ADAMAS UNIVERSITY

SCHOOL OF LIFE SCIENCE AND BIOTECHNOLOGY

Department of Biotechnology

B.Sc. Biotechnology Program

Program Code: BIT3407

(2024-25)

Total credits: 172

SCHOOL OF LIFE SCIENCE AND BIOTECHNOLOGY

UNDERGRADUATE COURSE STRUCTURE

B.SC (H) BIOTECHNOLOGY

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	BIT101	Biochemistry and Metabolism	2	1	1	4	CC-1
2	CC	BIT102	Cell Biology	2	1	1	4	CC-2
3	MDC	BIT105	Renewable Energy Resources	2	0	1	3	MDC 1
4	AEC	AEC101	Communicative English-I	2	1	0	3	AEC I
5	Minor	100-199	To be chosen from a pool of minors	2	1	1	4	Minor I
6	VAC	VAC101	Environmental Education-I	2	0	0	2	VAC 1
Semester Credits							**20**	
SEMESTER II								
7	CC	BIT107	Basics of Animal Sciences	2	1	1	4	CC-3
8	CC	BIT104	Microbiology	2	1	1	4	CC-4
9	MDC	BIT106	Astrobiology	2	0	1	3	MDC 2
10	SEC	SEC134	Enzymology	1	0	1	2	SEC 1
11	VAC	VAC105	Community Engagement and Social Responsibility	1	0	1	2	VAC 2
12	AEC	AEC102	Communicative English-II	2	1	0	3	AEC 2
13	Minor	100-199	To be chosen from a pool of minors	2	1	1	4	Minor II
Semester Credits							**22**	
SEMESTER III								
14	CC	BIT207	Basics in Plant Biology	2	1	1	4	CC-5
15	CC	BIT202	Genetics	2	1	1	4	CC-6
16	MDC	BIT206	Introduction to Biomaterials	2	0	1	3	MDC 3

17	Minor	200-299	To be chosen from a pool of minors	2	1	1	4	Minor III
18	AEC		Pan University Course				2	AEC 3
19	SEC	SEC135	Basics of Forensic Biology	1	0	1	2	SEC 2
20	VAC	VAC102	Human Values and Ethics	2	0	0	2	VAC 3
21	PDC	PDC201	Professional Development Course-I	0	0	1	1	PDC 1
Semester Credits							**22**	
SEMESTER IV								
22	CC	BIT208	Animal Biotechnology	2	1	1	4	CC-7
23	CC	BIT209	Plant Biotechnology	2	1	1	4	CC-8
24	CC	BIT205	Molecular Biology	2	1	1	4	CC-9
25	SEC	SEC136	Applied Biophysics	1	0	1	2	SEC 3
26	Minor	200-299	To be chosen from a pool of minors	2	1	1	4	Minor IV
27	VAC		Pan University Course				2	VAC 4
28	PDC	PDC202	Professional Development Course- II	0	0	1	1	PDC 2
Semester Credits							**21**	
SEMESTER V								
29	CC	BIT301	Immunology	2	1	1	4	CC-10
30	CC	BIT302	Recombinant DNA Technology	2	1	1	4	CC-11
31	CC	BIT303	IPR and Biosafety	2	1	1	4	CC-12
32	Minor	300-399	To be chosen from a pool of minors	2	1	1	4	Minor V
33	SEC	SEC137	Molecular Diagnostics	1	0	1	2	SEC 4
34	INT	BIT304	Internship	0	0	4	4	Internship 1
35	PDC	PDC301	Professional Development Course- III	0	0	1	1	PDC 3

Semester Credits							**23**	
SEMESTER VI								
36	CC	BIT305	Bioinformatics	2	1	1	4	CC-13
37	CC	BIT306	Bioprocess Technology	2	1	1	4	CC-14
38	CC	BIT307	Bioanalytical Tools	2	1	1	4	CC-15
39	Minor	300-399	To be chosen from a pool of minors	2	1	1	4	Minor VI
40	SEC	SEC138	Biostatistics	1	0	1	2	SEC 5
41	Project	BIT308	Project Work	0	0	4	4	Project 1
42	PDC	PDC302	Professional Development Course-IV	0	0	1	1	PDC 4
Semester Credits							**23**	
Total Credits of the Program after 3rd Year							**131**	
			SEMESTER VII					
43	CC	BIT401	Genomics and Proteomics	2	1	1	4	CC-16
44	CC	BIT402	Environmental Biotechnology	2	1	1	4	CC-17
45	CC	BIT403	Developmental Biology	2	1	1	4	CC-18
46	CC (For With research)	BIT404	Research Methodology (should start working on dissertation topic)	3	1	0	4	CC-19 (Research)
47	CC (For Without research)	BIT405	Ecology and Environmental Management	3	1	0	4	CC-19 (without Research)
48	Minor	400-499	To be chosen from a pool of minors	2	1	1	4	Minor VII
49	PDC	PDC401	Professional Development Course-V	0	0	1	1	PDC 5
Total Semester Credit							**21**	
			Semester VIII					
50	CC	BIT406	Molecular Modelling and Drug Design	2	1	1	4	CC-20

51	CC (For Without research)	BIT407	Medical Microbiology	2	1	1	4	CC-21 (without Research)
52	CC (For Without Research)	BIT408	Nanotechnology	2	1	1	4	CC-22 (without Research)
53	Minor (For without research)	400-499	To be chosen from a pool of minors	2	1	1	4	
54	Minor (For with/without research)	400-499	To be chosen from a pool of minors	2	1	1	4	
55	Dissertation	BIT409	Project/Dissertation	12	0	0	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 Biotechnology Department

1. Biochemistry– Sem I (BIT151)
2. Basic Animal Science– Sem II (BIT152)
3. Basic Plant Science – Sem III (BIT251)
4. Elementary Molecular Biology – Sem IV (BIT252)
5. Basics of IPR and Biosafety - Sem V (BIT353)
6. Introduction to Bioinformatics – Sem VI (BIT352)
7. Elementary Genomics and Proteomics-Sem VII (BIT451)
8. Basic Medical Microbiology - Sem VIII (BIT452)

MDC Courses from the Department of Biotechnology

1. Renewable Energy Resources (BIT105)

2. Astrobiology (BIT106)

3. Introduction to Biomaterials (BIT206)

List of Minors to be offered

Semester	Course Code	Courses	L	T	P	C
1	BIT151	Biochemistry	2	1	1	4
2	BIT152	Basic Animal Science	2	1	1	4
3	BIT251	Basic Plant Science	2	1	1	4
4	BIT252	Elementary Molecular Biology	2	1	1	4

5	BIT353	Basics of IPR and Biosafety	2	1	1	4
6	BIT352	Introduction to Bioinformatics	2	1	1	4
7	BIT451	Elementary Genomics and Proteomics	2	1	1	4
8	BIT452	Basic Medical Microbiology	2	1	1	4

List of Multi-disciplinary courses to be offered

Semester	Course Code	Courses	L	T	P	C
1	BIT105	Renewable Energy Resources	2	0	1	3
2	BIT106	Astrobiology	2	0	1	3
3	BIT206	Introduction to Biomaterials	2	0	1	3

ADAMAS UNIVERSITY

B.Sc. Biotechnology (Hons.)

SEMESTER-I

BIT101	**Biochemistry and Metabolism**	**L**	**T**	**P**	**C**
Version 1.0	**Contact Hours – 75**	2	1	1	4
Pre-requisites/Exposure	PLUS TWO (12^{th}) LEVEL BIOLOGY				
Co-requisites	--				

Course Objectives

1. The main objective of this course is to emphasize the detailed knowledge and importance of biological macromolecules.
2. Students should acquire knowledge in the quantitative and qualitative estimation of biomolecules and be able to study the basic structural and functional aspects of different biomolecules.
3. They study the influence and role of structure in reactivity of biomolecules.
4. To provide students modern view about biochemistry and metabolism.

Course Outcomes

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

CO1. **Define** the concepts of solvents and solutes in biochemistry and describe their role in various metabolic processes

CO2. **Identify** the different types of lipids, amino acids, enzymes and their functions in the human body.

CO3. **Evaluate** the role of nucleic acids in protein synthesis and genetic information transfer

CO4. **Describe** the different types of carbohydrates and their importance in energy production.

CO5. **Demonstrate** the ability to perform basic biochemical experiments and analyze the results

Catalog Description

The course is designed as an introduction to the molecules and other organic compounds found in different living systems. The course provides a foundation of the structural and functional

properties of different bio macromolecules present in our system and how they play the basic fundamental chemical reactions to sustain a complex chemical process, which is known as life. 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

Biochemistry and Metabolism

UNIT I: 10 hr

Physical and Chemical Properties of water: Water as solvent, different types of Non covalent interactions present in the biological systems, pH scale, Buffer concept, Henderson Hasselbalch Equation.

Carbohydrates: Structure, Function and properties of Monosaccharides, Disaccharides and Polysaccharides. Homo & Hetero Polysaccharides, Mucopolysaccharides, Bacterial cell wall polysaccharides.

UNIT II 15 hr

Amino acids & Proteins: Structure & Function. Structure and properties of Amino acids. Types of proteins and their classification, Forces stabilizing protein structure and shape. Different Level of structural organization of proteins, Protein Purification.

Lipids: Structure and functions –Classification, nomenclature and properties of fatty acids, essential fatty acids. Phospholipids, sphingolipids, glycolipids, cerebrosides, gangliosides, Prostaglandins, Cholesterol.

UNIT III 20 hr

Nucleic acids: Structure and functions: Double helical model of DNA structure.

UNIT IV 15 hr

Enzymes: Nomenclature and classification of Enzymes, Holoenzyme, apoenzyme, Cofactors, coenzyme, prosthetic groups. Enzyme Kinetics.

UNIT V 15 hr

Carbohydrates Metabolism: Reactions, energetics and regulation. Glycolysis: Fate of pyruvate under aerobic and anaerobic conditions. Pentose phosphate pathway and its significance, Gluconeogenesis, Glycogenolysis and glycogen synthesis. TCA cycle, Electron Transport Chain, Oxidative phosphorylation. ß-oxidation of fatty acids.

List of Practical:

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.

SUGGESTED READING:

1. Biochemistry by Jeremy M. Berg, John L. Tymozko, Lubert Stryer, Fifth edition, W.H. Freeman and Company.

2. Lehninger Principles of Biochemistry Edition 4, Nelson, David L. Cox, Michael M. Lehninger, Albert L. W H Freeman & Co.

3. Biotechnology by John E. Smith. Fifth Edition. Cambridge University Press.

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	3	3	3	3	-	-	-	-	-
CO2	3	3	2	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	3	3	-	-	-	-	-
CO4	3	3	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	3	2	3	3	-	-	-	-	-
Avg	3	3	2.8	3	2.8	3	3	-	-	-	-	-

1=weakly mapped

2= moderately mapped

3=strongly mapped

BIT102	CELL BIOLOGY	L	T	P	C
Version 1.0	**Contact Hours – 75**	2	1	1	4
Pre-requisites/Exposure	12th LEVEL BIOLOGY				
Co-requisites	Chemistry, Physics				

Course Objectives

1. To enable students **explain** the structures and purposes of basic components of prokaryotic and eukaryotic cells, especially macromolecules, membranes, and organelles.
2. **Explain** the transport of molecules across cell membrane and cell signaling and **examine** the series of events taking place during division and apoptosis of a eukaryotic cell. Students will also be able to **Explain** the molecular mechanism of carcinogenesis and cellular transduction
3. Students will learn skills and knowledge by doing e**xperiment with** different procedures to know the structural and functional basis of a cell

Course Outcomes

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

CO1. **Recall** the key differences between eukaryotic and prokaryotic cells by identifying and describing their structural and functional characteristics.

CO2. **Analyze** the different mechanisms of membrane transport such as passive diffusion, facilitated diffusion, active transport, and endocytosis/exocytosis, and evaluate their roles in maintaining cell homeostasis.

CO3. **Explain** the process of cell signaling including the role of receptors, signaling molecules, and signal transduction pathways in coordinating cellular responses.

CO4. **Apply** knowledge of the cell cycle phases (G1, S, G2, and M) and the mechanisms of apoptosis to explain how cells regulate their growth and proliferation and know the underlying mechanism of cancer development, including the role of oncogenes, tumor suppressor genes, and mutations in cell cycle regulation.

CO5. **Design** and conduct cell biology experiments to investigate specific cellular processes, such as Membrane permeability, cell division and interpret the results to draw meaningful conclusions.

