Molecular biology.4th edition, McGraw-Hill

Reference books:
R1. Watson JD, Baker TA, Bell SP, Gann A, Levine M and Losick R (2008).
R2. Molecular Biology of the Gene, 6th edition, Pearson
R3. Becker WM, Kleinsmith LJ, Hardin J and Bertoni GP (2009). The World of the Cell, 7th edition,Pearson.

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

Components	Class Assessment (including lab)				End Term
	Experiential learning	Quiz etc.	Regular evaluation	Attendance	
Weightage (%)	10	5	30	5	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

SEC141	Microbial and Molecular diagnostics	L	T	P	C
Version 1.0	**Contact Hours - 30**	1	0	1	2
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

CO1:Recall the key concepts, techniques, and principles of microbial and molecular diagnostics used in identifying pathogens and diseases.

CO2:Understand the molecular mechanisms behind pathogen detection and diagnostic techniques such as PCR, ELISA, and sequencing.

CO3:Apply diagnostic methods to detect microbial infections and interpret test results for clinical and research purposes.

CO4:Analyze the advantages and limitations of various diagnostic techniques in terms of sensitivity, specificity, and reliability.

CO5:Evaluate the role of microbial and molecular diagnostics in public health, epidemiology, and personalized medicine and **design** diagnostic protocols and strategies using molecular techniques to detect and manage microbial diseases effectively.

Catalogue 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

Microbial and Molecular diagnostics (SEC141)

Unit 1: Molecular typing methods

Restriction fragment length polymorphism (RFLP) - Amplified fragment length polymorphism (AFLP)- PCR (Polymerase Chain Reaction) Fundamentals, RT PCR and qPCR, Modifications of PCR-Hot start, Touch down, nested PCR, Multiplex, Modifications of PCR 2-Long-range PCR, Single-cell PCR, Fast-cycling PCR, Methylation-specific PCR (MSP), Digital Droplet PCR-modern implications, PCR-based mutation analysis DNA primers, linkers, adapters, ribotyping –Pulse field gel electrophoresis (PFGE) and Microarray.

Unit 2: Microbial Molecular Epidemiology

Definition of epidemiology– molecular epidemiology- Multi locus sequence typing (MLST). Targets of molecular epidemiology-relevant species subspecies, strains clones and genes. DNA analysis in Duchenne Muscular Dystrophy – Molecular diagnostic method for Sickle cell anemia, Cystic fibrosis, X-linked CGD. Molecular cytogenetics: FISH. Molecular detection of *Mycobacterium tuberculosis*& HIV–variable number of tandem repeats (VNTR). Molecular methods & detection of H5N1, Corona Virus.

Unit 3: Infectious diseases and diagnosis:

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. Serological and ELISA based methods. Discrimination of foodborne pathogens- Repetitive element palindromic, Clustered Regularly Interspaced Short Palindromic Repeats (CRISPRs). DNA sequencing methods, Next-generation sequencing (NGS). Transcriptome and Proteome analysis.

Unit 4: Omics in Diagnostics:

Clinical Applications Overview of proteomics techniques and workflows, Protein separation techniques-brief discussion of gel electrophoresis and chromatography, mass spectrometry, label-free and isotope labelling methods, role of metabolomics in laboratory diagnosis. Advanced topics in Clinical Proteomics High throughput proteomics like-Shotgun and data independent acquisition (DIA), Single cell proteomics and spatial profiling, methods to detect post translational modification and protein-protein interaction, proteomic data analysis and bioinformatic tools, Luminex multiplex assays and its application in biomarker analysis.

Unit 5: Quality control and Ethical Concerns:

Quality control and Ethical Concerns in and Futuristic Trends Quality control in molecular diagnostics, Ethical Concerns in Molecular Diagnostics, Microfluidics and Lab-on-chip in molecular diagnostics, AI and ML in molecular diagnostics, Nanotechnology based molecular diagnostics, Single cell Analysis, Integration of Multi-omics Data.

List of Practicals:

1. Isolation of genomic DNA from bacteria
2. Designing of PCR primers
3. PCR amplification of 16s rRNA genes
4. Isolation of DNA fragments from Agarose gel
5. Study on the restriction digestion pattern of different bacterial DNA on Agarose gel
6. Antibiotic susceptibility testing by broth microdilution method

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. Human Chromosomes by Miller & Tharman, Springer Publishing Company
4. "Molecular Diagnostics: Techniques and Applications for the Clinical Laboratory" by Wayne W. Grody and Robert M. Nakamura
5. "PCR (The Basics)" by Michael L. Mader
6. "Bioinformatics for Beginners: Genes, Genomes, Molecular Evolution, Databases and Analytical Tools" by Supratim Choudhuri

Reference:
1. 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
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. "Real-Time PCR: Advanced Technologies and Applications" by Nick A. Saunders and Martin A. Lee
5. "Next-Generation Sequencing: Translation to Clinical Diagnostics" by Alireza Heravi-Moussavi
6. "Genetic Testing and Molecular Biomarkers" by George P. Patrinos and William B. Coleman

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

PDC202	Professional Development Course-II (Practical)	L	T	P	C
Version 1.0	**Contact Hours - 30**	0	0	1	**1**
Pre-requisites/Exposure	**Semester-wise course**				
Co-requisites	**Completion of PDC-1 course**				

Catalog Description: This personal 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 (preferably 3rd semester-7th semester of U.G)

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

Course learning outcomes:

Level Course Outcome (CO)

Remember Identify key concepts related to advanced professional skills, including leadership and conflict resolution.

Understand Explain the importance of emotional intelligence and ethical practices in professional environments.

Apply Demonstrate advanced interpersonal skills, including negotiation, mentoring, and networking.

Analyze Critique workplace challenges to identify underlying causes and recommend appropriate solutions.

Evaluate Appraise personal and team performance using feedback mechanisms to foster continuous improvement

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

ADAMAS UNIVERSITY

B.Sc. Microbiology (Hons.)

SEMESTER-V

MIB301	IMMUNOLOGY	L	T	P	C
Version 1.0	**Contact Hour:60**	2	1	1	4
Pre-requisites/Exposure	Basic knowledge of microbiology and life science				
Co-requisites	--				

Course Objectives

1. To provide those students with apt understanding of innate and adaptive immunity.
2. It will also provide in depth knowledge about antigen-antibody interaction and their effects.
3. 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.
4. 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

CO1:Recall - Students will be able to **list** the fundamental concepts of innate and adaptive immunity, the structure and function of immune cells and organs, and the contributions of key immunologists.

CO2:Understand - Students will be able to **explain** the mechanisms behind primary and secondary immune responses, the generation of humoral and cell-mediated immune responses, and the roles of various immune cells in these processes.

CO3:Apply - Students will be able to **demonstrate** the application of antigen-antibody interactions, complement activation, and MHC functions in immune responses and utilize immunological techniques for diagnostics.

CO4:Analyze - Students will be able to **analyze** antigen processing, antigen-antibody interactions, and the mechanisms of isotype switching and affinity maturation in immune responses.

CO5:Evaluate - Students will be able to **assess** the biological consequences of complement activation, evaluate immunological techniques, and analyze the impact of immunological disorders (autoimmunity and hypersensitivity) on health and **design** experiments or clinical approaches using immunological techniques such as ELISA and flow cytometry to study immune responses or diagnose immunological disorders.

Catalogue Description

The core-course of 'immunology' 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

Immunology

Course Content:

Unit 1 Introduction to Innate & adaptive immunity and components of the immune system (12Hrs)

Concept of Innate and Adaptive immunity; Contributions of following scientists to the development of field of immunology - Edward Jenner, Karl Landsteiner, Robert Koch, Paul Ehrlich, Elie Metchnikoff, Peter Medawar, MacFarlane Burnet, Neils K Jerne, Rodney Porter, Louis Pasteur and Susumu Tonegawa

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

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

Unit II Antigen, Antibody, Ag-Ab interaction (12Hrs)

Characteristics of an antigen; Haptens; Epitopes (T & B cell epitopes); Adjuvants – complete and incomplete

Structure, Types, Functions and Properties of antibodies; Antigenic determinants on antibodies (Isotypic, allotypic, idiotypic); VDJ rearrangements; Monoclonal and Chimeric antibodies

Antigen processing and presentation (Cytosolic and Endocytic pathways), isotype switching, affinity maturation

Ag-Ab interaction, Affinity, Avidity, Cross-reactivity, Precipitation, Agglutination, WidalTest

Unit III Complement system & Major Histocompatibility Complex (12Hrs)

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

Organization of MHC locus (Mice & Human); Structure and Functions of MHC I & II molecules

Unit IV Immunological Techniques (12Hrs)

Immunodiffusion, Immunoelectrophoresis, ELISA, RIA, ELISPOT, Western blotting, Immunofluoresence, Flow cytometry, Immunoelectron microscopy.

Vaccine

Unit V Immunological Disorders (12Hrs)

Types of Autoimmunity and Hypersensitivity with examples

Practical applications of immunology

1. Identification of human blood groups.
2. To perform Total & Differential Leukocyte Count of the given blood sample.
3. To separate serum from the blood sample (demonstration).

4. To perform immunodiffusion by Ouchterlony method.
5. To perform radial immunodiffusion assay.
6. To perform immunoelectrophoresis

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	Continuous 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

MIB302	Recombinant DNA Technology	L	T	P	C
Version 1.0	**Contact Hours - 60**	2	1	1	4
Pre-requisites/Exposure	Basic knowledge of microbiology and biochemistry				
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 -** Students will be able to **identify** the key concepts, techniques, and tools used in recombinant DNA technology, including the structure of DNA, vectors, and enzymes involved in gene manipulation.

CO2: **Understand -** Students will be able to **explain** the principles and processes of recombinant DNA technology, such as gene cloning, polymerase chain reaction (PCR), and gene editing techniques like CRISPR.

CO3: **Apply -** Students will be able to **demonstrate** the use of recombinant DNA techniques in laboratory settings, such as cloning a gene, transforming cells, or performing gel electrophoresis.

CO4: **Analyze -** Students will be able to **analyze** experimental data from recombinant DNA techniques, such as interpreting results from PCR, restriction enzyme digests, or sequencing to evaluate the success of cloning or gene modification.

CO5: **Evaluate -** Students will be able to **evaluate** the ethical, safety, and regulatory concerns surrounding the use of recombinant DNA technology in research, medicine, and industry and d**esign -** Students will be able to **design** experiments or applications involving recombinant DNA technology to address specific research questions or biotechnological problems, such as producing recombinant proteins or genetically modified organisms (GMOs).

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.

Course Content

Unit 1 Basics of DNA cloning (8 hours)

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 (7 hours)

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 (7 hours)

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 (7 hours)

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(8 hours)

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).

Lab (15 h):

List of Practicals

1. Competent Cell Preparation	2 hrs
2. Isolation of plasmid DNA	2hrs
3. Restriction digestion analysis by agarose gel electrophoresis	2hrs
4. Transformation of ligation mix	2hrs
5. PCR and primer designing	4 hrs
6. Restriction mapping analysis	3hrs

Experiential learning:

1. Attending online small workshops on RDNA
2. Small project works

Text Book: Molecular Biotechnology: Principles and Applications of Recombinant DNA by Bernard Glick 2009

Reference Books:

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. Genomes 3 by T.A. Brown, 2006

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

Components	Class Assessment (including lab)				End Term
	Experiential learning	Quiz	Regular evaluation	Atten dance	
Weightage (%)	10	5	30	5	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

MIB303	Pharmaceutical Microbiology	L	T	P	C
Version 1.0	**Contact Hours - 60**	2	1	1	4
Pre-requisites/Exposure	Basic knowledge of Microbiology and Biochemistry				
Co-requisites	--				

Course Objectives

- To understand the role of microorganisms in pharmaceutical processes.
- To learn the methods of controlling microbial contamination in pharmaceutical products.
- To explore the use of microorganisms in the production of pharmaceuticals.
- To understand the regulatory aspects of pharmaceutical microbiology.

Course Outcomes

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

CO1: Recall - Students will be able to **define** the key concepts, terminology, and types of microorganisms relevant to pharmaceutical microbiology, including bacteria, viruses, fungi, and their role in pharmaceuticals.