Catalog Description

Cell biology course will help to understand the biology of cells of higher organisms: Structure, and function of cellular membranes and organelles; cell cycle and its regulation, apoptosis and oncogenic transformation; receptors, and cell signalling. All the lectures will be devoted on discussions of basic theories and advanced topics, focusing on practical implementation of knowledge. CO1. Experiment with different procedures will be conducted to know the structural and functional basis of a cell. Classes will be conducted by lecture as well as power point presentation, audio visual virtual lab session as per requirement and laboratory

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

Course Content

Cell Biology

UNIT 1 10 Lecture Hours

Eukaryotic & prokaryotic cells: Structure of a cell, Cell organelles and function, cell cytoskeleton; cytosolic, Composition and function of cell membrane, nuclear & membrane bound receptors; autocrine, paracrine & endocrine models of actions

UNIT 2 15 Lecture Hours

Membrane transport and Cell Signaling: transport across cell membrane, types of transport-diffusion, osmosis, passive transport, active transport, lipid raft, liposome. Cell signaling & signal transduction pathways: Hormones & their receptors, cell surface receptors; signaling through G-protein coupled receptors; second messengers; regulation of signaling pathways;

UNIT 3 20 Lecture Hours

Cell cycle and apoptosis: Components of cell cycle control system; Intracellular & Extracellular control of cell division; Programmed cell death / Apoptosis; intrinsic and extrinsic pathways of cell death; Apoptosis in relation with Cancer; Viral disease (AIDS) and Organ transplant.

UNIT 4 15 Lecture Hours

Cancer: The Development & causes of cancer; tumor viruses, oncogenes and tumor suppressor gene, prevention & treatment of cancer.

UNIT 5 15 Hours

Cell biology Applications; **Analyse appraise** and **discuss** the different tools and techniques: Types of microscopy, Centrifugation

List of experiments

- Lab safety
- Working knowledge of the Microscope and its use.
- Examine structure of prokaryotic and eukaryotic cells
- Effect of temperature and organic solvents on semi permeable membrane.
- Demonstration of mitosis in onion root tips
- Buccal smear – Identification of Barr Body
- Cell Counting and viability

SUGGESTED READING:

1. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley & Sons. Inc.
2. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington
3. De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology. 8th edition. Lippincott Williams and Wilkins, Philadelphia.
4. Practical Handbook of Cytology: Protocols in Cell Biology 2016 by Chetan Jawale and Laxmikant Dama , Lap Lambert Academic Publishing
5. Cell Biology : Practical Manual Paperback - 2018 by Renu Gupta , Seema Makhija & Ravi Toteja, Prestige Publishers

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	3	3	3	3	-	-	-	-	-
CO2	3	3	3	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	3	3	-	-	-	-	-
CO4	3	2	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	3	2	3	3	-	-	-	-	-
Avg	3	2.8	3	3	2.8	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. **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.

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

Renewable Energy Resources

UNIT-I (7 hr):

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 different energy sectors

UNIT-III (5hr):

Basic of Solar Energy, Solar Cells and its types. Wind Energy: Introduction, Advantages and disadvantages of wind mills, Applications of wind energy.

UNIT-IV (3 hr):

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., New Delhi.

2. Non-Conventional Energy Sources, G.D.Rai, New Delhi.

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 Shobh Nath 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 Alagarsamy Pandikumar, Ramasamy Ramaraj, 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 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	2	2	3	3	2	-	-	-	-	-	-
CO2	3	3	2	3	3	3	-	-	-	-	-	-
CO3	3	3	2	3	3	3	-	-	-	-	-	-
CO4	3	2	2	2	2	3	-	-	-	-	-	-
CO5	3	2	2	2	3	3	-	-	-	-	-	-
Avg	3	2.4	2	2.6	2.8	2.8	-	-	-	-	-	-

1=weakly mapped

2= moderately mapped

3=strongly mapped

AEC101	Communicative English I	L	T	P	C
Version1.0	Contact Hours – 45	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:

CO1. **Identify** and understand the basic rules of English grammar.

CO2. **Demonstrate** the ability to comprehend spoken English in various contexts

CO3. **Practice** active listening skills in various situations

CO4. **Apply** grammatical rules in spoken and written communication.

CO5. **Integrate** listening, speaking, grammar, reading, and writing skills in communicative tasks.

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.

Course Content

Communicative English I

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

VAC101	Environmental Education-I	L	T	P	C
Version 1.1	Contact Hours – 30	2	0	0	2
Pre-requisites/Exposure	None				
Co-requisites	--				
Academic year	2024-2025				

Course Objectives

1. To understand the intrinsic relation between humans and environment, our position in theecosystem around us
2. To comprehend the significance of the biodiversity surrounding us.
3. To figure out the importance and need for energy resources, various sources of energy, renewable and non-renewable sources, conventional and unconventional sources.
4. To have basic concepts about sustainability, our dependence on nature and the consequences of overexploitation.
5. To enable students to appreciate the importance and how much we owe to the earth systems for our survival.
6. To have a basic concept about the types of pollution and mitigation procedures.
7. To have an overall idea about the environmental legal framework in our country and about theEIA and environmental audit procedures.

Course Outcomes:

CO1	**Understand** and explain key ecological principles and their importance in maintaining balance in ecosystems**.**
CO2	**Interpret** the significance of biodiversity conservation in ensuring ecological stability.
CO3	**Apply** waste management techniques to minimize environmental pollution and promote sustainability.
CO4	Critically **evaluate** the effectiveness of environmental policies in addressing pollution and promoting sustainable development.
CO5	**Integrate** knowledge of ecological principles, conservation strategies, and pollution prevention measures to develop comprehensive environmental management plans.

Course Description:

To distinguish between various types of ecosystems, ecosystem dynamics, perceive and appreciate the surrounding nature and feel connected, develop the concept of innate relationship of humans and biodiversity, need for conservation and different conservation strategies. The students will be developed in a way so that they can spontaneously comprehend the importance of studying about the various air pollutants, their significance and impacts, and develop the underlying concepts involved invarious air pollution prevention and mitigation measures, understand fundamental water chemistry, deduce the relationship between various water pollutants, and understand the principles of various water and wastewater treatment procedures. They will understand the routes of generation, classification, management and environmental significance of solid waste, apply the basic concepts ofwaste management in their daily lives, and understand the need of the 5Rs of waste management, importance of waste minimization.

Course Content

Environmental Education

UNIT I: Introduction to Environmental Education (5 hours)

Definition, scope and history of environmental education; Importance of environmental literacy and sustainability; Environmental ethics and values; natural resources, types and their conservation; Concept of sustainable development; Sustainable use of natural resources: water, energy, forests, fisheries; Role of technology in sustainable development

UNIT 2: Ecological Principles and impacts of climate change (5 hours)

Basic ecological concepts: ecosystems, biodiversity, trophic levels; Ecological interrelationships and energy flow; Climate Change and Global Warming: Causes and consequences of climate change; Greenhouse gas emissions and the carbon cycle; Impacts of climate change on ecosystems, weather patterns, and human societies

UNIT 3: Conservation of Biodiversity and Ecosystems (5 hours)

Importance of biodiversity and ecosystems; Threats to biodiversity and ecosystem degradation; Human impacts on the environment and biodiversity loss; Role of protected areas and wildlife conservation; Conservation strategies and approaches

UNIT 4: Pollution, Waste Management and Environmental Health (5 hours)

Types and sources of pollution: air, water, soil, and noise pollution; Health impacts of pollution on human populations and ecosystems; Pollution prevention and control measures; Public health awareness and environmental pollution; Principles and concepts of environmental management (5Rs) Environmental impact assessment and policy making; Role of government, organizations, and individuals in addressing environmental issues

UNIT 5: Environmental Policy, Governance, Ethics and Action (5 hours)

International agreements and conventions on environmental protection; Role of government

agencies, NGOs, and grassroots movements in environmental conservation; Ethical perspectives on the environment: anthropocentrism, biocentrism, ecocentrism; Environmental Treaties and Legislation: Overview of international environmental treaties and agreements; National and local environmental legislation and regulations; Role of stakeholders in environmental governance

UNIT 6: Case Studies and Fieldwork (5 hours)

Analysis of case studies related to environmental issues and solutions; Discussion on one national and one international case study related to the environment and sustainable development.

Field visits to identify local/regional environmental issues, make observations including data collection and prepare a brief report.

Campus environmental management activities such as solid waste disposal, water management, and sewage treatment.

Suggested Reading:

1. "Environmental Science: Toward a Sustainable Future" by Richard T. Wright and Dorothy F. Boorse

2. "Living in the Environment: Principles, Connections, and Solutions" by G. Tyler Miller Jr. and Scott Spoolman

3. "Introduction to Environmental Engineering and Science" by Gilbert M. Masters and Wendell P. Ela

4. Central Pollution Control Board Web page for various pollution standards. https://cpcb.nic.in/standards/

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

1=weakly mapped

2= moderately mapped

3=strongly mapped

Semester-II

BIT107	Basics of Animal Sciences	L	T	P	C
Version 1.0	**CONTACT HOURS-75**	2	1	1	4
Pre-requisites/Exposure	PLUS TWO (12^{th}) LEVEL BIOLOGY, PHYSICS, CHEMISTRY				
Co-requisites	--				

	Course Outcomes (COs)
CO1	**Memorize** and differentiate between the various phyla of invertebrates and vertebrates.
CO2	**Understand** the physiological mechanisms behind special adaptations in invertebrates and vertebrates.
CO3	**Utilize** knowledge of special adaptations in invertebrates and vertebrates to understand their survival strategies in various environments.
CO4	Critically **evaluate** the advantages and disadvantages of various special adaptations in animals.
CO5	**Create** educational resources to raise awareness about the importance of animal biology in understanding and protecting biodiversity.

Course Content

Basics of Animal Sciences

UNIT 1: (20 hr)

Outline of classification of non-chordates up to sub classes and general features of all the major phyla. Protochordates: outline of classification, general features. Outline of classification of chordates up to order general features of all the major classes. Protochordates: outline of classification, general features. Outline of classification of chordates up to order general features of all the major classes.

UNIT 2: (10 hr)

Special topics on non-chordates and chordates: Conjugation in *Paramoecium* polymorphism in Cnidaria, Metamerism in Annelida, Torsion in gastropoda, Water Canal system in Porifera & Water Vascular system in Starfish, Special topics on chordates: Parental care in Fish, Neoteny and Paedogenesis, Flight adaptations in birds, Dentition in mammals.

UNIT 3: (15hr**)**

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.

UNIT 4: (15 hr**)**

Respiratory System: General structure of respiratory system and functions- Lungs and Trachea, Respiratory Pathways, Functional aspects and mechanics of respiration, Mechanics and regulation of breathing, Gas exchange and gas laws, Hypoxia, effect of exercise. Nervous System: Functions of nervous system, Organization of the Nervous System - Structural Classification, Functional Classification, and Nervous Tissue: Structure and Function – Neurons, Supporting Cells, The Blood-Brain Barrier, reflex arc, PNS (autonomic and somatic), Sensory motor nerve functions.

UNIT 5: (15 hr)

Basics of 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.
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.

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

[2] 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.

Examination Scheme:

Components	Internal	End Term
Weightage (%)	50	50

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

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	1	1	1	1	1	1	1	-	-	-	-
CO2	3	3	1	1	3	1	1	1	-	-	-	-
CO3	3	3	1	1	3	3	1	1	-	-	-	-
CO4	3	3	1	3	1	1	3	1	-	-	-	-
CO5	3	1	3	1	3	1	3	3	-	-	-	-
Avg	3	2.2	1.4	1.4	2.2	1.4	1.8	1.4	-	-	-	-

1=weakly mapped

2= moderately mapped

3=strongly mapped

Course Title	Microbiology	L	T	P	C
Course Code	BIT104	2	1	1	4
Contact Hours	75				
Pre-requisites/Exposure	12th level Biology				

Course Objectives

1. To gain a deeper explaining in the history and developments in the field of Microbiology
2. To be able to distinguish between structures of prokaryotes and eukaryotes
3. To be able to explain microbial nutrition, cultivation, isolation and preservation

Course Outcomes

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

No.	Course Outcomes
CO1	**Recall** and identify the fundamental concepts and terminology in microbiology.
CO2	**Explain** the principles of microbial growth, metabolism, and genetics.
CO3	**Apply** knowledge of microbial physiology to predict the growth and behavior of microorganisms under different conditions.
CO4	**Evaluate** the impact of microorganisms on human health, agriculture, and food production.
CO5	Critically **evaluate** research articles and scientific literature in microbiology.

CO = Course Outcomes

Catalog Description:

The core-course of 'general microbiology' will help to explain the classification, structure and evolution of microorganisms. This course includes comprehensive approach through studying bacteria, virus, algae, and fungi. Furthermore, the growth and cultivation of microorganisms are a plus. Application of different antimicrobial agents and their mode of action 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

Microbiology (BIT104)

UNIT I (**10 hrs**)

Classification of microorganisms: Microbial taxonomy, criteria used including molecular approaches, Microbial phylogeny and current classification of bacteria. Microbial Diversity: Distribution and characterization Prokaryotic and Eukaryotic cells, Morphology and cell structure of major groups of microorganisms eg. Bacteria, Algae, Fungi, Protozoa and Unique features of viruses.

UNIT II (**10 hr)**

Cultivation and Maintenance of microorganisms: Nutritional categories of micro-organisms, methods of isolation, Purification and preservation.

UNIT III (**10 hrs**)

Microbial growth: Growth curve, Generation time, synchronous batch and continuous culture, measurement of growth and factors affecting growth of bacteria. Microbial Metabolism: Metabolic pathways, amphi-catabolic and biosynthetic pathways. Bacterial Reproduction: Transformation, Transduction and Conjugation. Endospores and sporulation in bacteria.

UNIT IV (**15 hr)**

Control of Microorganisms: By physical, chemical and chemotherapeutic Agents. Water Microbiology: Bacterial pollutants of water, coliforms and non coliforms. Sewage composition and its disposal.

UNIT V (**10 hr)**

The applications of microbiology in various fields: Microorganisms in the food industry, Microorganisms in the health industry, Microorganisms in the agricultural industry, Microorganisms in the biofuel industry, Microorganisms in the mining industry, Microorganisms in the water industry , Microorganisms in the cosmetic industry.

Proposed list of practicals: **(30 hr)**

Isolation of bacteria & their biochemical characterization.

Staining methods: simple staining, Gram staining, spore staining, negative staining, hanging drop.

Preparation of media & sterilization methods.

Methods of Isolation of bacteria from different sources.

Enumeration of microorganism - total & viable count.

Books & Other Resources

1. Alexopoulos CJ, Mims CW, and Blackwell M. (1996). Introductory Mycology. 4 th edition. John and Sons, Inc.

2. Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGraw Hill Book Company.

3. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. (2005). General Microbiology. 5th edition. McMillan.

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

8. Willey JM, Sherwood LM, and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. 7th edition. McGraw Hill Higher Education.

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

Examination Scheme:

Components	**Internal**	**End Term**
Weightage (%)	50	50

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

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	3	3	3	3	3	3	-	-	-	-	-
CO2	3	3	3	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	2	3	-	-	-	-	-
CO4	3	2	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	3	2	3	3	-	-	-	-	-
Avg	3	2.8	3	3	2.8	2.8	3	-	-	-	-	-

1=weakly mapped

2= moderately mapped

3=strongly mapped

BIT106	Astrobiology (THEORY+LAB)	L	T	P	C
Version 1.0	Contact Hours – 60	2	0	1	3
Pre-requisites/Exposure	PLUS TWO (12th) LEVEL BIOLOGY				

Course Content

	Course Outcomes (COs)
CO-1	**Recall** and define the basic principles of astrobiology including the search for extraterrestrial life, the conditions necessary for life to exist, and the key elements and molecules associated with life.
CO-2	**Explain** the factors that contribute to the habitability of a planet, including distance from its star, atmosphere composition, and presence of liquid water.
CO-3	**Evaluate** the implications of discovering life beyond Earth on our understanding of biology and the universe.
CO-4	**Estimate** the impact of space law on current and future space missions, as well as the implications of astrobiology research on our understanding of life beyond Earth.
CO-5	**Assess** the ethical implications of conducting research on space biology, including the potential for contaminating other planets with Earth-based life forms.

Astrobiology

UNIT-I

Introduction to Astrobiology **(7 hr)**

Definition and scope of astrobiology; Historical development and significance of the field; Interdisciplinary nature of astrobiology; Astrobiology missions and their objectives.

.

UNIT-II

Planetary Systems and Habitability **(10 hr)**

Formation and evolution of planetary systems; habitable zones and planetary parameters for life; Exoplanets and the search for potentially habitable worlds; Human space exploration and the search for life.

UNIT-III

Life beyond Earth: Microbial Life **(13 hr)**

Definitions of Microbial Habitability**;** Possibilities of microbial life in our solar system; Mars exploration and the search for Martian life; Ocean worlds: Europa, Enceladus, and Titan.

Life beyond Earth: Intelligent Life

The Drake Equation and the Fermi Paradox; SETI: Search for Extra-terrestrial Intelligence; Communication and contact with extra-terrestrial civilizations.

UNIT-IV

Space Law **(5 hr)**

Understand the historical development of space law; analyze the legal framework governing space activities; evaluate the impact of international agreements on space exploration and utilization; Discuss potential future developments and trends in space law.

UNIT-V (10 hr)
Fundamental Research on Space Biology

Space Agriculture; Space Animal Biology; The Human Body in Space; Sample return missions and their significance.

Suggested Books

1. An Introduction to Astrobiology
   David A. Rothery (Editor), Iain Gilmour (Editor), Mark A. Sephton (Editor)

2. **Astrobiology: Understanding Life in the Universe**
   Charles S. Cockell (Author)

List of Lab Experiments (30 hr)

- Introduction to Astrobiology Laboratory Techniques- Laboratory safety protocols
  Microscopy techniques for studying extremophiles life.
- Extra planetary radiation study on living organisms.
- Microgravity study.
- Space crop production system.
- Statistical analysis of experimental data.
- Extra planetary instrumentation- Demonstration.
- Observatory visit for space exploration.

Recommended Laboratory Manuals:
"Astrobiology: A Laboratory Manual" by Stefan Leuko and Sherry L. Cady.

"Laboratory Exercises in Astrobiology" by Sarah Milkovich and John W. Jones

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

Examination Scheme:

Components	Mid Term	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	3	3	3	3	-	-	-	-	-
CO2	3	3	2	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	3	3	-	-	-	-	-
CO4	3	3	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	3	2	3	3	-	-	-	-	-
Avg	3	3	2.8	3	2.8	3	3	-	-	-	-	-

1=weakly mapped

2= moderately mapped

3=strongly mapped

Course Title	Enzymology	L	T	P	C
Course Code	SEC134	1	0	1	2
Contact Hours	45				
Pre-requisites/Exposure	12th level Biology				

Course Objectives

• To acquire fundamental knowledge on enzymes and their importance in biological reactions.
• To understand ability to difference between a chemical catalyst and biocatalyst.
• Exposure to the nature of non-protein enzymes such as ribozymes.
• Understanding the role of enzymes in clinical diagnosis and industries.

Course Outcomes

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

No.	Course Outcomes
CO1	**Define** the key concepts related to bioanalytical tools and enzymology
CO2	**Explain** the principles behind common bioanalytical techniques used in enzymology
CO3	**Apply** the knowledge of enzyme kinetics to analyze enzyme activity data
CO4	**Analyze** experimental results obtained from bioanalytical tools to draw conclusions about enzyme function.
CO5	**Design** a research project incorporating different bioanalytical techniques for studying enzyme kinetics and mechanisms.

CO = Course Outcomes

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

presentation on various topics of this course. Students will be expected to interact with media resources, such as, web sites, videos, research papers etc.

Course Content

Enzymology (SEC134)

UNIT I: 5 Lecture Hours

Enzymes: Definition, historical perspective, general characteristics, co-factors – coenzymes and metal ions. Classification and units of enzymes: Based on IUB with examples. unit of enzyme activity, definition of IU, enzyme turn over number and nature of non-enzymatic and enzymatic catalysis. Specific activity. Enzyme specificity. Concept of active site, ES complex, specificity.

UNIT II: 10 Lecture Hours

Theories of enzyme catalysis: Lock and key model, induced fit theory. Enzyme kinetics: Factors affecting rate of enzyme catalyzed reactions, Characterization: Effect of enzyme concentration, substrate concentration, pH and temperature. Michaelis – Menten equation, Lineweaver – Burk (L-B) plot. Determination of Vmax & Km from L-B plot and their significance. Enzyme inhibition –competitive, non-competitive and uncompetitive. Graphical representation by L-B plot. Evaluation of Km, Ki and Vmax in presence of inhibitor.

UNIT III: 5 Lecture Hours

Allosteric enzymes: Sigmoidal curve, positive and negative modulators, qualitative description of "concerted" & "sequential" models for allosteric enzymes. Half site reactivity, Flipflop mechanism, positive and negative co-operativity with special reference to aspartate transcarbamylase and phosphofructokinase.

UNIT IV: 5 Lecture Hours

Isoenzymes: Detection, nature, importance. Lactate dehydrogenase as an example. Multi enzyme complex – Pyruvate dehydrogenase complex. – Composition, subunits, assembly, enzymatic reaction functions. RNA as an enzyme. (Ribozymes).

Applications of Enzymes: Enzymes as reagents, Marker enzymes in diagnostics, Immobilized enzymes, Industrial applications of enzymes.

UNIT V: 20 Lecture Hours

Enzymology applications

List of experiments

- Laboratory safety
- Preparation of buffers
- Assay of protease with azocasein as substrate
- Isolation and assay of bacterial enzyme
- Isolation and assay of fungal enzyme
- Blood glucose estimation by GOD-POD method
- Demonstration of enzyme purification by Gel filtration chromatography

SUGGESTED READINGS:

1. Biochemistry, Lubert Stryer, 6th Edition, WH Freeman, 2006.

2. Harper's illustrated Biochemistry by Robert K. Murray, David A Bender, Kathleen M. Botham, Peter J. Kennelly, Victor W. Rodwell, P. Anthony Weil. 28th Edition, McGrawHill, 2009.
3. Biochemistry, Donald Voet and Judith Voet, 2nd Edition, Publisher: John Wiley and Sons, 1995.
4. Biochemistry by Mary K. Campbell & Shawn O. Farrell, 5th Edition, Cenage Learning, 2005.
5. Fundamentals of Enzymology Nicholas Price and Lewis Stevens Oxford University Press 1999
6. Fundamentals of Enzyme Kinetics Athel Cornish-Bowden Portland Press 2004
7. Practical Enzymology Hans Bisswanger Wiley–VCH 2004
8. The Organic Chemistry of Enzyme-catalyzed Reactions Richard B. Silverman Academic Press 2002.

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

Components	Internal	End Term
Weightage (%)	50	50

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

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	3	3	3	3	3	3	-	-	-	-	-
CO2	3	3	3	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	2	3	-	-	-	-	-
CO4	3	3	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	3	2	3	3	-	-	-	-	-
Avg	3	3	3	3	2.8	2.8	3	-	-	-	-	-

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

VAC105	Community Engagement and Social Responsibility	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 ordnance.

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. **Recognize** the importance of community service and social responsibility in enhancing the well-being of individuals and communities.

CO2. **Explain** the concept of social support and its role in building resilient and inclusive communities.

CO3. **Demonstrate** effective ways to engage in community service activities and provide support to those in need.

CO4. **Evaluate** the impact of community learning initiatives on community development and social cohesion.

CO5. **Design** and implement innovative projects that address local challenges and contribute to the overall well-being of the community.

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), and 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

Community Engagement and Social Responsibility

UNIT I: Introduction [12 Lecture 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.

UNIT II: 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 group wise 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 especially for young adults.

UNITV: Community Learning (Education) & social Help [12 Lecture hours]

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 oppor**unit**ies – Basic App (in mobile). Rights of Women, children and others – marketing - Entrepreneurial skills & Schemes - Creating livelihood oppor**unit**ies – 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 by Allen McNaught.
3. In Quest of Humane Development. By B. Dasgupta et.al.
4. Practicing Social Work in Deprived Communities (Springer) by Ana Opacic.
5. Service Learning Through Community Engagement by Lori Gardiner

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

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

AEC102	Communicative English II	L	T	P	C
Version1.0	Contact Hours – 45	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 II course, which is offered in semester II. 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** and apply vocabulary words learned in the course.

CO2: **Interpret** and explain the meaning of written texts.

CO3: **Practice** active listening skills in various situations.

CO4: **Create** original written and spoken texts using appropriate language conventions.

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.

Course Content

Communicative English- II

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.