CO2: Understand - Students will be able to **describe** the principles of microbial contamination control, sterilization methods, and the microbiological quality control of pharmaceutical products.

CO3: Apply - Students will be able to **perform** microbiological tests and techniques, such as microbial limit tests, endotoxin testing, and sterility testing, in accordance with pharmaceutical standards and guidelines.

CO4: Analyze - Students will be able to **analyze** the impact of microbial contamination on pharmaceutical products, assess the effectiveness of antimicrobial agents, and interpret results from microbiological assays.

CO5: Evaluate - Students will be able to **evaluate** the safety and efficacy of pharmaceutical products based on microbiological testing, including assessing the risks of contamination in manufacturing environments and the potential impact on product quality and **design -** Students will be able to **design** strategies for preventing microbial contamination in pharmaceutical production, including the selection of appropriate sterilization methods and contamination control procedures for different pharmaceutical forms.

Catalogue Description

This course covers the essential aspects of microbiology relevant to pharmaceutical sciences, including microbial contamination control, the use of microorganisms in pharmaceutical production, and the regulatory framework governing pharmaceutical microbiology.

Course Content

Unit 1: Introduction to Pharmaceutical Microbiology *(6 hours)*

History and scope of pharmaceutical microbiology, Types of microorganisms in pharmaceuticals, Sources and types of microbial contamination.

Unit 2: Sterilization and Disinfection*(10 hours)*

Principles of sterilization and disinfection, Methods of sterilization: physical and chemical, Validation of sterilization processes.

Unit 3: Microbial Contamination and Preservation*(8 hours)*

Sources and control of microbial contamination, Preservation of pharmaceutical products, antimicrobial agents and their applications.

Unit 4: Microbiological Assay of Pharmaceuticals*(10 hours)*

Microbiological assay of antibiotics, Sterility testing of pharmaceutical products, Pyrogen testing and its significance.

Unit 5: Production of Pharmaceuticals by Microorganisms*(8 hours)*

Production of antibiotics, vitamins, and vaccines, Fermentation technology in pharmaceutical production, Biotransformation and enzyme technology.

Unit 6: Quality Control and Regulatory Aspects*(10 hours)*

Good Manufacturing Practices (GMP) in pharmaceutical microbiology, Regulatory guidelines and standards, Quality control of raw materials and finished products.

Lab (16 hours):

- Sterilization techniques: Autoclaving and filtration.
- Microbial limit testing.
- Antibiotic sensitivity testing.
- Microbiological assay of vitamin B12.
- Preparation and maintenance of microbial cultures.

Experiential Learning:

- Participation in workshops and seminars on pharmaceutical microbiology.
- Small project work on contamination control in pharmaceutical production.

Text Book:

- "Pharmaceutical Microbiology" by W.B. Hugo and A.D. Russell, 8th Edition, 2011.

Reference Books:

1. "Microbiology and Biotechnology" by Michael J. Pelczar, 6th Edition, 2007.
2. "Principles of Microbiological Quality Assurance" by Anthony B. Wolff, 2008.
3. "Pharmaceutical Microbiology: Essentials for Quality Assurance and Quality Control" by Tim Sandle, 2016.

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

Components	Class Assessment (including lab)				End Term
	Experiential learning	Quiz	Regular evaluation	Atten dance	
Weightage (%)	10	5	30	5	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

SEC142	Intellectual Property Right & Biosafety	L	T	P	C
Version 1.0	**Contact Hours - 30**	1	1	0	2
Pre-requisites/Exposure	Basic knowledge of Biology				
Co-requisites	--				

Course Objectives

The main objective of this course is to orient, popularize, create awareness and get knowledge about the domain of IPR.

1. Students will be able to categorize biosafety levels.
2. Students should acquire knowledge in the domain of IPR.
3. Students will be able to differentiate between various components of IPR.
4. Students will be able to apply their field of knowledge/ innovation to various forms of IPR.

Course Outcomes

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

CO1: Recall - Students will be able to **define** key terms and concepts related to intellectual property rights (IPR) and biosafety, including patents, trademarks, copyrights, and biosafety levels.

CO2: Understand - Students will be able to **explain** the importance of intellectual property rights in the context of biotechnology, pharmaceuticals, and research, as well as the principles of biosafety regulations and practices.

CO3: Apply - Students will be able to **apply** IPR principles to real-world scenarios by identifying patentable innovations, trademarks, and copyrights in the field of biotechnology and proposing biosafety measures in laboratory settings.

CO4: Analyze - Students will be able to **analyze** the impact of intellectual property laws on innovation, research, and commercialization, as well as assess the risks and challenges of biosafety in various laboratory or industrial environments.

CO5: Evaluate - Students will be able to **evaluate** the effectiveness of IPR protection strategies and biosafety protocols in ensuring ethical research practices, compliance with regulations, and the safe handling of biological materials and **design -** Students will be able to **design** an IPR protection plan for a biotechnology invention or product and develop a biosafety management strategy for a research facility or laboratory.

Catalog Description

The course is designed as an elementary course on Biosafety and IPR. This course outlines various levels of biosafety, biohazard and regulatory requirements for conducting microbiological research. The course further discusses all types of IPR to a moderate level of depth. Patent, copyright, trademark, industrial design and GI, theirs criteria, application, process, duration and application has been dealt in the course.

Course Content

UNIT I: Biosafety

Biosafety Levels of Specific Microorganisms; Introduction to Biological Safety Cabinets; Primary Containment for Biohazards; Recommended Biosafety Levels for Infectious Agents; Biosafety guidelines, Ethics committee on research: Human, Ethical and Animal usage. Overview of Biotechnology Regulations and relevant International Agreements including Cartegana Protocol.

UNIT II: Patent and Industrial Design

Nature of rights, Origin, need and development, Patentability Standards: Novelty, Non- obviousness, Utility; Patentable subject matter, Patent Prosecution, Patent Application, Pre and Post grant opposition, International Patent prosecution : Patent Co-operation Treaty, Patent specification, Patent revocation, Patent term and enforcement, Term of patent – Patent term extension and adjustment, Patent infringement – Literal and non-literal infringement, Doctrine of Equivalents, Defences to patent infringement claims, Remedies – Civil and criminal, Compulsory licensing of patents in India. Industrial Design, types and application.

UNIT III: Copyright & Trademark

Concept of Copyright and Trademarks; Nice classification, Types of Trademark, International conventions; Indian statutes; Trademark search filing, examination, opposition, drafting; trademark infringement and passing off, Copyright, works in which copyright subsists, basic features of copyright; originality, skill and labour, idea-expression dichotomy, infringement of copyright, limitations and exceptions.

UNIT IV: Geographical Indications

Introduction to GI and certification mark, International Agreements Concerning Geographical Indication, Paris Convention, LISBON Agreement, TRIPS (relevant articles), Registration of Geographical Indication and effect of registration, Geographical Indication that cannot be registered, Homonymous Geographical Indication, Opposition to registration, Correction/amendments to registrations, Conditions on registrations, Registration as authorized user of GI, Duration, Renewal etc. Of geographical indication, authorized user, Effect, and benefit of Registration.

UNIT V: Application of IPR

WIPO: Formation, activities. Role of IPR in start-up, business, academic institutions.Global Innovation Index. IP Schemes of India: NIPAM, KAPILA and others. Jobs in IP sector: IP agent, IP attorney, IP examiner etc.

List of Activities (Experiential Learning)

1. Basic Patent Search: Indian, European, US.
2. Reading/ Analyzing granted patent
3. Basic drafting of patent
4. IP awareness and sensitization
5. Patent application process

SUGGESTED READING:

1. Intellectual Property Right, Bharat Publisher, 2nd Ed 2024
2. Ganguli, Prabuddha. *Intellectual Property Rights: Unleashing the Knowledge Economy*. Tata McGraw-Hill Education, 2001.
3. Narayanan, P. *Intellectual Property Law*. Eastern Law House, 2017.

4. Basheer, Shamnad, et al. *Intellectual Property Rights: An Overview and Implications in Pharmaceutical Industry*. CCH India, 2010.

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

MIB304	Industry Internship	L	T	P	C
Version 1.0		0	0	4	4
Pre-requisites/Exposure	Basic concept about microbial techniques				
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: Recall - Students will be able to **identify** key industry practices, processes, and terminology relevant to their field of internship, including specific tools, techniques, and standards used in the industry.

CO2: Understand - Students will be able to **describe** the structure, goals, and operational workflow of the organization where they are interning, along with the application of theoretical knowledge to real-world industry problems.

CO3: Apply - Students will be able to **demonstrate** the use of practical skills and techniques gained during their internship, such as project management, teamwork, or technical tasks relevant to the industry setting.

CO4: Analyze - Students will be able to **analyze** industry problems or challenges, evaluate existing solutions, and assess the impact of decisions made within the organization during their internship experience.

CO5: Evaluate - Students will be able to **evaluate** their own performance and the work environment, identifying strengths, weaknesses, and areas for improvement in both personal and professional development during the internship and **design -** Students will be able to **design** a project or solution based on their internship experience, using industry-specific tools and methodologies to address a problem or contribute to the organization's objectives.

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

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:

Components	Report	Presentation
Weightage (%)	50	50

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

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
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

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

MIB351	Genetic Engineering	L	T	P	C
Version 1.0	**Contact Hours - 60**	2	1	1	4
Pre-requisites/Exposure	Basic knowledge of microbiology and computer				
Co-requisites	--				

Course Objectives

1.Toacquaint the students with versatile tools and techniques in genetic engineering

2. To implement skills in 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 genetic engineering.

Course Outcomes

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

CO1: **Recall -** Students will be able to **define** key terms and concepts in genetic engineering, including gene cloning, recombinant DNA technology, and the tools used in genetic modification such as restriction enzymes and plasmids.
CO2: **Understand -** Students will be able to **explain** the principles and techniques of genetic engineering, such as gene cloning, PCR, CRISPR-Cas9, and the process of transforming organisms with foreign DNA.
CO3: **Apply -** Students will be able to **demonstrate** the use of genetic engineering techniques in the laboratory, including the creation of recombinant DNA, transformation of bacterial cells, and gene editing applications.
CO4: **Analyze -** Students will be able to **analyze** experimental data from genetic engineering procedures, such as interpreting results from PCR, gel electrophoresis, and sequencing to evaluate the success of gene manipulation.
CO5: **Evaluate -** Students will be able to **evaluate** the ethical, safety, and regulatory considerations associated with genetic engineering, including the implications for medicine, agriculture, and the environment and d**esign -** Students will be able to **design** a genetic engineering experiment or project, selecting appropriate techniques and methodologies to address specific research or biotechnological objectives.

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.

Course Content

Unit 1 Basics of DNA cloning (8 hours)

Basics of cloning and cloning using linkers and adaptors. Gene Isolation and expression, Cloning into various kinds of vectors – plasmids, phages lambda and M13, Selection and screening of clones.

Unit 2 Methods of DNA and Protein Analysis (7 hours)

Agarose, polyacrylamide and pulsed-field gel electrophoresis of DNA, Southern and Northern Blotting. Native PAGE, SDS-PAGE, and two-dimensional PAGE analysis of proteins. Western Blotting Analysis.

Unit 3 Polymerase Chain Reaction (7 hours)

Concept of PCR and various thermophilic enzymes used in PCR. Gradient PCR versus Touchdown PCR. Designing primers.

Unit 4 Construction of cDNA and Genomic DNA Libraries (7 hours)
Vectors used in the construction of cDNA versus genomic DNA libraries. Steps and enzymes involved in the construction of cDNA versus genomic DNA libraries.

Unit 5 Transcriptional Analysis of Gene Expression and Transcriptomics (8 hours)
Gene expression analysis by Northern Blotting, RT-PCR, mapping transcriptional start sites by S1 nuclease mapping, primer extension studies, DNA microarrays (cDNA arrays and oligo arrays), Serial Analysis of Gene expression (SAGE).