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	1	3	-	-	-	-	3	-	3	-	3
CO2	3	1	3	-	-	-	-	3	-	3	-	3
CO3	3	1	3	-	-	-	-	3	-	3	-	3
CO4	3	1	3	-	-	-	-	3	-	3	-	3
Avg	3	1	3	-	-	-	-	3	-	3	-	3

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

ADAMAS UNIVERSITY

B.Sc. Biotechnology (Hons.)

SEMESTER-III

BIT207	**Basics in Plant Biology**	**L**	**T**	**P**	**C**
Version 1.0	**Contact Hours – 75**	2	1	1	4
Pre-requisites/Exposure	$12^{th}$with Biology as one subject				
Co-requisites	12^{th} level English				

Course Objectives:

1. Provide a comprehensive understanding of plant diversity, evolution, and basic anatomical structures, including cellular and tissue levels, to lay a strong foundation in plant biology.
2. Explore the physiological processes governing plant growth, development, and nutrition, emphasizing the significance of key metabolic pathways and regulatory mechanisms in plant life cycles.
3. Students will be able to develop fundamental knowledge and can be implemented agro techniques practices of economic important plant.

Course Outcomes

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

CO 1	**Identify** and categorize different plant taxa based on their distinctive characteristics and evolutionary relationships.
CO 2	**Explain** the processes of plant growth, development, and metabolism such as photosynthesis, transpiration, and nutrient uptake.
CO 3	**Use** practical skills like microscopic examination, biochemical assays, and experimentation to analyze and interpret plant biology concepts.
CO 4	**Assess** the economic significance of plants in various sectors like agriculture, industry, medicine, and ecosystem conservation.
CO 5	**Develop** innovative approaches to integrate theoretical knowledge with practical applications in plant biology for effective problem-solving.

Catalogue Description

Plant Biology (BIT201) provides a comprehensive exploration of fundamental concepts in plant science, covering a wide array of topics from plant diversity and evolution to growth, development, and practical applications in agriculture and industry. Through an in-depth examination of plant anatomy and morphology at cellular and tissue levels, students gain insights into the intricate structures of roots, stems, leaves, flowers, fruits, and seeds. Additionally, the course delves into plant tissue systems, elucidating their structural characteristics and functions. Students also explore the physiological processes underlying plant growth and development, including photosynthesis, transpiration, and nutrient metabolism, fostering a deep understanding of plant biochemistry and physiology. Practical sessions offer hands-on experience in plant biology techniques such as microscopic

examination, biochemical assays, and experimentation, enhancing students' ability to apply theoretical knowledge to real-world scenarios.

Basics in Plant Biology (BIT207)

Course Content:

UNIT I

Overview of plant diversity and evolution: Introduction to Plant Kingdom; Diversity of Algae; Bryophytes; Pteridophytes; Gymnosperms; Angiosperms; Fungi; Economic importance of fungi, Pathogenic and poisonous fungi. Lichen: Habitat and thallus structures

UNIT II

Basic plant anatomy and morphology: Overview of plant structure at the cellular and tissue levels; Root Anatomy; Stem Anatomy; Leaf Anatomy; Flower Anatomy; Fruit and Seed Anatomy.Overview of Plant Tissue Systems: Tissues: Classification - structural characteristics and functions of the following tissues.

UNIT III

Basic plant Physiology: Growth and development: phases of growth, growth curve, Transpiration and significance, Water use efficiency, Carbon and nitrogen metabolism: Photosynthesis- Photosynthesis pigments, concept of two photo systems, photophosphorylation, Calvin cycle, CAM plants, photorespiration, compensation point. Translocation of assimilates, Phloem loading, apoplastic and symplastic transport of assimilates, source and sink concept,

UNIT IV

Nutriophysiology: Definition-Mengel's classification of plant nutrients-Physiology of nutrient uptake – Functions of plant nutrients-Deficiency and toxicity symptoms of plant nutrients; Foliar nutrition-Hydroponics. Plant growth regulators- occurrence-Biosynthesis-Mode of action of auxins, Gibberellins, Cytokinis, ABA, Ethylene. Photoperiodism and Vernalization; Senescence and abscission– Climacteric and non-climacteric;

UNIT V

Mushroom Cultivation: Identification - edible and poisonous Mushrooms - external factors for growth; Spawn production; Cultivation of Mushrooms; Economic Importance and Cultivation of Lichen; Industrial and Commercial Plants; Ornamental Plants: cereals; spices; Medicinal Plants; Fiber Plants; Timber and Wood Products; Drug-yielding plants:

Practical on Plant Biology (BIT201) (30 hr)

1. Cytochemical test for starch, sugar and protein.
2. Microscopic Examination of Algal Diversity
3. Study of simple & Complex (primary and secondary) tissues (by maceration.)
4. Study of internal structure of Young and old stem of dicotyledons.
5. Observation of stomatal structure and distribution on plant leaves
6. Examination of photosynthetic pigments using leaf extracts and spectrophotometry.
7. Experiments on Osmosis and Respiration in Plants
8. Fungi Observation and Identification: The morphology and structures
9. Perform a fungal culture experiment to cultivate fungi

10. Collection of lichen samples from different substrates, such as rocks, trees, or soil
11. pH tolerance test of lichen samples to different levels of acidity and observe their responses.
12. Perform propagation experiments of Mushroom under controlled conditions
13. Measurement of rate of transpiration.

SUGGESTED READING:

1. Phycology by Robert Edward Lee

2. Introduction to Fungi by John Webster

3. Plant Pathology by G.N. Agrios

4. Plant Physiology by Lincoln Taiz, Eduardo Zeiger

5. College Botany Vol. II by Gangulee and Kar

6. Studies in Botany Vol I & II by J.N. Mitra, D. Mitra, S.K. Chaudhuri

Reference Books

5. College Botany Vol. II by Gangulee and Kar

6. Studies in Botany Vol I & II by J.N. Mitra, D. Mitra, S.K. Chaudhuri

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	3	3	3	3	-	-	-	-	-
CO2	3	3	3	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	3	3	-	-	-	-	-
CO4	3	2	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	3	2	3	3	-	-	-	-	-
Avg	3	2.8	3	3	2.8	3	3	-	-	-	-	-

1=weakly mapped

2= moderately mapped

3=strongly mapped

BIT202	Genetics	L	T	P	C
Version 1.0	Contact Hours – 75	2	1	1	4
Pre-requisites/Exposure	PLUS TWO (12th) LEVEL BIOLOGY				
Co-requisites	--				

Course Objectives

1. To provide students basic idea about Mendel's principle and chromosomal basis of heredity.
2. It will also provide in depth knowledge about mechanism of genetic exchange in bacteria.
3. To illustrate linkage, crossing over and gene mapping technique.
4. To provide students modern view about population genetics and evolutionary genetics.

Course Outcomes

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

CO1: **Define** basic genetic terms and concepts

CO2: **Explain** the mechanisms of genetic inheritance, including dominant and recessive traits.

CO3: **Comprehend** the role of mitosis & meiosis in genetic diversity and inheritance.

CO4: **Apply** knowledge of genetic mutations and other non-Mendelian inheritance patterns to discuss their impact on genetic disorders

CO5: **Evaluate** the effectiveness of different genetic technologies and techniques in practical applications

Catalog Description

The core-course of 'Genetics' will help to explain Mendel's principle and chromosomal basis of heredity. This course includes comprehensive approach through studying different mechanism of genetic exchange in bacteria. Furthermore, the implication of population genetics and evolutionary genetics will 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 sessions and hands on 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

Genetics

UNIT I **(20 hr)**

Mendelian Genetics and its Extension: Principles of inheritance, Incomplete dominance and co-dominance, Multiple alleles, Lethal alleles, Epistasis,, Sex-linked, sex-influenced and sex-limited characters' inheritance.

UNIT II **(15 hr)**

Linkage, Crossing Over and Chromosomal Mapping: Linkage and crossing over, Cytological basis of crossing over, Molecular mechanisms of crossing over including models of recombination, Recombination frequency as a measure of linkage intensity.

Sex Determination: Chromosomal mechanisms of sex determination in Drosophila and Man.

UNIT III **(20 hr)**

Mutations: Types of gene mutations (Classification), Types of chromosomal aberrations (Classification, figures and with one suitable example of each), Molecular basis of mutations in relation to UV light and chemical mutagens; Detection of mutations.

Transposable Genetic Elements: Transposons in bacteria, Ac-Ds elements in maize and P elements in Drosophila, Transposons in humans.

UNIT IV **(15 hr)**

Gene pool, Gene and genotype frequencies: Hardy-Weinberg principle, Evolutionary agents: Selection – differential selection, gametic selection, zygotic selection, fitness; Migration; Mutation and genetic drift. Population bottleneck and founder effect.

Extra-chromosomal Inheritance, Polygenic Inheritance: Polygenic inheritance with suitable examples; simple numerical problems based on it.

UNIT V: **(5 hr)**

Genetics Applications: Evaluate the effectiveness of different genetic technologies and techniques in practical applications

Proposed list of Practical:

1. Permanent and temporary mount of mitosis.

2. Permanent and temporary mount of meiosis.

3. Mendelian deviations in dihybrid crosses

4. Demonstration of - Barr body.

5. Karyotyping with the help of photographs

6. Pedigree charts of some common characters like blood group, colour blindness and PTC tasting.

7. Application of Hardy-Weinberg principle.

SUGGESTED READINGS:

1. Genetics (2012) 6th ed., Snustad, D.P. and Simmons, M.J., John Wiley & Sons. (Singapore), ISBN: 978-1-118-09242-2.

2. Genetics - A Conceptual Approach (2012), 4th ed., Pierce, B.A., W.H. Freeman & Co. (New York), ISBN:13:978-1-4292-7606-1 / ISBN:10:1-4292-7606-1.

3. An Introduction to Genetic Analysis (2010), 10th ed., Griffiths, A.J.F, Wessler, S. R, Carroll, S. B. and Doebley, J., W.H. Freeman & Company (New York), ISBN:10: 1-4292-2943-8.

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	1	1	3	1	1	1	1	1	1	1	1
CO2	3	3	3	1	1	1	1	1	1	1	1	1
CO3	3	3	1	1	1	3	1	1	1	1	1	1
CO4	3	3	1	3	1	3	3	1	1	1	1	1
CO5	3	3	1	1	1	3	3	1	1	1	1	1
Avg	3	2.6	1.4	1.8	1	2.2	1.8	1	1	1	1	1

1=weakly mapped

2= moderately mapped

3=strongly mapped

BIT206	Introduction to Biomaterials	L	T	P	C
Version 1.0	CONTACT HOURS-60	2	0	1	3
Pre-requisites/Exposure	PLUS TWO (12th) LEVEL BIOLOGY, PHYSICS, CHEMISTRY				
Co-requisites	--				

Course description

The course aims to introduce the concept of biomaterials, biomedical materials and medical implants, their degradation mechanisms, biocompatibility criteria and evaluation. The learning goals that students should have achieved at the end of the lesson are the following:

- to familiarize oneself with the characteristics and features of biomaterials
- to be able to fabricate biomaterials and use them in biomedical research and medicine
- to be intellectually ready to work on a graduation thesis in the fields of biomaterials, bioengineering, tissue engineering, and regenerative medicine in a lab setting

Course Outcomes

CO1. Define the concept of biomaterials, implants, and biodegradable materials
CO2. Classify different types of biomaterials and explain their applications
CO3. Identify the importance of the biocompatibility of biomaterials
CO4. Analyze the advantages and disadvantages of diverse morphologies of biomaterials
CO5. Evaluate the application of biomaterials

Module I (10 Hrs)
Definition of biomaterials – Introduction to Materials in Medicine, Concept and importance of biomaterials, Classification of biomaterials – Natural and synthetic materials, Various classes of biomaterials - Metals, Ceramics, Polymers and Composites

Module II: (5 Hrs)
Medical implants – Implantable biomaterials (Temporary or permanent implants), Bio-degradable and non-biodegradable materials, Permanent versus absorbable implants

Module III: (5 Hrs.)
Property requirement of biomaterials – Concept of Biocompatibility, Assessment of biocompatibility of biomaterials

Module IV: (5 Hrs)
Materials Used in Medicine – Two-dimensional and three-dimensional biomaterials for cell fate regulation**,** Porous materials Vs Nonporous materials

Module V: (5 Hrs)
Application of Biomaterials – Medical implants; Adhesives and Sealants; Drug Delivery System; Sutures; Biosensors

List of Practicals: (30 Hrs)

1. Fabrication of 2D biomaterials
2. Fabrication of 3D biomaterials
3. Characterization of biomaterials: morphology, stability, solubility, degradibility

Text Books

1. Biomaterials Science - An Introduction to Materials in Medicine, Buddy Ratner, Allan Hoffman, Frederick Schoen, Jack Lemons, ISBN: 9780080470368, Academic Press, Published Date: 18th August 2004.
2. Biomaterials: An Introduction- J. Bo. Park.
3. Materials Science and Engineering- Callister.
4. Materials for Medical Engineering- Euromat 99 vol-2.

Optional Materials: Reference Books

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

Experiential learning

1. Flip classes
2. Integrated lab classrooms for hands-on experiences, do, watch, feel, share thoughts
3. Reflective observation by project-based presentations/ experimental outcome
4. Field trips
5. 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**
Weightage (%)	**Experiential learning**	**Quizetc.**	**Regular evaluation**	**Attendance**	
	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	3	3	3	3	3	-	-	-	-	-
CO2	3	3	3	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	3	2	-	-	-	-	-
CO4	3	3	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	2	2	3	3	-	-	-	-	-
Avg	3	3	3	2.8	2.8	3	2.8	-	-	-	-	-

1=weakly mapped

2= moderately mapped

3=strongly mapped

SEC135	Basics of Forensic Biology	L	T	P	C
Version 1.0	Contact Hours - 45	1	0	1	2
Pre-requisites/Exposure	12th LEVEL BIOLOGY				
Co-requisites	Chemistry, Physics				

Course Objectives

1. Students will explain & develop the concept and purposes of studying cause and manner of death.
2. Students will explain & develop the concept and purposes of studying different types of injuries.
3. Students will explain the structure and function of different human systems like respiratory, circulatory, digestive etc. and develop their knowledge in explaining the process of post mortem.
4. Students will develop the concept and purposes of studying ballistics.

Course Outcomes

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

CO1. Understand the fundamental concepts and historical development of forensic science.

CO2. Classify the cause and manner of death, and differentiate between natural and unnatural death using forensic science principles.

CO3. Apply the principles of forensic ballistics, including projectile trajectories and impact analysis.

CO4. Illustrate the role of forensic toxicology in detecting poisons and drugs in biological specimens.

CO5. Analyze forensic science applications by appraising and discussing different tools and techniques used in investigations.

Catalog Description

The core-course of 'Basics of Forensic Biology' will help to explain the classification and differences between cause of death and manner of death. This course includes comprehensive approach through studying different techniques of identifying the possible cause of an unidentified death or an assault. It also includes the role of different chemicals as homicidal or suicidal agents. Furthermore, the cause of death behind strangulation, drowning and others is including accidental deaths. Different types of trauma and physical changes after death are also 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

Basics of Forensic Biology

UNIT I **(5 hr)**

Introduction and principles of forensic science, forensic science laboratory and its organization and service, tools and techniques in forensic science, branches of forensic science, Pioneers in Forensic Sciences: History and development of branches of forensic science: forensic biology, forensic chemistry and toxicology, forensic anthropology, fingerprints, questioned document examination, forensic ballistics, digital and cyber forensics, forensic audio analysis, forensic psychology; Contribution of Sir Edgar Hoover through the FBI.

UNIT II **(20 hr)**

Causes of crime, role of modus operandi in criminal investigation. Theories of Criminology: Pre-Classical, Classical, Neo-Classical, Positivist, Biological, Social Learning Theory, Differential Association theory, Labelling Theory, Containment theory and Routine Activity Theory Causes of crime: Social, Economic, Political and Psychological; Social Problems and crime: Juvenile

UNIT III **(20 hr)**

Delinquency, Prostitution, Dowry, drug abuse, and child labour. Types of Crime: Crimes against persons, violent crimes, sexual offences, crimes against property, cyber-crime, hate crimes and public disorder, emerging crimes. Types of Criminals: Habitual, Professional and White-Collar criminals. Classification of injuries and their medico-legal aspects, method of assessing various types of deaths.

UNIT IV **(20 hr)**

Classification of fire arms and explosives, introduction to internal, external and terminal ballistics. Chemical evidence for explosives. General and individual characteristics of handwriting, examination and comparison of handwritings and analysis of ink various samples.

UNIT V **(10 hr)**

Role of the toxicologist, significance of toxicological findings, Fundamental principles of fingerprinting, classification of fingerprints, development of finger print as science for personal identification.

List of practical:

1. Analysis of medullary patterns of different hair samples
2. Analysis of cuticle pattern of different hair samples
3. Pollen anatomy
4. Soil sample analysis
5. Bite mark analysis

6. Foot print analysis

Textbook:

1. Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.

2. B.B. Nanda and R.K. Tiwari, Forensic Science in India: A Vision for the Twenty First Century, Select Publishers, New Delhi (2001).

Reference book:

1. M.K. Bhasin and S. Nath, Role of Forensic Science in the New Millennium, University of Delhi, Delhi (2002).

2. S.H. James and J.J. Nordby, Forensic Science: An Introduction to Scientific and Investigative Techniques, 2nd Edition, CRC Press, Boca Raton (2005).

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	3	3	3	3	-	-	-	-	-
CO2	3	3	3	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	2	3	-	-	-	-	-
CO4	3	2	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	3	2	3	3	-	-	-	-	-
Avg	3	2.8	3	3	2.8	2.8	3	-	-	-	-	-

1=weakly mapped

2= moderately mapped

3=strongly mapped

VAC102	HUMAN VALUES AND ETHICS	L	T	P	C
Version1.0	CONTACT HOURS-30	2	0	0	2
Pre-requisites/Exposure	12th level English				
Co-requisites	--				

Course Objectives

- To inculcate students towards personal, professional & societal relationships and achieve harmony in life.
- To develop more responsibilities and ethical vision.

Course Outcomes

At the completion of the course, the student should be able to:

CO1. **Define** the concept of human values and ethics

CO2. **Explain** the significance of upholding human values in creating a harmonious society

CO3. **Demonstrate** the ability to make ethical decisions in real-life scenarios

CO4**. Critically** assess the ethical frameworks and theories guiding moral conduct

CO5. **Design** a comprehensive ethical framework for addressing complex societal challenges

Catalog Description

This course aims to develop an explaining for a movement from rule based society to a relationship based society. Apart from teaching values, this course encourages students to discover what values are for them and for society. Self-exploration also enables them to critically evaluate the pre-conditionings and present beliefs. It is designed in a way where students get familiar with the ethical Code of Conduct, Ethical Dilemma, Conflict of Interest and all this will help them eventually in their professional life.

Course Content

Unit I: Introduction to Human Values: Character, Integrity, Credibility, Mutual Respect, Dedication, Perseverance, Humility and Perception. Self-Assessment & Analysis, Setting Life Goals, Consciousness and Self-Transformation. Team Work, Conflict, Resolution, Influencing and Winning People, Anger Management, Forgiveness and Peace, Morality, Conscience. Yoga and Spirituality.

Unit II: Harmony and Life Long Perceive the knowledge: Harmony in human being, Nature and Existence. Harmony in family and society–Responsibilities towards society, respecting teachers. Transition from School to College-Freedom & Responsibilities,

Respecting Cultural Diversity, Perceive the knowledge beyond the Classrooms, Independent study and research

Unit III: Introduction to Professional Ethics: Work Ethics, Engineering Ethics, Moral Dilemma, Moral Development Theories, Ethical Theories-Kantinism, Utilitarianism, etc. Case Studies for Choice of the theory, Code of Ethics

Unit IV: Individual to Global Issues: Industrial Standards, A Balanced Outlook on Law, Safety, Responsibility, Rights, Confidentiality, Conflict of Interest, Occupational Crime, Whistle Blowing, Environmental Ethics, Business Conduct in MNC, E-Professionalism (IPR, Internet Ethics & Privacy issues)

SUGGESTED READINGS:

Shetty, Foundation Course in Human Values and Professional Ethics [R.R. Gaur, R. Sangal, G.P. Bagaria]

Modes of Evaluation: Quiz/Assignment/ Seminar/Written 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	-	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 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.

Course learning outcomes:

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

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

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

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

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

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

Examination Scheme:

Components	CA	End Term
Weightage (%)	50	50

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

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

1=weakly mapped

2= moderately mapped

3=strongly mapped

ADAMAS UNIVERSITY

B.Sc. Biotechnology (Hons.)

SEMESTER-IV

BIT208	**Animal Biotechnology**	**L**	**T**	**P**	**C**
Version 1.0	**CONTACT HOURS-75**	2	1	1	4
Pre-requisites/Exposure	PLUS TWO (12^{th}) LEVEL BIOLOGY				
Co-requisites	--				

Course Objectives

- To develop an understanding on the basic requirements of animal cell culture
- To impart knowledge and hands-on-skills in various animal cell culture techniques
- To develop an understanding of various gene delivery methods and applications of cell fusion
- To impart knowledge on the technique of in vitro fertilization
- To impart knowledge on industrial applications of transgenic animals and gene therapy

Course Outcomes

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

No.	**Course Outcomes**
CO1	**Recall** key concepts and principles related to cell culture, gene cloning vectors, stem cell and cloning, gene therapy, IVF, and transgenic animals.
CO2	**Explain** the processes involved in cell culture, gene cloning, stem cell and cloning techniques, gene therapy applications, IVF procedures, and development of transgenic animals.
CO3	**Apply** cell culture techniques, gene cloning vectors, stem cell and cloning procedures, gene therapy protocols, IVF principles, and transgenic animal technologies in laboratory experiments and research projects.
CO4	**Analyze** the advantages and limitations of different cell culture methods, gene cloning vectors, stem cell and cloning techniques, gene therapy strategies, IVF processes, and transgenic animal models.
CO5	**Evaluate** the ethical considerations and societal implications of utilizing cell culture, gene cloning vectors, stem cell and cloning technologies, gene therapy approaches, IVF procedures, and transgenic animal applications.

CO = Course Outcomes

Catalogue Description:
Animal biotechnology is a branch of biotechnology in which molecular biology techniques are used to genetically engineer animals in order to improve their suitability for agriculture, industrial and pharmaceutical applications. The objective of this course is to familiarize the techniques involved in animal biotechnology. The course aims to provide theory and practical sessions of biotechnology as part of Professionalization.

Course Content:

Animal Biotechnology

UNIT I. Basic requirement of Animal Cell Culture: (15 hours)
Equipment & materials for animal cell culture technology; culture medium; natural media, synthetic media, sera. Introduction to balanced salt solutions & simple growth medium; maintenance and preservation of cell line. Brief discussion on the different constituents of culture medium; role of carbon dioxide, and supplements.

UNIT II. Cell culture techniques: (15 hours)
Primary cell culture, establishment of cell line, various systems of tissue culture and their distinguishing features- advantages & limitations. Co-culturing of cells, 3D culture, cytotoxicity assays, introduction to stem cells and tissue engineering.

UNIT III. Gene transfer & Cell fusion: (15 hours)
Methods of gene transfer- Physical, Chemical, and Biological; Applications of cell fusion-Hybridoma Technology.

UNIT IV. Assisted Reproductive Technology: (15 hours)
Artificial insemination and germ cell manipulation, In Vitro fertilization and Embryo transfer Technology; Ethical issues.

UNIT V. Gene Therapy & Transgenic Animals: (15 hours)
Principles of Ex vivo and In vivo gene therapy; Concepts of Transgenic Animals; Strategies for the production of transgenic animals and their importance in Biotechnology; Production of Vaccines in animal Cells.

List of Practicals

1. Demonstration of preparation and sterilization of animal cell culture media.
2. Demonstration of subculture of animal cells.
3. Demonstration of cryopreservation of animal cells.
4. Demonstration of culture initiation.
5. Cell counting.
6. Evaluation of drug toxicity.

SUGGESTED READINGS:

1. Introduction to Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications by R. Ian Freshney Sixth Edition. Publisher, John Wiley & Sons, 2011.

2. Primrose S.B. and R.M. Twyman. Principles of Gene manipulation and Genomics. 7th Ed.2006 Blackwell Publishing.
3. T. A. Brown: Gene Cloning and DNA Analysis: An Introduction. 8th Ed.2020 Wiley-Blackwell publishing.
4.Essentials of Stem Cell Biology: Robert Lanza and Anthony Atala. 3rd Ed. 2014 Academic Press.
5. Animals as Biotechnology: Ethics, Sustainability and Critical Animal Studies by Richard Twine, 2010.