Lab (15 h):
List of Practicals

1. Competent Cell Preparation	4hrs
2. Isolation of plasmid DNA	4hrs
3. Restriction digestion analysis by agarose gel electrophoresis	4hrs
4. PCR and primer designing	3hrs

Experiential learning:
1. Attending online small workshops on Genetic Engineering
2. Small project works

Text Book: Molecular Biotechnology: Principles and Applications of Recombinant DNA by Bernard Glick 2009
Reference Books:
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. Genomes 3 by T.A. Brown, 2006

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

Examination Scheme:

Components	Class Assessment (including lab)				End Term
	Experiential learning	Quiz	Regular evaluation	Atten dance	
Weightage (%)	10	5	30	5	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

PDC301	Professional Development Course-III (Practical)	L	T	P	C
Version 1.0	**Contact Hours - 30**	0	0	1	**1**
Pre-requisites/Exposure	**Semester-wise course**				
Co-requisites	**Completion of PDC-2 course**				

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 (preferably 3rd semester-7th semester of U.G)

1. Interview Skills.
2. Aptitude and Technical Skills.
3. Group Discussion and Communication Skills.
4. Personal Branding and Online Presence.
5. Professional Skills.
6. Industry Insights and Company Presentations.
7. Career Guidance for competitive entrance exams and Job Search Strategies
8. Mock Tests and Assessments.

Course learning outcomes:

Remember List the essential skills and strategies for effective interviews, group discussions, and aptitude tests.

Understand Describe the importance of personal branding, online presence, and professional communication in career development.

Apply Demonstrate interview techniques, problem-solving skills, and teamwork during group discussions and mock sessions.

Analyze Examine company presentations and industry insights to align career goals with industry expectations.

Evaluate Assess individual performance in mock tests and group discussions to identify areas for improvement.

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

ADAMAS UNIVERSITY

B.Sc. Microbiology (Hons.)

SEMESTER-VI

MIB305	Bioinformatics	L	T	P	C
Version 1.0	**Contact Hours - 60**	2	1	1	4
Pre-requisites/Exposure	Basic knowledge of microbiology and computer				
Co-requisites	--				

Course Objectives

1. To provide those students with apt understanding of informatics for biological data.
2. It will also provide in depth knowledge of data basses, sequence analysis, alignment and phylogeny.
3. It will also offer an outline of basic prediction methods for biological system.
4. In depth understanding of structure prediction for proteins and RNA.

Course Outcomes

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

CO1: **Recall -** Students will be able to **identify** key concepts, tools, and databases used in bioinformatics, such as sequence alignment, genome databases, and bioinformatics algorithms.

CO2: **Understand -** Students will be able to **explain** the principles and methodologies used in bioinformatics, including sequence analysis, structural bioinformatics, and computational biology techniques.

CO3: **Apply -** Students will be able to **use** bioinformatics tools and software to analyze biological data, such as DNA, RNA, and protein sequences, and apply appropriate algorithms for tasks like sequence alignment or homology searching.

CO4: **Analyze -** Students will be able to **analyze** biological datasets, interpreting results from sequence alignment, phylogenetic tree construction, or protein structure prediction to draw conclusions about genetic relationships or molecular functions.

CO5: **Evaluate -** Students will be able to **evaluate** the reliability and accuracy of bioinformatics tools and databases, assessing their relevance for different biological research questions and validating results based on known data and **design** bioinformatics workflows or experiments, integrating multiple computational approaches and resources to solve complex biological problems or to analyze large-scale genomic or proteomic datasets.

Catalogue Description

The course of 'bioinformatics' will help to understand the basic concept and application of computational biology. This course includes comprehensive approach through studying data bases, sequence alignment and phylogenetic analysis. Furthermore, the application of computation structure prediction will also be elaborated.

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 to bioinformatics (9h): RDBMS - Definition of relational database Mode of data transfer (FTP, SFTP, SCP), advantage of encrypted data transfer. Relational an object oriented data bases. OS, Codes and languages.

Unit 2 Introduction to Bioinformatics &Biological Databases (9 h)

Biological databases - nucleic acid, genome, protein sequence and structure, gene expression databases, Database of metabolic pathways, Mode of data storage – File formats - FASTA, Genbank, PDB. Data submission & retrieval from NCBI, EMBL, DDBJ, Uniprot, PDB and specialized databases.

Unit 3Molecular Phylogeny (9 h)

Sequence Alignments, Phylogeny and Phylogenetic trees- Local and Global Sequence alignment, pairwise and multiple sequence alignment. Scoring an alignment, Gap penalties, ClustalW, scoring matrices, PAM & BLOSUM series of matrices Types of phylogenetic trees, Different approaches of phylogenetic tree construction - UPGMA, Neighbour joining, Maximum Parsimony, Maximum likelihood

Unit 4 Genome organization and analysis (9 h)

Diversity of Genomes: Viral, prokaryotic & eukaryotic genomes, Genome, transcriptome, proteome, Major features of completed genomes: *E.coli, S.cerevisiae, Arabidopsis*, Human

Unit 5 Predictions regarding protein structures (9 h)

Hierarchy of protein structure - primary, secondary and tertiary structures, modeling Structural Classes, Motifs, Folds and Domains Protein structure prediction in presence and absence of structure template Energy minimizations and evaluation by Ramachandran plot

Protein structure and rational drug design

Lab (15 h):

List of Practical

1. Exploring biological data bases, down loading sequences and structure data.
2. Pairwise and multiple sequence alignment, BLAST
3. Molecular phylogenetic analysis: NJ and ML trees
4. Outline of gene prediction and genome annotation
5. Homology modelling, structure prediction and evaluation of predicted models

Experiential learning:

1. Attending on line small workshops on bioinformatics
2. Small project works

Extra credit in offer:

NPTEL course:

BioInformatics: Algorithms and Applications Prof. Michael Gromiha, IITM

Or a relevant one (up on due approval)

Text Book:

1. Essential Bioinformatics, Jin XIONG, CAMBRIDGE

Reference Books:

1. Sanjay S (2003). A First Course in Computers, Vikas Publishing House
2. Pradeep and Sinha Preeti (2007). Foundations of Computing, 4th ed., BPB Publications
4. Rastogi SC., Mendiratta N. and Rastogi P. (2007). Bioinformatics: methods and applications, genomics, proteomics and drug discovery, 2nd ed. Prentice Hall India Publication
5. Primrose and Twyman (2003). Principles of Genome Analysis & Genomics. Blackwell

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

Examination Scheme:

Components	Class Assessment (including lab)				End Term
	Experiential learning	Quizetc.	Regular evaluation	Attendance	
Weightage (%)	10	5	30	5	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

MIB306	Industrial Microbiology	L	T	P	C
Version 1.0	**Contact Hours - 60**	2	1	1	4
Pre-requisites/Exposure	Basic concept of microbiology and chemistry				
Co-requisites	--				

Course Objectives

The aim of the course is to give the students broad theoretical and practical skills in industrial microbiology. This course covers the principles of various processes associated with the production and recovery of different bio-products derived from microorganisms. The students will be able to discuss the role of microorganisms in industry, as well as to carry out experiments to produce microbial metabolites.

Course Outcomes

Upon successful completion of the course, the students can

CO1: **Recall -** Students will be able to **identify** the key microorganisms used in industrial processes, including their roles in fermentation, antibiotic production, and waste treatment.

CO2: **Understand -** Students will be able to **explain** the principles of industrial microbiology, such as the processes of fermentation, bioreactor design, and microbial growth kinetics in industrial settings.

CO3: **Apply -** Students will be able to **demonstrate** the application of microbiological techniques in industrial microbiology, such as inoculum preparation, fermentation process monitoring, and quality control procedures for microbial products.

CO4: **Analyze -** Students will be able to **analyze** data from industrial microbiological processes, such as growth curves, fermentation yields, and product quality, to evaluate the efficiency of production methods.

CO5: **Evaluate -** Students will be able to **evaluate** the potential of microorganisms for use in industrial applications, considering factors like scalability, cost-effectiveness, and product yield, as well as assessing microbial safety and regulatory compliance and **design** an industrial microbiology process or experiment, including selecting the appropriate microorganism, fermentation parameters, and production techniques to optimize the yield and quality of a desired product.

Catalogue Description

The course discusses on industrially important microbes, recent development in fermentation processes and various optimization strategies at fermenter level. This course explicates the connection between microbial growth, product formation, mass transfer and environment. Likewise, this course gives an overview of the design, types of fermenters and various critical components of bioreactors. Downstream processing will be discussed. This course explains the processes and techniques used for extraction and purification of a product from culture medium.

Course Content

Unit 1: Isolation of microorganisms of commercial significance and fermentation media (10h)

Sources of industrially important microbes and methods for their isolation, maintenance of industrial strains, methods for strain improvement and selection, Crude and synthetic media

Unit 2: Types of fermentation processes, bio-reactors and measurement of fermentation parameters (10h)
Types of fermentation processes - Solid-state and liquid-state (stationary and submerged) fermentations; batch, fed-batch and continuous fermentations; components of a typical bio-reactor, types of bioreactors, fermentation process optimization and scale-up

Unit 3 Down-stream processing, Product Recovery, and Quality Control and Quality Assurance (10h)
Separation and purification techniques in industrial microbiology, recovery of microbial products from fermentation broth, product formulation and storage, Methods of immobilization, advantages and applications of immobilization, principles of quality control in industrial microbiology, microbiological testing methods and standards, Good Manufacturing Practices (GMP) and quality assurance in industrial settings

Unit 4: Microbial production of industrial products (10h)
Microbial production of food and beverage products, pharmaceuticals and biologics using recombinant microorganisms, Emerging applications and future directions in industrial microbiology, applications of microbial biopolymers in bioplastics, food packaging, and biomedical materials.

Unit 5: Immobilization of Enzymes (10h)
Methods for immobilizing enzymes: adsorption, covalent attachment, cross-linking. Factors influencing enzyme immobilization: enzyme properties, carrier materials, immobilization conditions, Industrial applications of immobilized enzymes in food, pharmaceutical, and biofuel industries, Techniques for immobilizing microbial cells: adsorption, entrapment, encapsulation, Challenges and future prospects of immobilizing whole cells.

List of Practicals (10h)
1. Study different parts of a fermenter/bioreactor
2. Microbial fermentations for the production and estimation (qualitative and quantitative) of:
(a) Enzymes (Amylase and Protease)
(b) Alcohol
3. Purification techniques: chromatography, filtration, and precipitation.
4. Immobilizing enzymes using calcium alginate.
5. A visit to any educational institute/industry to see an industrial fermenter, and other downstream processing operations.

Textbook:

1. Patel A.H. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited.
2. 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 Principles by Pauline M. Doran, 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

BIC352		L	T	P	C
Version 1.0	**Contact Hours - 45**	2	1	1	4
Pre-requisites/Exposure	BASIC NUTRITION AND TOXICOLOGY (THEORY) UNDERSTANDING OF BIOCHEMISTRY				
Co-requisites	--				

Course Objectives

1. To provide students the basic understanding of nutrition, energy metabolism and toxicology.
2. It will also provide in depth knowledge of functional aspects food and drug interactions with nutriceuticals.
3. Elaborating dietary components of health and diseases.
4. General overview of nutritional and toxicological assessment .

Course Outcomes

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

CO1: **Recall -** Students will be able to **define** key terms and concepts in nutrition and toxicology, including macronutrients, micronutrients, toxins, and their role in health and disease.

CO2: **Understand -** Students will be able to **explain** the processes of digestion, absorption, metabolism, and the physiological effects of nutrients and toxic substances on the human body.

CO3: **Apply -** Students will be able to **apply** the principles of nutrition and toxicology to assess dietary requirements, toxicity levels, and the impact of specific nutrients or toxins on human health.

CO4: **Analyze -** Students will be able to **analyze** the relationship between diet, nutrition, and toxicology, evaluating how various factors (e.g., age, gender, and lifestyle) influence nutrient absorption, metabolism, and the body's response to toxins.

CO5: **Evaluate -** Students will be able to **evaluate** the nutritional status of individuals or populations and assess the safety and potential health risks of exposure to various toxic substances based on scientific evidence and **design** a nutrition plan or toxicological risk assessment, incorporating knowledge of nutrient requirements, toxicity levels, and appropriate safety measures for different populations.

Catalog Description

The core-course of 'Nutritional Biochemistry' will help to understand the classification, structure and properties of foods and nutraceuticals. Nutritional biochemistry has also helped to reveal facts about how nutrients influence the growth, development, and function of cells and tissues. Therefore, studying the biochemistry of nutrition has a significant real-world impact. It has the potential to greatly influence the future of preventative and therapeutic strategies for mental and physical illness.

Course Content

NUTRITION AND TOXICOLOGY (THEORY)

Unit I Introduction to Nutrition and Energy Metabolism

Defining Nutrition, role of nutrients. Unit of energy, Biological oxidation of foodstuff. Measurement of energy content of food, Physiological energy value of foods, SDA. Measurement of energy expenditure, estimating energy requirements, BMR factors Recommended Nutrient Intakes (RNI) and Recommended Dietary Allowances for different age groups.

Unit II Dietary components and health

Review functions of carbohydrates, lipids, proteins and vitamins. Digestion, absorption. Their classification, sources, functions, digestion, absorption, utilization and storage. Deficiency diseases (Kwashiorkor, Scurvy, Rickets, Xeropthalmia etc.).Minerals (Ca,P,Fe etc.) absorption, importance and deficiency disease.

Unit III Assessment of Nutritional status

Anthropometric measurements; Z scores, BMI, skinfold, circumference ratios. Biochemical assessment; Basal metabolic panel, Comprehensive metabolic panel, CBC, Urine Analysis, Assessment of Anemia, ROS assessment, GTT and glycosylated Hb, Differential diagnosis of B12 and folate.

Unit IV Food, Drug interactions, Nutraceuticals and Toxicology

Nutrient interactions affecting ADME of drugs, Alcohol and nutrient deficiency, Anti-depressants, psychoactive drugs and nutrient interactions, Appetite changes with drug intakes and malnutrition. Food as medicine.

Unit V 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, Toxins Poisonous Mushrooms , Mycotoxins ,Toxicants Resulting from Food Processing I , Food Additives I , Food Adulteration Pesticides .

Textbook:

1. Nutritional Biochemistry 1st Edition, ISBN: 978-93-90699-76-6, Nitya Publication. Dr. Renu Verma.
2. Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H.
Freeman and Company (New York), ISBN:13: 978-1-4641-0962-1 / ISBN:10:1-4292-3414-8.

Reference books:

1.Physical Biochemistry (2009) 2nd ed., Sheehan, D., Wiley-Blackwell (West Sussex), ISBN: 9780470856024 / ISBN: 9780470856031.
2.The Tools of Biochemistry (1977; Reprint 2011) Cooper, T.G., Wiley India Pvt. Ltd. (New Delhi), ISBN: 978-81-265-3016-8.

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

SEC143	Quality Control and Quality Assurance	L	T	P	C
Version 1.0	**Contact Hours - 45**	1	0	1	2
Pre-requisites/Exposure	Basic knowledge in Biology				
Co-requisites	--				

Course Objectives

This course provides a comprehensive understanding of quality control and quality assurance principles and practices specifically in the field of microbiology. Students will learn about quality management systems, quality control techniques, quality assurance methodologies, and regulatory requirements applicable to microbiological testing and analysis. Through lectures, laboratory visit, and case studies, students will gain knowledge and skills to implement and maintain quality standards in microbiology laboratories.

Course Outcomes

Upon successful completion of the course, the students can

CO1: **Recall -** Students will be able to **identify** key concepts, standards, and terminology used in quality assurance (QA) and quality control (QC), including various testing methods and regulatory frameworks.

CO2: **Understand -** Students will be able to **explain** the principles and processes of quality assurance and quality control, including the roles of risk management, audits, and compliance in ensuring product quality.

CO3: **Apply -** Students will be able to **apply** quality assurance and control techniques in practical scenarios, such as performing product testing, conducting inspections, and maintaining regulatory documentation.

CO4: **Analyze -** Students will be able to **analyze** quality data, identifying patterns, deviations, and root causes of quality issues, and assessing the effectiveness of corrective actions or process improvements.

CO5: **Evaluate -** Students will be able to **evaluate** the performance of quality control systems and procedures, assessing their ability to meet regulatory standards and industry best practices and **design** a quality assurance and quality control plan, incorporating risk management strategies, validation protocols, and performance metrics to ensure product consistency and compliance with industry standards.

Catalogue Description

This course provides a comprehensive study of quality control and quality assurance principles and practices specifically tailored to the field of microbiology. Students will explore the importance of quality control and quality assurance in ensuring accurate and reliable microbiological testing and analysis.

Course Content

Unit 1: Introduction to Quality Control, Quality Assurance and Quality Management Systems in Microbiology (8h)

Overview of quality control and quality assurance in microbiology, Importance of quality in microbiological testing and analysis, Regulatory requirements and standards specific to microbiology laboratories, Introduction to quality management systems (QMS) in microbiology, Overview of ISO 9000 Quality Management System and ISO14000 Environmental Management System and other relevant quality standards for microbiology laboratories

Unit 2: Quality Control Techniques in Microbiology, Laboratory Safety and Quality Assurance (7h)
Monitoring and control of media, reagents, and equipment, Proficiency testing and inter-laboratory comparisons, Microbiological laboratory safety procedures and practices, Personnel training and competency assessment, Internal auditing and corrective actions in microbiology laboratories, Standard operating procedures (SOPs) for microbiological testing methods, Document control and record-keeping requirements in microbiology laboratories

Unit 3: Quality Control of Microbiological Media, Reagents and Testing Methods (8h)
Preparation, storage, and quality control of culture media, Control of microbiological reagents and reference materials, Quality control of microbial identification, microbial limits testing and antibiotic susceptibility testing methods, Environmental monitoring

Unit 4: Quality Assurance in Microbial Enumeration and Testing (7h)
Quality control of microbial limits testing, Endotoxin testing and pyrogen detection in pharmaceutical microbiology, Participation in external quality assessment programs, Accreditation and certification of microbiology laboratories, Preparation for regulatory inspections and audits.

Unit 5:Documents and formats (5h)
SOP and record of vendor certification, SOP on receipt storage and sampling raw material and product material, SOP on dispensing of materials, SOP and releasing of finished product, SOP on handling on rejected materials.

List of Practicals: (10h)

1. Prepare inventory of the chemicals in the department according to barcode and CAS Number. 2. Check the material data sheet for the above listed chemicals and segregate according their safe nature.
3. Prepare SOP for the newly arrived equipment in the laboratory.
4. Fire extinguishing techniques uses.
5. Measure least count and handling micropipettes.
6. Sampling technique used for dilution.
7. Visit to a manufacturing unit.

Textbook:

1. Pharmaceutical Microbiology: Essentials for Quality Assurance and Quality Control by Tim Sandle.
2. Handbook of Microbiological Quality Control in Pharmaceuticals and Medical Devices by Rosamund M. Baird.
3. Amitava Mitra, Fundamentals of Quality Control and Improvement, WILEY Publications, 4th Edition.

Reference books:

1. ISO 17025 Quality Manual for Testing Laboratories: A Complete Guide to the ISO/IEC 17025:2017 Standard by Rodolfo Strivieri.
2. Microbiology Quality Assurance: Principles and Application by Claude S. Weil and Patricia H. Steele.

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

PDC302	Professional Development Course-IV (Practical)	L	T	P	C
Version 1.0	**Contact Hours - 30**	0	0	1	**1**
Pre-requisites/Exposure	**Semester-wise course**				
Co-requisites	**Completion of PDC-3 course**				

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 (preferably 3rd semester-7th semester of U.G)

1. Interview Skills.
2. Aptitude and Technical Skills.
3. Group Discussion and Communication Skills.
4. Personal Branding and Online Presence.
5. Professional Skills.
6. Industry Insights and Company Presentations.
7. Career Guidance for competitive entrance exams and Job Search Strategies
8. Mock Tests and Assessments.

Course learning outcomes:

Remember List the essential skills and strategies for effective interviews, group discussions, and aptitude tests.

Understand Describe the importance of personal branding, online presence, and professional communication in career development.

Apply Demonstrate interview techniques, problem-solving skills, and teamwork during group discussions and mock sessions.

Analyze Examine company presentations and industry insights to align career goals with industry expectations.

Evaluate Assess individual performance in mock tests and group discussions to identify areas for improvement.

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

ADAMAS UNIVERSITY

B.Sc. Microbiology (Hons.)

SEMESTER-VII

MIB401	FOOD AND DAIRY MICROBIOLOGY	L	T	P	C
Version 1.0	**Contact Hour: 60**	2	1	1	4
Pre-requisites/Exposure	Basic knowledge of microbiology				
Co-requisites	--				

Course Objectives

1. Students will learn about different microorganisms naturally associated with food and their role in production of fermented food.
2. Students will learn in details about various microorganisms associated with food spoilage and food preservation techniques.
3. To study the methods of enumerating and identifying food spoilage and causative agent.
4. To study the concept of food sanitation and control.

Course Outcomes

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

CO1: **Recall -** Students will be able to **identify** key microorganisms involved in food and dairy fermentation, spoilage, and foodborne illnesses, as well as common methods used to control microbial growth.

CO2: **Understand -** Students will be able to **explain** the role of microorganisms in food and dairy products, including their effects on fermentation, spoilage, and food safety.

CO3: **Apply -** Students will be able to **apply** microbiological techniques for detecting and identifying microorganisms in food and dairy samples, including microbial culturing, microscopy, and biochemical testing.

CO4: **Analyze -** Students will be able to **analyze** the factors influencing microbial growth in food and dairy products, such as pH, temperature, and moisture content, and assess their impact on food safety and quality.

CO5: **Evaluate -** Students will be able to **evaluate** the effectiveness of various microbial control methods (e.g., pasteurization, fermentation, refrigeration) in preventing spoilage and ensuring food safety in dairy and food products and **design** a microbiological quality control system for food and dairy production, including protocols for microbial testing, contamination prevention, and maintaining product safety and shelf life.

Catalog Description

The core-course of food and dairy microbiology deals with the identity and role of different microorganisms introduced in food materials naturally or artificially. It will also help the students to elaborate the contribution of microorganisms in production of fermented foods as well as in spoilage for different types of food materials. There will be a detailed information about different food preservation and food sanitation techniques. Aetiology of different food borne diseases along with their preventive measures are also dealt with.

Course Content

Food and dairy microbiology

Theory

Unit I: Foods as a substrate for microorganisms (12 Hrs)

Natural inhabitants of food: Intrinsic and extrinsic factors that affect growth and survival of microbes in foods, natural flora and source of contamination of foods in general, Water in food, water activity and shelf life of food, Carbohydrates-chemical reactions, functional properties of sugars and polysaccharides in foods, Lipids: classification, and lipids-chemical reactions in foods, Protein and amino acids distribution, Protein -chemical reactions and functional properties of proteins in foods.

Types of Milk, cream, eggnog, buttermilk, butter, cheese, ice-cream. Reactions of milk,

Microorganisms present in the milk and their characteristics. milk standards

Probiotics

Unit II: Microorganisms and Spoilage of food (12 Hrs)

Food contaminants and spoilage of vegetables, fruits, meat, eggs, milk and butter, bread, canned foods.

Unit III: Role of Microorganisms in food fermentation (12 Hrs)

Dairy starter cultures, fermented dairy products: yoghurt, acidophilus milk, buttermilk, kumiss, kefir, curds and cheese,

Other fermented foods: dosa, idli, sauerkraut, soy sauce and tampeh

Unit IV: Principles and methods of food preservation and food sanitation (12 Hrs)

Physical methods of food preservation: temperature (low, high, canning, drying), appertization, Tyndallization, Pasturization, additives, irradiation, hydrostatic pressure, high voltage pulse, extrusion cooking, microwave processing, dielectric heating, and aseptic packaging,

Chemical methods of food preservation: salt, sugar, organic acids, SO_2, nitrite and nitrates,

ethylene oxide, antibiotics and bacteriocins

HACCP, Indices of food sanitary quality and sanitizers

Unit V: Food borne diseases (causative agents, foods involved, symptoms and preventive measures) (12 Hrs)

Food intoxications: *Staphylococcus aureus, Clostridium botulinum* and mycotoxins;

Food infections: *Bacillus cereus, Vibrio parahaemolyticus, Escherichia coli, Salmonellosis, Shigellosis, Yersinia enterocolitica, Listeria monocytogenes and Campylobacter jejuni*

Milk borne infections

Practical application in food and dairy industry

List of experiments

MBRT of milk samples and their standard plate count.