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

Components	Internal	End Term
Weightage (%)	**50**	**50**

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

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	3	3	3	2	3	3	3	3	3	2	2
CO2	3	3	2	3	2	3	2	2	2	2	2	2
CO3	3	3	2	3	3	3	3	3	2	2	2	3
CO4	3	2	2	3	3	3	3	3	3	3	2	3
CO5	3	2	2	2	3	3	3	3	3	3	3	3
Avg	3	2.6	2.2	2.8	2.6	3	2.8	2.8	2.6	2.6	2.2	2.6

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

BIT209	PLANT BIOTECHNOLOGY	L	T	P	C
Version 1.0	**Contact Hours – 75**	2	1	1	4
Pre-requisites/Exposure	12^{th} with Biology as one subject				
Co-requisites	12^{th} level English				

Course Description:

This course provides a comprehensive overview of plant biotechnology, focusing on genetic solutions to enhance agricultural productivity and tackle global challenges. Students explore advanced techniques such as tissue culture, genetic modification, and transgenic crop development. Emphasis is placed on understanding plant genetics, biotechnological tools, and their applications in agriculture and pharmaceuticals. Through theory, labs, and case studies, students gain insight into the potentials, challenges, and ethics of plant biotechnology. Topics include tissue culture, micropropagation, transgenic plants, and molecular farming. By course end, students are equipped to contribute to sustainable agriculture and biotechnology through innovative approaches.

Course Objectives:

1. Explore micropropagation methods and somaclonal variation techniques, emphasizing cell and organ differentiation.
2. Acquire knowledge of transgenic plant for improved traits such as herbicide resistance, stress tolerance, and enhanced nutritional quality.

Course Outcomes

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

CO1: Understand plant tissue culture basics, including the preparation of media and the roles of growth regulators, for use in various biotech applications.

CO2: Demonstrate understanding of somaclonal variation and its impact on plant characteristics

CO3: Develop practical skills in protoplast culture and somatic hybridization for use in breeding and genetic engineering.

CO4: Evaluate the challenges and benefits of creating transgenic plants

CO5: Assess current and future plant biotech trends, including molecular farming and GM crop development, with a focus on regulatory considerations.

Course Content

Plant Biotechnology

UNIT I: Plant Culture media and cell culture (9 hrs.)

Plant tissue culture – theory and methods: Concept of totipotency; physico-chemical conditions for propagation of plant cells and tissues, Culture media and their constituents: Types of media, media selection, media preparation, mode of action of Plant growth regulators. Cell culture: Isolation and culture of single cells, suspension cultures, application of cell culture: mutant selection, production of secondary metabolites

UNIT II Micropropagation and Somaclonal variation (9 hrs.)

Cell and organ differentiation: cytodifferentiation, organogenic differentiation; clonal propagation: Bioreactors for micropropagation and for bioactive compounds, synthetic seeds

for micropropagation, production of virus free plants. Somaclonal variation; overcoming crossing barriers using culture techniques: pre and post fertilization crossing barriers, embryo rescue, Types of cultures; Gametoclonal techniques

UNIT III Protoplast culture and somatic hybridization (9 hrs.)

Production of haploids: anther and microspore culture, chromosome elimination; use of haploids in plant breeding: use of haploids in disomic and polysomic inheritance; Isolation and purification techniques of protoplasts, viability and plating density of protoplasts. Protoplast fusion and somatic hybridization: techniques of fusion, selection of fused protoplasts; cytoplasmic hybrids or cybrids. Genetic modification of protoplasts

UNIT IV Transgenic plants (9hrs.)

Transformation techniques: Agrobacterium medicated transformation; transformation using pollen or pollen tube; Selectable markers used in transgenic plants; Study of regulatory sequences of induced genes: heat shock genes, genes for seed storage, EPSP synthase gene, Genes for chlorophyll a/b binding proteins. Genetically modified crops and floriculture plants: herbicide and pesticide resistant transgenic plants; abiotic stress resistant transgenic plants, improved crop and nutritional quality in plants

UNIT V Applied Plant biotechnology (9 hrs.)

Molecular farming and gm crops future prospects: -molecular farming of proteins-economic considerations for molecular farming. Edible vaccines; Transplastomic plants and chloroplast engineering, Current status-concerns about GM crops- regulations of GM crops and products-Greener genetic engineering.

List of practical for Plant Biotechnology (30 hrs)

1. Requirements for Plant Tissue Culture Laboratory
2. Techniques in Plant Tissue Culture
3. Media components and preparations
4. Sterilization techniques and Inoculation of various explants
5. Aseptic manipulation of various explants
6. Callus induction and Plant Regeneration
7. Micro propagation of important crops and hardening / acclimatization of regenerated plants
8. Anther, Embryo and Endosperm culture
9. Isolation of protoplast
10. Somatic embryogenesis and synthetic seed production

SUGGESTED READINGS:

"Introduction to Plant Biotechnology" by H.S. Chawla.
"Plant Development and Biotechnology" by Robert N. Trigiano
Plant Tissue Culture: Theory and Practice by Sant S Bhojwani and M. K. Razdan.
Introduction to Plant Tissue Culture Written by M. K. Razdan
Plant Tissue Culture: Techniques and Experiments Written by Roberta H. Smith
Plant Cell Culture Protocols By Victor M Loyola-Vargas (Editor), Neftali Ochoa-Alejo (Editor)

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	3	3	3	3	-	-	-	-	-
CO2	3	3	3	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	2	3	-	-	-	-	-
CO4	3	3	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	3	2	3	3	-	-	-	-	-
Avg	3	3	3	3	2.8	2.8	3	-	-	-	-	-

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

Course Title	Molecular Biology	L	T	P	C
Course Code	BIT205	2	1	1	4
Contact Hours	75				
Pre-requisites/Exposure	12th level biology				

Course Objectives

1. To provide basic concepts of central dogma of Molecular Biology.

2. Elaborating gene expression and regulation in prokaryotes and in eukaryotes.

Course Outcomes

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

No.	Course Outcomes
CO1	**Explain** the structure of nitrogen bases and nucleic acids, the replication process, and the repair mechanism in molecular biology.
CO2	**Illustrate** the transcription process in both prokaryotes and eukaryotes, as well as the post-transcriptional events in the eukaryotic system.
CO3	Compare and contrast the translation process in prokaryotes and eukaryotes.
CO4	Analyze the process of regulation of gene expression in prokaryotes, identifying key regulatory mechanisms and their impact on cellular function.
CO5	Demonstrate and practice applications of molecular biology, using their knowledge to design experiments, develop research projects, and solve research problems in the field.

CO = Course Outcomes

Catalog Description:

In classroom sessions students will study the theoretical and applied aspects of basic biotechnology techniques for the study of DNA and proteins. In the laboratory students will develop theory and practical skills from this and previous courses to perform standard molecular biology techniques for the isolation, manipulation and analysis of DNA as well as the expression and purification of protein. Students will be assisted in career development through instruction and practice in resume-writing and interview skills, and will be exposed to

different biotechnology job possibilities via a number of special interest seminars and/or company tours.

Course Content

Molecular Biology

UNIT I (9 hr)

Structures of DNA and RNA / Genetic Material: Miescher to Watson and Crick- historic perspective, DNA structure, and Salient features of double helix, Types of DNA, Types of genetic material, denaturation and renaturation, cot curves. Replication of DNA (Prokaryotes and Eukaryotes): semi- conservative, semi- discontinuous replication. Mechanism of DNA replication: Enzymes and proteins involved in DNA replication –DNA polymerases, DNA ligase, primase, telomerase – for replication of linear ends. Mechanism of DNA Repair: Direct Repair, Base Excision repair, Nucleotide Excision repair, Methyl directed mismatch repair. Recombination in Bacteria and Viruses: Conjugation, Transformation, Transduction, Complementation test in Bacteriophage.

UNIT II (8 hr)

Transcription in Prokaryotes and Eukaryotes: Definition, difference from replication, promoter - concept and strength of promoter 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, Polyadenylation and capping.

UNIT III (8 hr)

Translation (Prokaryotes and Eukaryotes): Translational machinery, Charging of tRNA, aminoacylt RNA synthetases, Mechanisms of initiation, elongation and termination of polypeptides in both prokaryotes and eukaryotes, Fidelity of translation, Inhibitors of protein synthesis in prokaryotes and eukaryotes.

UNIT IV (8 hr)

Regulation of gene expression, regulation of gene expression in prokaryotes –operon concept (Lac and Tryp), regulation of gene expression in eukaryotes -transcriptional activation, galactose metabolism in yeast. Coding and Non-coding genes. Gene organization and expression in mitochondria and choloroplasts. Insertional elements and transposons. Transposable elements in maize and drosophila.

UNIT V (8 hr)

Polymerase Chain Reaction and its applications; DNA sequencing technique; Environmental DNA (eDNA) techniques for biodiversity assessment; Engineered nucleases in genome engineering - meganucleases, ZFNs, TALEN and CRISPR-Cas system – Mechanisms and applications – Benefits of genome engineering DNA fingerprinting techniques such as Short Tandem Repeat (STR) analysis and forensic DNA profiling; Next-Generation Sequencing (NGS) technologies and their applications; Single-cell genomics techniques for understanding cellular heterogeneity

Practicals of Molecular Biology

1. Preparation of solutions for molecular biology experiments
2. Protein extraction from plant cell
3. Molecular weight determination of DNA and Quantification of DNA
4. Physical mutations: UV irradiation
5. Total RNA isolation from bacteria
6. Melting curve analysis of DNA
7. Isolation of chromosomal DNA from bacterial cells.
8. DNA isolation from eukaryotes- Saccharomyces cerevisiae
9. Isolation of Plasmid DNA by alkaline lysis method
10. Resolution and visualization of DNA by Agarose Gel Electrophoresis.
11. Resolution and visualization of proteins by Polyacrylamide Gel Electrophoresis (SDS-PAGE).

SUGGESTED READINGS:

1. Watson JD, Baker TA, Bell SP, Gann A, Levine M and Losick R (2008) Molecular Biology of the Gene, 6th edition, Cold Spring Harbour Lab. Press, Pearson Publication

2. Becker WM, Kleinsmith LJ, Hardin J and Bertoni GP (2009) The World of the Cell, 7th edition, Pearson Benjamin Cummings Publishing, San Francisco

3. De Robertis EDP and De Robertis EMF (2006) Cell and Molecular Biology, 8th edition. Lippincott Williams and Wilkins, Philadelphia

4. Karp G (2010) Cell and Molecular Biology: Concepts and Experiments, 6th edition, John Wiley & Sons. Inc.

5. Sambrook J and Russell DW. (2001). Molecular Cloning: A Laboratory Manual. 4th Edition, Cold Spring Harbour Laboratory press.

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

Examination Scheme:

Components	Internal	End Term
Weightage (%)	50	50

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

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	3	3	3	3	3	3	-	-	-	-	-
CO2	3	3	3	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	3	2	-	-	-	-	-
CO4	3	3	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	2	2	3	3	-	-	-	-	-
Avg	3	3	3	2.8	2.8	3	2.8	-	-	-	-	-

1=weakly mapped

2= moderately mapped

3=strongly mapped

SEC136	Applied Biophysics	L	T	P	C
Version 1.0	Contact Hours – 30	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

CO1. Understand the fundamental principles of biophysics.
CO2. Apply biophysical principles and techniques to analyze and solve practical problems in bioenergetics.
CO3. Develop skills in analyzing and interpreting experimental data obtained through spectroscopic techniques.
CO4. Exposed to a range of chromatography techniques commonly used in research and industry.
CO5. Learn skills in the analysis and interpretation of experimental data produced using microscopic methods.

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

Applied Biophysics

UNIT 1: General physico-chemical principles (5h)

Physico-chemical properties of water, Nature of interactions, concept of pH and Buffer, Henderson–Hasselbatch equation, Titration curve and pK values, numerical problems, examples of redox potential in biological system.

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, Thermodynamics of passive and active

transport, Concept of bioenergetics, Applications of bioenergetics in biotechnology and bioengineering.

UNIT 3: Spectroscopic techniques (6h)
Colorimetry and UV-Vis spectroscopy, Data analysis and interpretation, Recent developments in colorimetry and UV-Vis spectroscopy, 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.
(c) Determination of the Concentration of an Unknown $KMnO_4$ and $K_2Cr_2O_7$ solution by colorimetry.
(d) Operating instructions for UV-Visible spectrophotometer.
(e) Separation of amino acids by Paper and thin layer chromatography.
(f) Operating instructions for bright field microscope.

Text 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	3	3	3	3	3	-	-	-	-	-
CO2	3	3	2	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	3	3	-	-	-	-	-
CO4	3	3	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	3	2	3	3	-	-	-	-	-
Avg	3	3	2.8	3	2.8	3	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.
9. Career Guidance for competitive entrance exams and Job Search Strategies
10. Mock Tests and Assessments.

Course learning outcomes:

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

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

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

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

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

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

Examination Scheme:

Components	CA	End Term
Weightage (%)	50	50

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

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

1=weakly mapped

2= moderately mapped

3=strongly mapped

ADAMAS UNIVERSITY

B.Sc. Biotechnology (Hons.)

SEMESTER-V

BIT301	**IMMUNOLOGY**	**L**	**T**	**P**	**C**
Version 1.0	**Contact Hours - 75**	2	1	1	4
Pre-requisites/Exposure	12^{TH} LEVEL BIOLOGY				
Co-requisites	--				

Course Objectives:

1. To provide basic understanding of our immune system and its medical implication.
2. To provide basic understanding B-cell, T-cell, antibody structure and their interaction with antigen.
3. To provide basic understanding of the activation, mechanism and regulation of the immune system and Host pathogen interaction.

Course Outcomes

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

CO1. **Define** the basic concepts of immunology like the immune system, antigen-antibody interactions, and the role of innate and adaptive immunity

CO2. **Describe** the mechanisms of immune responses at the molecular level, including the functions of cytokines, complement system, and major histocompatibility complex

CO3. **Analyze** the experimental techniques used to study the fundamental principles of immunology, such as ELISA, flow cytometry, and Western blotting.

CO4. **Evaluate** the significance of immunology in various fields such as diagnostics, therapeutics, and biotechnology

CO5. **Develop** critical skills to do experiments and interpret data related to immunology and make connections to real-world applications

Catalog Description:

Immunology course will provide n through understanding of the principles and mechanisms of the immune system and immune responses in the context of infection, and immunological disorders. 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 and laboratory experiments as per requirement. The tutorials will familiarize the students with practical problem-solving techniques led by the course coordinator. Students will strongly grab the basic concepts of the subject via exercise, practical work and discussions with the coordinator.

Course Content:

Immunology

UNIT I **12 Lecture Hours**

The immune system:
Innate & adaptive immunity, comparative immunity; cells & organs of the immune system; Antigens.

UNIT II **16 Lecture Hours**

Immunoglobulin structure & functions and antigens: Basic structures of Immunoglobulins; Ig classes & biological activities; Innate and adaptive components of the immune system; cytokines; complement system

UNIT III **16 Lecture Hours**

Antigen – antibody interactions and components of innate and adaptive immunity: Antibody Affinity & activity; Precipitation reactions; agglutination reactions; MHC Antigen processing and presentations.

UNIT IV **16 Lecture Hours**

Immune system in health and disease:

Leukocyte migration & inflammation; hypersensitive reactions; immune response to infectious diseases, vaccines.

UNIT V **15 Hours**

Immunology Applications: **Analyse appraise** and **discuss** the different tools and techniques: Radio immunoassay; ELISA; Immunoprecipitation; Monoclonal antibodies.

List of experiments

- Understanding immune system through models
- To perform blood grouping test
- To perform blood smear and Giemsa staining
- To perform blood smear and Leishman staining
- To perform total leucocyte count (Tc) and differential leucocyte count (Dc).
- To perform oucterlony double diffusion (ODD)
- To perform latex agglutination assay.
- To study phagocytosis through permanent slides.

Reference Books

1. Kuby Immunology by Richard A. Golds by Tharmas J. kindt fourth edition 2000 and Barbara Osborne. W.H.freeman and company.
2. Fundamental Immunology 7th Edition by William E. Paul. Publisher: LWW-2012
3. Immunology Lab Manual by Wilmore Weberly, 2015
4. Immunology methods manual - The comprehensive source book by Lefkovits. , 1996
5. Laboratory Immunology by Bradshaw LJ.1997

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	3	2	3	3	3	3	3	2	2
CO2	3	3	3	3	2	3	2	2	2	2	2	2
CO3	3	2	3	3	3	3	3	3	2	2	2	2
CO4	3	2	2	3	3	3	3	3	3	3	2	3
CO5	3	2	2	2	3	3	3	3	3	3	3	3
Avg	3	2.4	2.6	2.8	2.6	3	2.8	2.8	2.6	2.6	2.2	2.4

1=weakly mapped

2= moderately mapped

3=strongly mapped

Course Title	Recombinant DNA Technology	L	T	P	C
Course Code	BIT302	2	1	1	4
Contact Hours	75				
Pre-requisites/Exposure	12th level biology				

Course Objectives

1. To provide basic concepts of Recombinant DNA Technology.

2. To provide basic explaining of the molecular biology and gene manipulation techniques.

3. Elaborating genetic engineering strategies in plants, gene editing in human.

Course Outcomes

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

No.	Course Outcomes
CO1	Students will be able to **recall** the basic principles of genetics and molecular biology that underpin recombinant DNA technology.
CO2	Students will be able to **explain** how recombinant DNA technology is used to manipulate and engineer DNA sequences in order to produce desired outcomes.
CO3	Students will be able to **apply** recombinant DNA technology techniques to solve scientific problems or address real-world challenges.
CO4	Students will be able to **analyze** data generated from recombinant DNA experiments to draw conclusions and make predictions.
CO5	Students will be able to **design** and implement their own recombinant DNA experiments, demonstrating proficiency in the techniques and principles of the field.

CO = Course Outcomes

Catalog Description:

In classroom sessions students will study the theoretical and applied aspects of basic biotechnology techniques for the study of DNA and proteins. In the laboratory students will develop theory and practical skills from this and previous courses to perform standard molecular biology techniques for the isolation, manipulation and analysis of DNA as well as the expression and purification of protein. Students will be assisted in career development through instruction and practice in resume-

writing and interview skills, and will be exposed to different biotechnology job possibilities via a number of special interest seminars and/or company tours.

Course Content

Recombinant DNA Technology

UNIT I (15 hrs)

Molecular tools and applications- restriction enzymes, ligases, polymerases, alkaline phosphatase. Gene Recombination and Gene transfer: Transformation, Episomes, Plasmids and other cloning vectors (Bacteriophage-derived vectors, artificial chromosomes).

UNIT II (10 hrs)

Principle and applications of Polymerase chain reaction (PCR), primer-design, and RT- (Reverse transcription) PCR. Random and site-directed mutagenesis: PCR based methods of site directed mutagenesis, Protein engineering concepts and examples (any two).

UNIT III (15 hrs)

Restriction and modification system, restriction mapping. Southern and Northern hybridization. Preparation and comparison of Genomic and cDNA library, screening of recombinants, reverse transcription, DNA fingerprinting.

Applications of Genetic Engineering Genetic engineering in animals: Production and applications of transgenic mice, role of ES cells in gene targeting in mice, Therapeutic products produced by genetic engineering-blood proteins, human hormones, immune modulators and vaccines (one example each).

UNIT IV (5 hrs)

Genetic engineering in plants: Use of *Agrobacterium tumefaciens* and *A. rhizogenes,* Ti plasmids. CRISPR Cas mediated precise genome editing.

UNIT V (30 hrs)

List of experiments

1. Isolation of genomic DNA from *E.coli*.

2. Isolation of genomic DNA from plant parts.

3. Qualitative and quantitative analysis of DNA using spectrophotometer/colorimeter

4. Plasmid DNA isolation

5. Restriction digestion of DNA

6. Preparation of competent cells and transformation of competent cells.

7. Demonstration of PCR.

SUGGESTED READINGS:

1. Brown TA. (2006). Gene Cloning and DNA Analysis. 5th edition. Blackwell Publishing, Oxford, U.K.

2. Clark DP and Pazdernik NJ. (2009). Biotechnology-Applying the Genetic Revolution. Elsevier Academic Press, USA.

3. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington

4. Primrose SB and Twyman RM. (2006). Principles of Gene Manipulation and Genomics, 7th edition. Blackwell Publishing, Oxford, U.K.

5. Sambrook J, Fritsch EF and Maniatis T. (2001). Molecular Cloning-A Laboratory Manual. 3rd edition. Cold Spring Harbor Laboratory Press.

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

Examination Scheme:

Components	Internal	End Term
Weightage (%)	50	50

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

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	3	3	3	3	3	3	-	-	-	-	-
CO2	3	3	3	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	2	3	-	-	-	-	-
CO4	3	3	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	3	2	3	3	-	-	-	-	-
Avg	3	3	3	3	2.8	2.8	3	-	-	-	-	-

1=weakly mapped

2= moderately mapped

3=strongly mapped

BIT303	IPR AND BIOSAFETY	L	T	P	C
Version 1.0	**Contact Hours – 75**	2	1	1	4
Pre-requisites/Exposure	Basic Knowledge of Biology, application of biotechnology and concept of innovation				
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 should acquire knowledge in the domain of IPR.
2. Students will be able to differentiate between various components of IPR.
3. 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:

1. **Recognize** the importance of Intellectual Property Rights (IPR) and Biosafety regulations in the fields of science, technology, and innovation.
2. **Explain** the key concepts and principles of IPR and Biosafety, including patents, copyrights, and the regulatory framework.
3. **Evaluate** the relevance and implications of IPR and Biosafety regulations in scientific research, product development, and commercialization.
4. Critically **assess** the impact of IPR and Biosafety on technology transfer, public health, and environmental protection.
5. **Design** effective communication and training programs to raise awareness and ensure compliance with IPR and Biosafety regulations in research institutions and industry.

Catalog Description

The course is designed as an elementary course on IPR. The course further discusses all types of IPR to a moderate level of depth. Patent, copyright, trademark, industrial design and GI, their criteria, application, process, duration and application has been dealt in the course.

Course Content

UNIT I: 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, Defenses to patent infringement claims, Remedies – Civil and criminal, Compulsory licensing of patents in India. Industrial Design, types and application.

UNIT II: 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 III: 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 IV: 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:

4. Intellectual Property Right, Bharat Publisher, 2nd Ed 2024

5. Ganguli, Prabuddha. *Intellectual Property Rights: Unleashing the Knowledge Economy*. Tata McGraw-Hill Education, 2001.

6. Narayanan, P. *Intellectual Property Law*. Eastern Law House, 2017.

7. 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**	**3**	**2**	**3**	**3**	**3**	**3**	**3**	**3**	**2**
CO2	**3**	**3**	**3**	**3**	**2**	**3**	**2**	**2**	**2**	**2**	**3**	**2**
CO3	**3**	**3**	**2**	**3**	**3**	**3**	**3**	**3**	**2**	**2**	**3**	**3**
CO4	**3**	**2**	**2**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**
CO5	**3**	**2**	**2**	**2**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**
Avg	**3**	**2.6**	**2.4**	**2.8**	**2.6**	**3**	**2.8**	**2.8**	**2.6**	**2.6**	**3**	**2.6**

1=weakly mapped

2= moderately mapped

3=strongly mapped

SEC137	MOLECULAR DIAGNOSTICS	L	T	P	C
Version 1.0	**Contact Hours - 45**	1	0	1	2
Pre-requisites/Exposure	Basic Knowledge of Biology, microbiology and concept of diseases.				
Co-requisites	--				

Course Objectives

1. To provide the students with explaining of the concept of health, disease and the requirement of diagnostics with emphasis to molecular methods
2. It will also discuss various microbiological methods of detecting the causative agent of microorganisms
3. To study the application of molecular and automated methods for the purpose of diagnosis.

Course Outcomes

On completion of this course,

CO1. **Recall** key concepts and principles in molecular diagnostics, such as DNA/RNA extraction methods, PCR techniques, and genetic mutations.

CO2. **Interpret** the results of molecular diagnostic tests and understand how they are used in the diagnosis and treatment of genetic disorders and infectious diseases.

CO3. **Apply** molecular diagnostic techniques to analyze and interpret patient samples in a laboratory setting, and recommend appropriate course of action based on the results.

CO4. **Evaluate** the validity and reliability of molecular diagnostic tests, and analyze potential sources of error in the testing process.

CO5. **Develop** new molecular diagnostic assays or protocols to improve accuracy, sensitivity, and specificity of diagnostic tests in clinical settings.

Catalog Description

The core-course of molecular diagnostics is aimed to provide skill in the form of developing various fundamental concepts like clinical microbiology, molecular biology etc. for the purpose of diagnosis. This will help the students to develop the basic knowledge towards an application.