Alkaline phosphatase test to check the efficiency of pasteurization of milk.

Isolation of food borne bacteria and fungi from food products.

Isolation of spoilage microorganisms from spoiled vegetables/fruits.

Isolation of spoilage microorganisms from bread.

Preparation of Yogurt/Dahi.

Textbook:

1. Adams MR and Moss MO. (1995). Food Microbiology. 4th edition, New Age International (P)Limited Publishers, New Delhi, India.

2. Banwart JM. (1987). Basic Food Microbiology.1st edition. CBS Publishers and Distributors, Delhi, India.

3. Davidson PM and Brannen AL. (1993). Antimicrobials in Foods. Marcel Dekker, New York.
4. Dillion VM and Board RG. (1996). Natural Antimicrobial Systems and Food Preservation. CAB International, Wallingford, Oxon.
5. Frazier WC and Westhoff DC. (1992). Food Microbiology.3rd edition. Tata McGraw-Hill Publishing Company Ltd, New Delhi, India.
6. Gould GW. (1995). New Methods of Food Preservation. Blackie Academic and Professional, London.
7. Jay JM, Loessner MJ and Golden DA.(2005). Modern Food Microbiology. 7th edition, CBS Publishers and Distributors, Delhi, India.Of Foods.Vol. 1-2, ASPEN Publication, Gaithersberg, MD.

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

Components	Continuous 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

MIB402	Medical Microbiology	L	T	P	C
Version 1.0	**Contact Hour:60**	2	1	1	4
Pre-requisites/Exposure	Basic knowledge of microbiology and life science				
Co-requisites	--				

Course Objectives

1. Students will learn to discriminate pathogens from non-pathogenic microorganisms and comprehend their role in development of diseases.
2. Students will be able to identify appropriate techniques for disease diagnosis and sample collection.
3. Students will be able to interpret and analyze the patho-mechanism of different diseases of microbial origin.
4. Students will learn to assess the epidemiology of different infectious disease and elucidate preventive measures to combat the diseases.
5. Students will be adept of evaluating mode of action of antimicrobial agents and formulating their application.

Course Outcomes

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

CO1: **Recall -** Students will be able to **identify** common pathogenic microorganisms, including bacteria, viruses, fungi, and parasites, and their associated diseases.

CO2: **Understand -** Students will be able to **explain** the mechanisms of microbial pathogenesis, including how pathogens cause infections, evade immune responses, and spread in host organisms.

CO3: **Apply -** Students will be able to **apply** diagnostic microbiology techniques, such as microbial culture, staining, PCR, and serological tests, to identify infectious agents in clinical specimens.

CO4: **Analyze -** Students will be able to **analyze** the clinical and laboratory findings related to infections, assessing microbial resistance patterns, disease progression, and appropriate treatment options.

CO5: **Evaluate -** Students will be able to **evaluate** the effectiveness of antimicrobial therapies, vaccines, and infection control measures in preventing and treating microbial infections in healthcare settings and **design** a diagnostic workflow or infection control protocol, integrating laboratory techniques, treatment strategies, and preventive measures for managing infectious diseases.

Catalogue Description

The student will be able to use the knowledge obtained for understanding difference between pathogens from non-pathogenic ones and the basic mechanism by which they initiate the disease process. Students will be able to appraise patho-mechanism and risk factors for many diseases caused by bacteria, fungi, protozoa and virus and also explicate preventive measures against them. The mode of action of antimicrobial resistance will also be clarified. 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

Medical Microbiology

Unit 1 Normal microflora of the human body and host pathogen interaction (12 Hrs)

Major developments in medical microbiology, Koch's postulate, Factors responsible for microbial pathogenicity, Normal microflora of the human body: Importance of normal microflora, normal microflora of skin, throat, gastrointestinal tract, urogenital tract. Host pathogen interaction: Definitions - Infection, Invasion, Pathogen, Pathogenicity, Virulence, Toxigenicity, Carriers and their types, Opportunistic infections, Nosocomial infections. Transmission of infection, Pathophysiologic effects of LPS

Unit 2 Sample collection, transport and diagnosis (12 Hrs)

Collection, transport and culturing of clinical samples, principles of different diagnostic tests (ELISA, Immuno-fluorescence, Agglutination based tests, Complement fixation, PCR, DNA probes).

Unit 3 Bacterial and viral diseases (12 Hrs)

List of diseases of various organ systems and their causative agents. The following diseases in detail with Symptoms, mode of transmission, prophylaxis and control Respiratory Diseases: Hemophilic influenza, tuberculosis, leprosy, Pneumonia Gastrointestinal Diseases: Diarrhea, Typhoid, Cholera, Shigellosis, diphtheria, Peptic ulcer. Others: Tetanus, Anthrax, Syphilis, Gonorrhea.

List of diseases of various organ systems and their causative agents. The following diseases in detail with Symptoms, mode of transmission, prophylaxis and control, Polio, Herpes, Hepatitis, Rabies, Dengue, AIDS, measles, Influenza with brief description of swine flu, Ebola, Chikungunya, Japanese Encephalitis

Unit 4 Protozoan & fungal diseases (12 Hrs)

List of diseases of various organ systems and their causative agents. The following diseases in detail with Symptoms, mode of transmission, prophylaxis and control

Malaria, Kala-azar, Amoebiasis

Brief description of each of the following types of mycoses and one representative disease to be studied with respect to transmission, symptoms and prevention

Cutaneous mycoses: Tineapedis (Athlete’s foot)

Systemic mycoses: Histoplasmosis

Opportunistic mycoses: Candidiasis

Unit 5 Antimicrobial agents: General characteristics and mode of action (12 Hrs)

Antibacterial agents: Five modes of action with one example each: Inhibitor of nucleic acid synthesis;
Inhibitor of cell wall synthesis; Inhibitor of cell membrane function; Inhibitor of protein synthesis;
Inhibitor of metabolism

Antifungal agents: Mechanism of action of Amphotericin B, Griseofulvin

Antiviral agents: Mechanism of action of Amantadine, Acyclovir, Azidothymidine

Antibiotic resistance, MDR, XDR, MRSA, NDM-1

Experiments for Application of medical microbiology

1.Students will learn to experiment with and assess cultural, biochemical and morphological characteristics of different pathogens

2.Students will learn to isolate & identify microorganisms from clinical samples.

3.Students will be able to estimate and compare antimicrobial activity of different antimicrobial agents.

4.Students will learn to interpret symptoms of several diseases from photographs.

5.Students will learn to decide proper prognosis for different microbial diseases.

Text Book:

1. Ananthanarayan R. and Paniker C.K.J. (2009) Textbook of Microbiology. 8th edition, University Press Publication
2. 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
3. Goering R., Dockrell H., Zuckerman M. and Wakelin D. (2007) Mims' Medical Microbiology. 4thedition. Elsevier

Reference books:

1. Willey JM, Sherwood LM, and Woolverton CJ.(2013) Prescott, Harley and Klein's Microbiology.9thedition. McGraw Hill Higher Education
2. Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). Brock Biology of Microorganisms.14th edition. Pearson International Edition
3. Murray, P.R.; Rosenthal, K.S.; Pfaller, M.A. Medical microbiology. Elsevier Health Sciences: 2012.

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

Components	Continuous 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

MIB403	Genomics and Proteomics	L	T	P	C
Version1.0	**Contact Hours -45**	2	1	1	4
Pre-requisites/Exposure	Basic genetics and protein biochemistry				
Co-requisites	--				

Course Objectives:

1. The course will provide an introduction to genomics.
2. The course will intricately describe various sequencing techniques
3. The course will offer outlines of state of the art big data analysis approaches
4. The course will offer introduction to proteomics
5. The course will provide fundamental hands on knowledge on structural modelling and visualization.

Course outcome:

The students will be able

CO1: Recall - Students will be able to identify key concepts, terminology, and tools in genomics and proteomics, including DNA sequencing, protein analysis, and bioinformatics techniques.

CO2: Understand - Students will be able to explain the principles and technologies used in genomics and proteomics, such as genome sequencing, transcriptomics, mass spectrometry, and protein structure analysis.

CO3: Apply - Students will be able to apply bioinformatics tools and laboratory techniques to analyze genomic sequences, gene expression data, and proteomic profiles, using appropriate software and databases.

CO4: Analyze - Students will be able to analyze genomic and proteomic data, interpreting results from sequencing, protein identification, and functional annotation to gain insights into biological processes and disease mechanisms.

CO5: Evaluate - Students will be able to evaluate the significance of genomic and proteomic findings in the context of health, disease, and therapeutic development, assessing the potential for personalized medicine and biomarker discovery and design a genomics or proteomics experiment, selecting appropriate methodologies, tools, and data analysis techniques to address a specific research question or clinical application.

Course Description:

The main aim of this module is to provide an understanding about the genomics and proteomics techniques and their applications in biological sciences. The subject deals with a rapidly evolving scientific area that introduces students into genomes, proteomes, databases and nanobiotechnology that store various data about genes, proteins, genomes and proteomes. Students would learn about genomics ,proteomics and nano biotechnology and offer basic knowledge of genome sequencing, major differences between prokaryotic and eukaryotic genomes, basic proteomics and its applications. Students would gain skills in comparative evolutionary, human genomics and functional genomics. The acquired knowledge during the course would be helpful to those students who want to work in core facilities and commercial biological and medical laboratories as well as in their post graduate studies.

Course Content:

Genomics and Proteomics

Unit 1. Introduction 15Lecture hours
StructuralorganizationofgenomeinProkaryotesandEukaryotes;OrganelleDNA-mitochondrial, chloroplast; DNA sequencing-principles and translation to large scale projects;Recognitionofcodingandnon-codingsequencesandgeneannotation;Toolsforgenomeanalysis-RFLP, DNA fingerprinting, RAPD, PCR, Linkage and Pedigree analysis-physical and genetic mapping.

Unit2. Genome sequencing projects5 Lecture hours
Microbes,plantsandanimals;Accessingandretrievinggenomeprojectinformationfromweb;Comparativegenomics,Identificationandclassificationusingmolecularmarkers-16SrRNAtyping/sequencing,ESTs and SNPs.

Unit3. **Proteomics** 10Lecturehours
Protein analysis (includes measurement of concentration, amino-acid composition, N-terminal sequencing); 2-D electrophoresis of proteins; Microscale solution isoelectric focusing; Peptide fingerprinting;

Unit4. Quantitative Proteomics 5 lectures
LC/MS-MS for identification of proteins and modified proteins; MALDI-TOF;SAGE and Differential display proteomics, Protein-protein interactions. Yeast two hybrid system.

Unit V. Functional genomics and proteomics10 Lecture hours Analysis of microarray data; Epigenomics, CHIP-seq, Protein and peptide microarray-based technology; PCR-directed protein *insitu* arrays; Structural proteomics: structure prediction and visualization

List of practical:
1. PCR amplification of 16SrDNA and analysis
2. Demonstration of sequence reads and analysis pipelines
3. SDS PAGE
4. Analysis of mass-spec data
5. Protein structural modelling and visualization

Experiential learning:
1. Attending on line small workshops on genome analysis
2. Small project works from available genome project data
3. https://www.youtube.com/watch?v=qOW5e4BgEa4

Extra credit in offer:
NPTEL course:
Data Analysis For Biologists Prof. Biplab Bose, IITG
Structural Biology Prof. Saugata Hazra, IITR
Or a relevant one (up on due approval)

Suggested Books

1. Berg,J.M.,Tymoczko,J.L.andStryer,L.(2006).Biochemistry.VIEdition.W.HFreemanandCo.
2. Buchanan,B.,Gruissem,W.andJones,R.(2000)BiochemistryandMolecularBiologyofPlants.AmericanSociety of Plant Biologists.
3. Nelson,D.L.,Cox, M.M.(2004)Lehninger Principles of Biochemistry,4thEdition,WHFreemanandCompany,NewYork,USA.
4. Hopkins,W.G.andHuner,P.A.(2008)IntroductiontoPlantPhysiology.JohnWileyandSons.

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

Components	Class Assessment (including lab)				End Term
	Experiential learning	Quiz etc	Regular evaluation	Attendance	
Weightage (%)	10	5	30	5	50

RelationshipbetweentheCourseOutcomes(COs)andProgramOutcomes(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

MIB405	Modern Techniques & Bioinstrumentation (THEORY)	L	T	P	C
Version 1.0	**Contact Hours - 60**	3	1	0	4
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 various modern instrumentation techniques,
2. To increase students' understanding of principles behind different bio instruments
3. To build students' abilities to interpret data and to integrate results into decision making

Course Outcomes

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

CO1: **Recall -** Students will be able to **identify** various modern techniques and bioinstrumentation tools used in biological research, such as spectroscopy, chromatography, electrophoresis, and microscopy.

CO2: **Understand -** Students will be able to **explain** the principles and working mechanisms behind key bioinstrumentation techniques, including their applications in molecular biology, biochemistry, and medical diagnostics.

CO3: Apply - Students will be able to **use** modern bioinstrumentation techniques to conduct experiments, analyze biological samples, and generate data in laboratory settings.

CO4: Analyze - Students will be able to **analyze** the results obtained from bioinstrumentation tools, evaluating the quality and reliability of the data for biological interpretation.

CO5: Evaluate - Students will be able to **evaluate** the suitability and limitations of various bioinstrumentation techniques in different research or clinical contexts, considering factors like sensitivity, resolution, and sample preparation and **design** an experiment using modern bioinstrumentation tools, selecting the appropriate technique and instrumentation to address specific research questions or diagnostic objectives.

Catalog Description

By this course students will be able to learn basic concepts of physics and apply them to study the physicochemical properties of biomolecules. They will learn to investigate the light absorption properties of biomolecules through spectrophotometry, for qualitative and quantitative analysis of biomolecules. This course will enable them to understand mechanics of solids and liquids which will help them to understand the basic mechanisms of cell biology especially cell adhesion, migration and mechano-transduction.

Course Content

Modern Techniques & Bioinstrumentation (MIB405)

Unit 1: Imaging and related techniques

Principles of microscopy; Light microscopy; Fluorescence microscopy; Electron Microscopy (a) Flow cytometry (b) Applications of fluorescence microscopy: Chromosome banding, FISH, chromosome painting; Transmission and Scanning electron microscopy – sample preparation for electron microscopy, cryofixation, negative staining, shadow casting, freeze fracture, freeze etching. Radioisotopes Use in biological research, auto-radiography, pulse chase experiment.

Unit 2: pH and Centrifugation

pH meter: Principles and instrumentation, Centrifugation: Principles, types of centrifuges, types of rotors, differential and density gradient centrifugation, application. Sonication, Freeze drying.Cell fractionation, sucrose density gradient, CsCl gradient, analytical centrifugation, ultracentrifugation, marker enzymes.

Unit 3: Spectrophotometry

Principle involved in Spectrophotometer; Basic principles of electromagnetic radiation, energy, wavelength, wave numbers and frequency. Review of electronic structure of molecules (Molecular Orbital theory), absorption and emission spectra. Beer-Lambert law, light absorption and its transmittance. Spectrophotometric techniques, Instrumentation: ultraviolet and visible spectrophotometry (single and double beam, double wavelength spectrophotometers), Infrared spectrometers - Luminometry and densitometry – principles and their applications - Mass Spectroscopy-principles of analysis, application in Biology. Characterization of proteins and nucleic acids; X-ray crystallography, NMR; Characterization of proteins and nucleic acids; Electrophoresis: PAGE, SDS-PAGE

Unit 4: Chromatography

Chromatographic techniques: Principle and applications – TLC, GLC, HPLC, Ion exchange chromatography; Molecular sieve chromatography; Column - thin layer –paper, affinity and gas chromatography - Gel filtration - Ion exchange and High-performance liquid chromatography techniques– Examples of application for each chromatographic system - Basic principles of electrophoresis. UV and visible spectrophotometry-principles, instrumentation and applications. Fluorescence spectroscopy, static & dynamic quenching, energy transfer, fluorescent probes in the study of protein, nucleic acids, Infra-red spectroscopy, light scattering in biology, circular dichroism.

Unit 5: Electrophoretic Techniques

Theory, Principle, Apparatus, Methods and Applications of Paper Electrophoresis, Poly Acrylamide Gel Electrophoresis (PAGE), Agarose Gel Electrophoresis. Principle and Applications of: Iso-electric Focusing, Immuno Electrophoresis, Enzyme Linked Immunosorbant Assay (ELISA), Southern, Northern and Western Blotting

List of Practicals:

1. Efficacy testing of autoclave employing chemical and biological autoclave indicators.
2. Standardization of pH meter using standard buffers.
3. Studies on pH titration curves of amino acids/acetic acid and determination of pKa values
And Henderson-Hasselbach equation.
4. Separation of bacterial lipids/amino acids/sugars/organic acids by TLC and Paper Chromatography.
5. Study of UV absorption spectra of macromolecules (protein, nucleic acid, bacterial pigments).
6. Paper Electrophoresis of proteins.
7. Separation of Proteins/Nucleic acids by gel electrophoresis.
8. Density gradient centrifugation.

Textbooks:

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

2. Molecular Biology by David Freifelder, ISBN:9780867200690, 0867200693 Publisher:Jones and Bartlett
3. Physical Biochemistry: Applications to Biochemistry and Molecular Biology by David Freifelder, ISBN:9780716714446, 0716714442; Publisher: W. H. Freeman
4. Physical Biochemistry: Applications to Biochemistry and Molecular Biology by Freilder, D. Freeman, San. Francisco, 1976
5. Biochemical Techniques: Theory and Practice by Robyt, John F.; White, Bernard J. Waveland Press, Inc., U.S.A. Published: 1990.

Reference:

1. Biochemistry (4th edition): D Voet and JE Voet, 2011 John Wiley and Sons.
2. 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

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

MIB404	RESEARCH METHODOLOGY IN MICROBIOLOGY	L	T	P	C
Version	**Contact Hours - 60**	3	1	0	4
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,

CO1: Recall - Students will be able to identify the basic principles, methodologies, and techniques used in microbiological research, including experimental design, sampling, and data collection methods.

CO2: Understand - Students will be able to explain the various research methodologies used in microbiology, such as culture techniques, molecular biology methods, and statistical analysis in experimental microbiology.

CO3: Apply - Students will be able to apply research techniques in microbiology to conduct experiments, including sample preparation, microbial culture, and data analysis in laboratory-based research.

CO4: Analyze - Students will be able to analyze experimental data from microbiological research, evaluating trends, statistical significance, and drawing conclusions based on empirical evidence.

CO5: Evaluate - Students will be able to evaluate the quality and validity of research studies in microbiology, assessing experimental design, methodology, and the reliability of results and design a microbiological research project, incorporating appropriate experimental methods, controls, and analysis techniques to address specific research questions or hypotheses.

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 IN MICROBIOLOGY

Unit I

Definitions and characteristics of research; Types of research in microbiology; Main components of any research work. Problem identification, analyzing the problem and review of the literature

UNIT II

Microbial Research: Study population; Variables; Sampling; Sample size determination; Plan for data collection; Methods of data collection; Plan for data processing and analysis; **Ethical considerations.**

UNIT: III

Work Plan; Fieldwork; Writing a research report. **Introduction to the WHO/TDR Handbook on GLP,** WHO cGMP guidelines GAMP-5; Medical device and IVDs Global Harmonization Task Force (GHTF) Guidance docs, **Controlling the GLP** inspection process, Documentation, Audit, goals of Laboratory Quality Audit, **relevant ISO and Quality Council of India (QCI) Standards**

UNIT: IV

Good Automated Laboratory Practices, Principles of GALP, GALP Requirements, SOPs of GALP, Software Evaluation checklist, relevant ISO and QCI Standards, **Good Distribution Practices**, Introduction to GDP, Legal GDP requirements put worldwide, Stability testing principles, WHO GDP, USP GDP (Supply chain integrity), elevant CDSCO guidance and ISO standards

UNIT: V

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.

List of the Practical

1. **Patient application**
2. **Plagiarisms Checking**
3. **Ethical practice**
4. **Statistical analysis**
5. **Graphical Abstract**

Experiential learning:

1. Evaluating research articles (peer review)
2. Training on patent application

Extra credit in offer:

NPTEL course:
Biostatistics and Design of experiments Prof. Mukesh Doble IITM
Or a relevant one (up on due approval)

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

Components	Class Assessment (including lab)				End Term
	Experiential learning	Quizetc.	Regular evaluation	Attendance	
Weightage (%)	10	5	30	5	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

BIC451	Introduction to Genomics & Proteomics	L	T	P	C
Version 1.0	**Contact Hours - 60**	2	1	1	4
Pre-requisites/Exposure	Basic knowledge in Biology and Chemistry				
Co-requisites	--				

Course Objectives:

1. The course will provide an introduction to genomics.
2. The course will intricately describe various sequencing techniques
3. The course will offer outlines of state of the art big data analysis approaches
4. The course will offer introduction to proteomics
5. The course will provide fundamental hands on knowledge on structural modelling and visualization.

Course outcome:

The students will be able

CO1: **Recall -** Students will be able to define key terms and concepts in genomics and proteomics, including genome sequencing, protein structure, mass spectrometry, and bioinformatics.
CO2: **Understand -** Students will be able to explain the basic principles and techniques used in genomics and proteomics, such as DNA sequencing, transcriptomics, and protein identification methods.
CO3: Apply - Students will be able to use introductory tools and techniques in genomics and proteomics, such as genome databases, protein analysis software, and sequence alignment tools, to analyze biological data.
CO4: Analyze - Students will be able to analyze genomic and proteomic data, interpreting results from sequencing, protein assays, and bioinformatics tools to derive meaningful biological insights.
CO5: Evaluate - Students will be able to evaluate the applications of genomics and proteomics in research, such as their role in understanding diseases, drug discovery, and personalized medicine and design a basic genomics or proteomics experiment, selecting the appropriate techniques and methodologies to address a biological question or problem.

Course Description:

The main aim of this module is to provide an understanding about the genomics and proteomics techniques and their applications in biological sciences. The subject deals with a rapidly evolving scientific area that introduces students into genomes, proteomes, databases and nanobiotechnology that store various data about genes, proteins, genomes and proteomes. Students would learn about genomics ,proteomics and nano biotechnology and offer basic knowledge of genome sequencing, major differences between prokaryotic and eukaryotic genomes, basic proteomics and its applications. Students would gain skills in comparative evolutionary, human genomics and functional genomics. The acquired knowledge during the course would be helpful to those students who want to work in core facilities and commercial biological and medical laboratories as well as in their postgraduate studies.

Course Content:

Genomics and Proteomics

Unit 1. Introduction 15Lecture

Structural organization of genome in Prokaryotes and Eukaryotes; Organelle DNA-mitochondrial, chloroplast; DNA sequencing-principles and translation to large scale projects;Recognitionofcodingandnon-codingsequencesandgeneannotation;Toolsforgenomeanalysis-RFLP, DNA fingerprinting, RAPD, PCR, Linkage and Pedigree analysis-physical and genetic mapping.

Unit2. Genome sequencing projects **5 Lecture hours** Genome sequencing and sequencing projects. 16SrRNAtyping/sequencing, ESTs and SNPs.

Unit3. Proteomics **10Lecturehours**

Protein analysis (includes measurement of concentration, amino-acid composition, N-terminal sequencing); concept of PAGE, pI, 2-D electrophoresis of proteins; isoelectric focussing

Unit4. Quantitative Proteomics **5 lectures**

LC/MS-MS for identification of proteins and modified proteins; MALDI-TOF

Unit V. Functional genomics and proteomics **10**

Lecture hours Functional genomic approach to charactize gene function, Epigenome, functional proteomics and protein protein interaction.

List of practical:

1. PCR amplification of 16SrDNA and analysis
2. DNA extraction and quantitation
3. Protein extraction and quantitation
3. SDS PAGE
5. Protein structural modelling and visualization

Suggested Books

1. Berg,J.M.,Tymoczko,J.L.andStryer,L.(2006).Biochemistry.VIEdition.W.HFreemanandCo.
2. Buchanan, B.,Gruissem,W.andJones,R.(2000)BiochemistryandMolecularBiologyofPlants. AmericanSocietyofPlantBiologists.
3. Nelson, D.L.,Cox,M.M.(2004)Lehninger Principles of Biochemistry,4thEdition,WHFreemanandCompany,NewYork,USA.
4. Hopkins, W.G.andHuner,P.A.(2008)IntroductiontoPlantPhysiology.JohnWileyandSons.

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

ExamExaminationScheme:

Components	Class assessment (including practical)	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

PDC302	Professional Development Course-V (Practical)	L	T	P	C
Version 1.0	**Contact Hours - 30**	0	0	1	**1**
Pre-requisites/Exposure	**Semester-wise course**				
Co-requisites	**Completion of PDC-IV course**				

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 (preferably 3rd semester-7th semester of U.G)

1. Interview Skills.
2. Aptitude and Technical Skills.
3. Group Discussion and Communication Skills.
4. Personal Branding and Online Presence.
5. Professional Skills.
6. Industry Insights and Company Presentations.
7. Career Guidance for competitive entrance exams and Job Search Strategies
8. Mock Tests and Assessments.

Course learning outcomes:

Remember List the essential skills and strategies for effective interviews, group discussions, and aptitude tests.

Understand Describe the importance of personal branding, online presence, and professional communication in career development.

Apply Demonstrate interview techniques, problem-solving skills, and teamwork during group discussions and mock sessions.

Analyze Examine company presentations and industry insights to align career goals with industry expectations.

Evaluate Assess individual performance in mock tests and group discussions to identify areas for improvement.

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

ADAMAS UNIVERSITY

B.Sc. Microbiology (Hons.)

SEMESTER-VIII

MIB406	Biostatistics and Biomathematics	L	T	P	C
Version 1.0	**Contact Hours - 60**	2	1	1	4
Pre-requisites/Exposure	Basic concept of Mathematics and biology				
Co-requisites	--				

Course Objectives

1. To provide those students with apt the knowledge to mathematics and statistics
2. It will also provide in depth knowledge of the mathematical modelling.
3. Elaborating the measures of central tendency, Correlation and
4. Explore the knowledge of the statistical inference and applications of biostatistics

Course Outcomes

On completion of this course,

CO1: **Recall -** Students will be able to **define** key terms and concepts in biostatistics and biomathematics, including statistical measures, probability, distributions, and mathematical models used in biological research.

CO2: **Understand -** Students will be able to **explain** the principles of statistical methods and mathematical models applied to biological data, including hypothesis testing, regression analysis, and differential equations in biological contexts.

CO3: **Apply -** Students will be able to **apply** statistical and mathematical techniques to analyze biological data, using tools such as t-tests, chi-square tests, ANOVA, and population models to solve biological problems.

CO4: **Analyze -** Students will be able to **analyze** complex biological data, interpreting results from statistical tests, model predictions, and identifying trends or patterns in datasets.

CO5: **Evaluate -** Students will be able to **evaluate** the suitability of different statistical or mathematical methods for a specific biological research question, assessing their accuracy, assumptions, and limitations and **design** a biostatistical experiment or biomathematical model, selecting the appropriate methodology, tools, and analysis techniques to address a research hypothesis or problem in biology.

Catalogue Description

The course of 'Biomathematics and Biostatistics' will help to understand the introductory level knowledge to statics in the field of biological science. This course is a beginning to the biostatistics, the application of different biostatistics methods to biological data analysis, different measures of central tendency, correlation and regression and some possible applications of biostatistics. Furthermore, the current research activities in the field of biostatistics 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

Biostatistics and Biomathematics[MIB406]

Unit 1. Sampling and distribution (9 h): Scope of statistics: utility and misuse. Principles of statistical analysis of biological data.Sampling parameters. Difference between sample and Population, Sampling Errors, Censoring, difference between parametric and non-parametric statistics; Sampling Distributions, Standard Error, Standard Deviation and Correlation,Testing of Hypothesis, Level of Significance and Degree of Freedom; Large Sample Test based on Normal Distribution, Small sample test based on t-test, Z- test and F test; Confidence Interval; Distribution-free test - Chi-square test; Basic introduction to Multivariate statistics, etc.

Unit 2. Central tendency, correlation, and regression (9 h)

Measures of central tendency, Measures of dispersion; skewness, kurtosis; Elementary Probability and basic laws; Discrete and Continuous Random variable, Mathematical Expectation; Curve Fitting; Correlation and Regression. Emphasis on examples from Biological Sciences; Mean and Variance of Discrete and Continuous Distributions namely Binomial, Poisson, Geometric, Weibull, Logistic and Normal distribution. Fitting of Distributions

Unit 3. Biomathematics (9 h)

Sets. Functions and their graphs: polynomial, sine, cosine, exponential and logarithmic functions. Motivation and illustration for these functions through projectile motion, simple pendulum, biological rhythms, cell division, muscular fibres etc., increasing, decreasing and, periodicity of the functions. Sequences - finite sequences, recursion and difference equations, the Fibonacci sequence branching habit of trees and breeding habit of rabbits. Intuitive idea of algebraic relationships and convergence. Infinite Geometric Series. Series formulas, log (1+x), sin x, cos x. Step function. Intuitive idea of discontinuity, continuity and limits.

Unit 4. Calculus (9 h): Differentiation, Conception to be motivated through simple concrete examples as given above from Biological and Physical Sciences. Use of methods of differentiation like Chain rule, Product rule and Quotient rule. Second order derivatives of above functions. Integration as reverse process of differentiation. Integrals of the functions introduced above. Differential Equations of first order, Linear Differential Equations.Points in plane and space and coordinate form. Examples of matrices arising in Biological Sciences and Biological networks. Sum and Product of matrices upto order 3.

Unit 5. Vectors (9 h): Physical quantities like position and force as vectors, Attracting and repelling charges, Vector addition- Calculation of magnitude and direction of a vector, Unit vectors, Calculation of resultant force ; Dot product and cross product, Polar coordinate system, Gradient of a scalar. Applications of calculus and vector algebra in biology. Nernst equation, Potential difference across a membrane, Flow of ions due to diffusion, Flow of ions due to electrostatic interactions. Diffusion equation, Continuity equation, Diffusion equation. Mean-square position Mean-square displacement.

Lab courses:

1. Simple model for polymerization depolymerisation.
2. Modelling using ODE
3. Simplest model in population genetics/evolution and Wright-Fisher model.
4. Application of statistics SPSS/ PRISM: Test of normality, One Sample t test, One sample Wilcoxon test, independent samples t test, Mann Whitney U test, Paired samples t test, Wilcoxon signed rank test, One Way ANOVA, Kruskal Wallis H test, correlation and regression analysis.
5. PLOTTER/ ORIGIN: Statistical Graphics

Experiential learning:

1. Data analysis workshop

2. Problem (numerical) solving
3. Video lectures:
https://www.youtube.com/watch?v=VPZD_aij8H0&list=PLUl4u3cNGP60uVBMaoNERc6knT_MgPKS0&ab_channel=MITOpenCourseWare

Extra credit in offer:
NPTEL course: .
Biostatistics and Design of experiments Prof. Mukesh Doble IITM
Or a relevant one (up on due approval)

Text Books:
1. Le CT (2003) Introductory biostatistics. 1st edition, John Wiley, USA
2. Glaser AN (2001) High Yield TM Biostatistics. Lippincott Williams and Wilkins, USA

Reference Books:
1. Edmondson A and Druce D (1996) Advanced Biology Statistics, Oxford University Press.
2. Danial W (2004) Biostatistics: A foundation for Analysis in Health Sciences, John Wiley and Sons Inc.

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

Components	Class Assessment (including lab)	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

MIB407	Clinical Trial Management	L	T	P	C
Version 1.0	**Contact Hours - 60**	2	1	1	4
Pre-requisites/Exposure	Basic knowledge in Biology				
Co-requisites	--				

Course Objectives

The course Clinical Trial Management is designed with the intent that the student will learn the ethics, principles and conduct of clinical trials for medical research. The protection of study participants and the need for equipoise will be covered, including regulatory restrictions and the latest patient privacy regulations for the dissemination and use of data associated with the participants in clinical trials.

Course Outcomes

By the end of this course, the student should be able to:

CO1: Recall - Students will be able to **define** key terms and concepts related to clinical trials, including study designs, phases of clinical trials, and regulatory frameworks such as GCP (Good Clinical Practice).
CO2: **Understand -** Students will be able to **explain** the processes involved in clinical trial management, including protocol development, patient recruitment, data collection, and monitoring.
CO3: **Apply -** Students will be able to **apply** the principles of clinical trial management by developing a clinical trial plan, ensuring adherence to protocols, and implementing appropriate methodologies for data collection and analysis.
CO4: **Analyze -** Students will be able to **analyze** clinical trial data, identifying trends, safety issues, or efficacy outcomes, and assessing the impact of these findings on the trial's progress and conclusions.
CO5: **Evaluate -** Students will be able to **evaluate** the ethical, legal, and scientific considerations involved in clinical trials, assessing the risks and benefits of clinical research on participants and society and **design** a clinical trial, including formulating the research question, selecting an appropriate trial design, identifying outcomes, and planning for recruitment, monitoring, and data analysis.

Catalogue Description

This course provides an in-depth understanding of the principles and practices involved in managing clinical trials. Students will learn about the entire lifecycle of a clinical trial, including study design, protocol development, participant recruitment, data collection and analysis, regulatory compliance, and ethical considerations. The course will also cover project management techniques and tools specific to clinical trials.

Course Content

Unit 1: Introduction to Clinical Research (10h)

Difference between Clinical Research and Clinical Practice, Medical Terminologies and Conditions (Important ones only), Definition and purpose of clinical trials, Different phases and types of clinical trials, Importance of clinical trial management

Unit 2: Study Design and Protocol Development (14h)

Introduction to study designs, Study design considerations, Protocol development process and components, Project planning and scheduling, Resource allocation and budgeting, Risk management and mitigation, Clinical Trial Process (Before, During, After), Monitoring visits and source document verification, Auditing and quality assurance in clinical trials

Unit 3 Data Collection and Management (8h)

Data collection methods and tools, Use of technology in data collection and analysis, Data management and quality control, Statistical considerations in clinical trials

Unit 4: Regulatory Compliance and Ethics (10h)

Regulations in Clinical Research, Regulatory authorities and guidelines (FDA, ICH, etc.), Institutional review boards (IRBs) and ethical considerations, Good Clinical Practice (GCP) guidelines, Safety reporting requirements, Adverse event reporting and management,

Unit 5: Clinical Trial Documentation and Archiving (8h)

Essential trial documents, Trial master file (TMF) and documentation management, Archiving and record retention requirements, Case studies.

List of practicals (10h)Bottom of Form

1. Developing a clinical trial protocol
2. Informed consent role-play assessment.
3. Case report form (CRF) development,
4. Summarizing findings from a mock monitoring visit.
5. Developing a Corrective and preventive actions (CAPAs) plan for a hypothetical audit finding

Textbook:

1. Clinical Trial Management: A Practical Guide to Success. Lorraine D. Ellis, Wiley-Blackwell, 2019
2. Principles and Practice of Clinical Trials, Editors**:** Steven Piantadosi, Curtis L. Meinert, 2020, Springer.

Reference books:

1. A Practical Guide to Managing Clinical Trials, 1st Edition**,** by JoAnn Pfeiffer, Cris Wells.
2. Lawrence M. Friedman, Curt D. Furberg, David L. DeMets, David M. Reboussin, Christopher B. Granger, Fundamentals of clinical trials, Fifth Edition, Springer

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

MIB408	Biomedical Nanotechnology	L	T	P	C
Version 1.0	**Contact Hours - 60**	2	1	1	4
Pre-requisites/Exposure	Basic knowledge in Biology and Chemistry				
Co-requisites	--				

Course Objectives

This course provides an introduction to the principles and applications of nanotechnology in the field of biomedicine. It covers the fundamental concepts of nanomaterials, nanofabrication techniques, and their applications in drug delivery, diagnostics, tissue engineering, and biosensing. The course also explores the ethical and safety considerations associated with biomedical nanotechnology.

Course Outcomes

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

CO1: Recall - Students will be able to **identify** key concepts and terminology in biomedical nanotechnology, including types of nanoparticles, fabrication techniques, and their applications in medicine.
CO2: Understand - Students will be able to **explain** the principles of nanotechnology and how nanomaterials interact with biological systems, including mechanisms of drug delivery, diagnostic applications, and tissue engineering.
CO3: Apply - Students will be able to **apply** nanotechnology techniques to develop biomedical solutions, such as creating nanoparticle-based drug delivery systems or diagnostic tools for medical applications.
CO4: Analyze - Students will be able to **analyze** the properties and behavior of nanomaterials in biological environments, evaluating their effectiveness, safety, and potential toxicity for medical use.
CO5: Evaluate - Students will be able to **evaluate** the ethical, regulatory, and safety implications of using nanotechnology in biomedical applications, considering both its potential benefits and risks in healthcare and **design** a biomedical nanotechnology-based system or device, selecting appropriate materials, techniques, and applications for specific medical purposes, such as targeted drug delivery or imaging.

Catalogue Description

This course provides an overview of nanotechnology, fabrication, characterization and functions of nanoscale structures, and serves as an introduction to major areas in biomedical sectors influenced by developments in nanotechnology. Moreover, this course provides the platform to improve the students' oral and written communication skills.

Course Content

Unit 1: Introduction to Nanotechnology and Nanomaterials (10 h)

Definition and scale of nanotechnology, Historical overview and key milestones, Interdisciplinary nature and applications in biomedicine, Introduction to nanomaterials (metals, polymers, carbon-based, piezoelectric crystals, etc.)

Unit 2: Synthesis and Characterization of Nanomaterials (10h)

Fabrication methods (top-down and bottom-up approaches), Characterization techniques (microscopy, spectroscopy, etc.)

Unit 3: Applications of nanotechnology in medicine (10h)

Challenges in conventional drug delivery systems, Nanoparticles and nanocarriers for targeted drug delivery, Controlled release systems, Imaging techniques at the nanoscale (fluorescence, magnetic resonance, etc.)

Unit 4: Nanotechnology in Tissue Engineering and Regenerative Medicine (10h)
Biomaterials for tissue engineering, Scaffold design and fabrication techniques, Application of nanotechnology in organ regeneration, Integration of nanomaterials and microfluidics

Unit 5: Safety and Ethical Considerations in Biomedical Nanotechnology (10h)
Toxicity and risk assessment of nanomaterials, Regulatory frameworks and guidelines, Societal and ethical implications

List of practicals: (10h)
1. Synthesis of metallic nanoparticles (e.g., gold, silver) using chemical reduction methods or green synthesis approaches.
2. Characterization of nanoparticles using UV-Vis spectroscopy.
3. Investigation of nanoparticle-biomolecule interactions using fluorescence spectroscopy.
4. Case studies exploring real-world applications of nanobiotechnology and their implications for healthcare, environment, and society.

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).

Reference Books:
4. Lamprecht, A., "Nanotherapeutics: Drug Delivery Concepts in Nanoscience", Pan Stanford Publishing Pte. Ltd. (2009).
5. Jain, K.K., "The Handbook of Nanomedicine", Humana press. (2008).

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

MIB452	Fundamentals of Nanobiotechnology	L	T	P	C
Version 1.0	**Contact Hours - 60**	2	1	1	4
Pre-requisites/Exposure	Basic knowledge in Biology and Chemistry				
Co-requisites	--				

Course Objectives

This course offers an overview of nanotechnology's principles and uses within biomedicine. It delves into key topics such as nanomaterials, fabrication methods, and their roles in drug delivery, diagnostics, tissue engineering, and biosensing. Additionally, the course examines the ethical and safety implications inherent in biomedical nanotechnology.

Course Outcomes

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

CO1: Recall - Students will be able to **define** key concepts and terminology in nanobiotechnology, including nanomaterials, nanodevices, and their applications in biological systems.
CO2: Understand - Students will be able to **explain** the basic principles of nanotechnology and biotechnology, and how they converge to create novel solutions in areas such as diagnostics, drug delivery, and biosensors.
CO3: Apply - Students will be able to **apply** nanobiotechnology techniques to solve real-world biological problems, such as using nanoparticles for targeted therapy or biosensors for disease detection.
CO4: Analyze - Students will be able to **analyze** the interaction between nanomaterials and biological systems, evaluating factors like bioavailability, toxicity, and biocompatibility in different applications.
CO5: Evaluate - Students will be able to **evaluate** the potential benefits, risks, and ethical concerns associated with the use of nanobiotechnology in healthcare, agriculture, and environmental management and **design** a nanobiotechnology-based solution or application, integrating appropriate nanomaterials and techniques to address a specific biological or medical challenge.

Catalogue Description

This course offers a comprehensive examination of nanotechnology, including its principles, fabrication methods, characterization techniques, and the diverse functionalities of nanoscale structures. It also serves as an introduction to key biomedical fields impacted by advancements in nanotechnology. Furthermore, the course aims to enhance students' abilities in both oral and written communication.

Course Content

Unit 1: Introduction to Nanobiotechnology

- Overview of nanotechnology and biotechnology.
- Introduction to nanomaterials and their properties.
- Applications of nanobiotechnology in healthcare, agriculture, and environmental remediation.

Unit 2: Nanomaterial Synthesis and Characterization

- Methods for the synthesis of nanoparticles (e.g., chemical reduction, sol-gel, template-assisted).
- Characterization techniques: TEM, SEM, AFM, XRD, DLS, and FTIR.

Unit 3: Interactions of Nanomaterials with Biological Systems

- Cellular uptake mechanisms of nanoparticles.
- Nanoparticle-biomolecule interactions.
- Toxicity and biocompatibility considerations.
- Lab session: Cellular uptake assays and toxicity testing.

Unit 4: Applications of Nanobiotechnology

- Drug delivery systems: Nanocarriers, targeted delivery, and controlled release.
- Biosensors and diagnostic assays: Nanoparticle-based detection platforms.
- Tissue engineering and regenerative medicine: Scaffold design and functionalization.
- Lab session: Design and fabrication of a nanobiotechnology-based application.

Unit 5: Emerging Trends and Future Directions

- Nanobiotechnology in personalized medicine and precision agriculture.
- Challenges and opportunities in commercializing nanobiotechnology products.
- Ethical, social, and environmental implications.
- Research project: Proposal and presentation on an emerging topic in nanobiotechnology.

List of practicals:

1. Synthesis of metallic nanoparticles (e.g., gold, silver) using chemical reduction methods or green synthesis approaches.
2. Characterization of nanoparticles using UV-Vis spectroscopy.
3. Investigation of nanoparticle-biomolecule interactions using fluorescence spectroscopy.
4. Case studies exploring real-world applications of nanobiotechnology and their implications for healthcare, environment, and society.

Text Books:

1. Malsch, N.H., "Biomedical Nanotechnology", CRC Press. (2005).
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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).

Reference Books:

4. Lamprecht, A., "Nanotherapeutics: Drug Delivery Concepts in Nanoscience", Pan Stanford Publishing Pte. Ltd. (2009).
5. Jain, K.K., "The Handbook of Nanomedicine", Humana press. (2008).

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

MIB409	Dissertation	L	T	P	C
Version 1.0		0	0	12	12
Pre-requisites/Exposure	Concept of Microbiology and allied subjects at UG				
Co-requisites	--				

Course Objectives

1. This will enable students to design, evaluate and present scientific work

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

CO1: Recall - Students will be able to **identify** the key components of a dissertation, including literature review, methodology, data analysis, and conclusion.

CO2: Understand - Students will be able to **explain** the research process, from formulating a research question to presenting findings and writing a structured dissertation.

CO3: Apply - Students will be able to **apply** appropriate research methods and techniques to address a specific research question, collecting and analyzing data to support their dissertation.

CO4: Analyze - Students will be able to **analyze** data and literature, evaluating trends, relationships, and discrepancies to draw valid conclusions for their research topic.

CO5: Evaluate - Students will be able to **evaluate** the significance and impact of their research findings, assessing how they contribute to the field and identifying limitations and future research directions and **design** an original research project, selecting appropriate methodologies, collecting data, and structuring their dissertation in a scholarly and logical manner.

Catalogue Description

The core-course of 'dissertation' will enable the students to nurture their research interest by compiling basic knowledge obtained in three 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
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	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

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

Composite CO-PO Mapping for B.Sc. Microbiology (2024-28)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
BIC101												
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
MIB102												
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
BIT105												
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
AEC101												
CO1	-	1	3	-	-	-	-	3	2	3	-	3
CO2	-	1	3	-	-	-	-	3	2	3	-	3
CO3	-	1	3	-	-	-	-	3	2	3	-	3
CO4	-	1	3	-	-	-	-	3	2	3	-	3
CO5	-	1	3	-	-	-	-	3	2	3	-	3
MIB152												
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

VAC101												
CO1	-	1	3	-	-	-	-	3	-	3	3	3
CO2	-	1	3	-	-	-	-	3	-	3	3	3
CO3	-	1	3	-	-	-	-	3	-	3	3	3
CO4	-	1	3	-	-	-	-	3	-	3	3	3
CO5	-	1	3	-	-	-	-	3	-	3	3	3
MIB103												
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
MIB104												
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
MIB108												
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
SEC139												
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
VAC105												
CO1	-	1	3	-	-	-	-	3	-	3	3	3

CO2	-	1	3	-	-	-	-	3	-	3	3	3
CO3	-	1	3	-	-	-	-	3	-	3	3	3
CO4	-	1	3	-	-	-	-	3	-	3	3	3
CO5	-	1	3	-	-	-	-	3	-	3	3	3
AEC102												
CO1	-	1	3	-	-	-	-	3	2	3	-	3
CO2	-	1	3	-	-	-	-	3	2	3	-	3
CO3	-	1	3	-	-	-	-	3	2	3	-	3
CO4	-	1	3	-	-	-	-	3	2	3	-	3
CO5	-	1	3	-	-	-	-	3	2	3	-	3
MIB201												
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
BIC202												
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
MIB206												
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
SEC140												
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
MIB252												
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
VAC102												
CO1	-	2	-	-	-	2	-	3	1	3	3	3
CO2	-	2	-	-	-	2	-	3	1	3	3	3
CO3	-	2	-	-	-	2	-	3	1	3	3	3
CO4	-	2	-	-	-	2	-	3	1	3	3	3
CO5	-	2	-	-	-	2	-	3	1	3	3	3
PDC201												
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
MIB203												
CO1	-	1	3	-	-	-	-	3	-	3	3	3
CO2	-	1	3	-	-	-	-	3	-	3	3	3
CO3	-	1	3	-	-	-	-	3	-	3	3	3
CO4	-	1	3	-	-	-	-	3	-	3	3	3
CO5	-	1	3	-	-	-	-	3	-	3	3	3
MIB204												
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

MIB205												
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
SEC141												
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
PDC202												
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
MIB301												
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
MIB302												
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
MIB303												
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
SEC142												
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
MIB304												
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
MIB351												
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
PDC301												
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
MIB305												
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
MIB306												
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
BIC352												
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
SEC143												
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
PDC302												
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
MIB401												
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

MIB402												
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
MIB403												
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
MIB405												
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
MIB404												
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
BIC451												
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
PDC302												
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
MIB406												
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
MIB407												
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
MIB408												
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
MIB452												
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
MIB409												
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
Total	480	580	455	470	555	130	120	615	55	150	250	586
No of Courses: 48	48											
Average	2	2.42	1.89	1.95	2.31	0.54	0.5	2.56	0.229	0.625	1.041	2.441