Course Content

SEC: Molecular Diagnostics

UNIT I **(10 hr)**

Fundamentals of genetics and DNA replication; Specimen types and uses; DNA and RNA extraction and isolation; Basic concepts of PCR; Applications of PCR for identification of pathogenic microorganisms;

UNIT II **(10 hr)**

Introduction to the molecular hybridization techniques; RFLP, AFPL & RAPD, their application in molecular diagnostics; Single nucleotide polymorphism and DNA fingerprinting;

UNIT III **(10 hr)**

Resolution and detection of nucleic acids by electrophoresis; Analysis of nucleic acids by Southern blotting; Rapid diagnostic tests of some important microorganisms, e.g. Covid-19 tests, comparison between PCR based test and Rapid tests.

UNIT IV **(5 hr)**

Basic concepts of purification of molecules/compounds w.r.t molecular diagnostics; size exclusion chromatography, ion exchange chromatography, Electron microscopy as a cutting-edge tool for molecular diagnostics, flowcytometry (FACS).

UNIT V: **(10 hr)**

Basic knowledge of clinical microbiology; Micro-dilution and macro-dilution broth procedures. Susceptibility tests: Diffusion test procedures. Susceptibility tests: Tests for bactericidal activity. Automated procedures for antimicrobial susceptibility tests.

Proposed list of Practicals

1. Fundamentals of Molecular Diagnostics.
2. DNA Extraction
3. DNA Separation by Electrophoresis
4. Types of PCR
5. Molecular Methods in Clinical Microbiology
6. Case Studies

SUGGESTED READINGS:

1. Practical Biochemistry, Principles and Techniques, Keith Wilson and John Walker

2. Bioinstrumentation, Webster

3. Advanced Instrumentation, Data Interpretation, and Control of Biotechnological Processes, J.F. Van Impe,Kluwer Academic

4. Ananthanarayan R and Paniker CKJ. (2005). Textbook of Microbiology. 7th edition (edited by Paniker CKJ). University Press Publication.

5. Brooks GF, Carroll KC, Butel JS and Morse SA. (2007). Jawetz, Melnick and Adelberg's Medical Microbiology. 24th edition. McGraw Hill Publication.

6. Goering R, Dockrell H, Zuckerman M and Wakelin D. (2007). Mims' Medical Microbiology. 4th edition. Elsevier.

7. Joklik WK, Willett HP and Amos DB (1995). Zinsser Microbiology. 19th edition. AppletonCentuary-Crofts 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	3	3	3	3	3	-	-	-	-	-
CO2	3	3	3	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	3	2	-	-	-	-	-
CO4	3	3	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	2	2	3	3	-	-	-	-	-
Avg	3	3	3	2.8	2.8	3	2.8	-	-	-	-	-

1=weakly mapped

2= moderately mapped

3=strongly mapped

BIT304	Internship	L	T	P	C
Version 1.0	**Contact Hours - 60**	0	0	4	4
Pre-requisites/Exposure	12^{TH} level Science + Subject knowledge of previous semesters				
Co-requisites	--				

Course Objectives:

1. Students will have the opportunity to put content from the classroom into practice consistent with the standards of the industry.
2. The primary goal of this course is to acquaint students with business or agency culture and to help them identify roles in that culture where scientific expertise in biotechnology is relevant.
3. Students will explain professional, ethical and social responsibilities and develop a respect for diversity and a knowledge of contemporary professional, societal and global issues of the need and an ability to engage in lifelong perceive the knowledge,

Course Outcomes

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

CO1. **Apply** theoretical knowledge learned in the classroom to real-world situations encountered during the internship.

CO2. **Analyze** and evaluate the work environment, tasks, and responsibilities assigned during the internship.

CO3. **Problem-solve** and troubleshoot issues that may arise during the internship independently.

CO4. **Develop** a professional network and establish meaningful relationships within the industry through the internship experience.

CO5. **Demonstrate** a thorough understanding of the internship experience and its impact on future career goals and aspirations.

Catalog Description:

Students participate in research or applied biology outside this university. Students must contact and obtain approval of a supervising instructor at the off-campus location and the department internship coordinator in the term prior to registration. Students have the opportunity to put content from the classroom into practice consistent with the standards of the industry. Industry internships are a powerful way for students to experience biotechnology first-hand and set them up for future employment. Industrial internship of approximately two months duration is required, and typically in the final year of graduation degree course.

Course Content:

UNIT 1: Student Notebook and Portfolio: A bound, paged notebook should serve as a reservoir

of observations, results or conclusions about daily activities during the internship. Each date should be entered with a title of the activity in a form that can be listed in the table of contents, with appropriate page numbers. A brief concluding statement which suggests awareness of the purpose and important events or results acquired during the day should appear following any other observations or entries followed by the intern's signature. In addition, any interim projects or progress reports should be assembled or otherwise documented into a portfolio of products or findings arising from the internship.

UNIT 2: Written Presentation: At the conclusion of the assignment student will be required to submit a formal written progress report a summary of the important findings; and a statement regarding the impact of these findings on future operations or directions relative to the problem under investigation.

UNIT 3: Oral Presentation: Each student is required to make a formal oral presentation on the experience. The presentations will summarize the findings and the overall experience, especially reflecting on the experience relative to the course goal and perceive the knowledgeing objectives.

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

Components	**Report 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	1	3	3	3	3	3	-	-	3
CO2	-	3	3	1	3	3	3	3	3	-	-	3
CO3	-	3	3	1	3	3	3	3	3	-	-	3
CO4	-	3	3	1	3	3	3	3	3	-	-	3
CO5	-	3	3	1	3	3	3	3	3	-	-	3
Avg	-	3	3	1	3	3	3	3	3	-	-	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:

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

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

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

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

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

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

Examination Scheme:

Components	CA	End Term
Weightage (%)	50	50

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

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

1=weakly mapped

2= moderately mapped

3=strongly mapped

ADAMAS UNIVERSITY

B.Sc. Biotechnology (Hons.)

SEMESTER-VI

BIT305	**Bioinformatics**	**L**	**T**	**P**	**C**
Version 1.0	**Contact Hours - 75**	2	1	1	4
Pre-requisites/Exposure	PLUS TWO LEVEL BIOLOGY				
Co-requisites	--				

Course Objectives

1. To provide those students with adopt the knowledge of bioinformatics
2. It will also provide in-depth knowledge of the general biological sequence and other biological databases.
3. Elaborating on the sequence alignments
4. Explore the knowledge of bioinformatics applications and perform research activities in bioinformatics.

Course Outcomes

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

1. **Recall** and identify key concepts, tools, and techniques used in bioinformatics, including sequence alignment, phylogenetics, and protein structure prediction.
2. **Explain** the principles and theories behind bioinformatics methods, processes, and algorithms, and demonstrate comprehension of the relationships between bioinformatics and other related disciplines.
3. **Utilize** bioinformatics software tools and databases to analyze biological data, interpret results, and make informed decisions in solving biological problems.
4. **Evaluate** and compare different bioinformatics methods and approaches, assess the quality of bioinformatics data, and identify limitations and biases in bioinformatics analyses.
5. Critically **assess** research articles, experimental designs, and bioinformatics methodologies, and provide constructive feedback on the validity and reliability of bioinformatics research.

Description

The core curriculum or course of 'Bioinformatics' will help to understand the introductory knowledge of bioinformatics tools, techniques, and biological databases. This course is a beginning to bioinformatics, the application of different bioinformatics methods to biological data analysis, and some current research activities in bioinformatics. Furthermore, the possible applications of bioinformatics will also be illuminated. All the lectures will be devoted to discussions of fundamental theories and advanced topics, focusing on the practical implementation of knowledge. Classes will be conducted by lecture as well as the PowerPoint presentation and audiovisual virtual lab session as per requirement. The tutorials will enable the students with problem-solving abilities led by the course coordinator. Students will perceive the basic concepts of the subject via exercise and discussions with the coordinator. The practical demonstration will help the students perform different modern bioinformatics activities using tools, techniques, and databases and perform research activities in bioinformatics.

Course Content

Bioinformatics

UNIT I **(Contact Hours – 10)**

Introduction to Bioinformatics and basic Concepts of Biological Databases:

Introduction, Branches of Bioinformatics, Aim, Scope and Research areas of Bioinformatics, Introduction and types of Biological Databases, Classification of Biological Databases (Nucleotide Database, Protein Database, Gene Expression Database), Overview of Artificial intelligence (AI) (definition, artificial neural network, Machine learning (ML), Deep learning (DL), Large Language models (LLMs))

UNIT II

Biological Sequence Databases: **(Contact Hours – 12)**

National Center for Biotechnology Information (NCBI): Tools and Databases of NCBI, Database Retrieval from NCBI; GenBank, Basic local alignment search tool (BLAST): EMBL Nucleotide Sequence Database (EMBL-Bank): Introduction, different tools and Salient Features. DNA Data Bank of Japan (DDBJ): Introduction, different tools and Salient Features; Protein Information Resource (PIR): Introduction and Salient Features.

UNIT IIII **(Contact Hours – 13)**

Sequence Alignments and Molecular Phylogeny:

Introduction, Concept of Alignment, Pairwise-Alignment, Multiple Sequence Alignment (MSA), MSA by CLUSTAL Omega, Scoring Matrices, Blocks of Amino Acid Substitution Matrix (BLOSUM).

Methods of Phylogeny, Software for Phylogenetic Analyses, Consistency of Molecular Phylogenetic Prediction.

UNIT VI **(Contact Hours – 10)**

Quantitative structure-activity relationship (QSAR), Basics introduction to artificial intelligence and machine learning. Basics introduction to data analytics

UNIT V

Applications of Bioinformatics: Structural Bioinformatics in Drug Discovery and Drug Design, Applications of Bioinformatics in Medical sector, Microbial genome applications, Application of AI in biological science.

Bioinformatics Lab **(Contact Hours-30)**

1. Nucleic acid and protein databases.

2. Sequence retrieval from structural databases.

3. Sequence alignment.

4. Sequence homology and Gene annotation.

5. Construction of phylogenetic tree.

SUGGESTED BOOKS:

1. Ghosh Z. and Bibekanand M, Bioinformatics: Principles and Applications. OxfordUniversity Press. (2008)

2. Pevsner J, Bioinformatics and Functional Genomics. II Edition. Wiley-Blackwell. (2009)

3. Campbell A. M., Heyer L. J. Discovering Genomics, Proteomics and Bioinformatics. IIEdition. Benjamin Cummings. (2006)

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

Examination Scheme:

Components	Class Assessment	End Term
Weightage (%)	50	50

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

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

1=weakly mapped

2= moderately mapped

3=strongly mapped

BIT306	Bioprocess Technology	L	T	P	C
Version 1.0	**Contact Hours - 75**	2	1	1	4
Pre-requisites/Exposure	Basic Knowledge of Genetics, RDT and Microbiology				
Co-requisites	--				

Course Objectives

1. Explain the bases for media preparation, sterilization.
2. Explain the basic structure of Bioreactors.
3. Know the basic physiology of a microorganism and how their structure dictates their function in Process Industries.
4. Outlining the relation between upstream processing and downstream processing.

Course Outcomes

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

CO1. **Define** key terms and concepts related to Process Biotechnology

CO2. **Explain** the importance of bioprocessing in producing valuable products

CO3. **Apply** the principles of Process Biotechnology to solve real-world bioprocessing challenges

CO4. **Evaluate** the environmental impact of bioprocessing activities

CO5. Critically **assess** the results and outcomes of bioprocessing experiments

Catalog Description

A fair knowledge of principles of main bioprocess unit operations like fermentation, downstream processing will be acquired. The focus of the course is on design of innovative microbial fermentations, for bio-products such as amino acids and monomers for bio-plastics, complemented with examples of marine and mammalian processes, for micro-algae products and bio-pharmaceuticals.

Course Content

Bioprocess Technology (BIT306)

UNIT I **(20hrs)**

Introduction to bioprocess technology. Range of bioprocess technology and its chronological development. Basic principle components of fermentation technology. Types of microbial culture and its growth kinetics– Batch, Fed batch and Continuous culture.

UNIT II **(20hrs)**

Design of bioprocess vessels- Significance of Impeller, Baffles, Sparger; Types of culture/production vessels- Airlift; Cyclone Column; Packed Tower and their application in production processes. Principles of upstream processing – Media preparation, Inocula development and sterilization.

UNIT III **(15hrs)**

Introduction to oxygen requirement in bioprocess; mass transfer coefficient; factors affecting KLa. Bioprocess measurement and control system with special reference to computer aided process control.

UNIT IV **(15hrs)**

Introduction to downstream processing, product recovery and purification. Effluent treatment. Microbial production of ethanol, amylase, lactic acid and Single Cell Proteins.

UNIT V **(10hrs)**

Applications of Bioprocessing: Pharmaceuticals, Foods, Fuels, Chemicals.

Suggested Practical's

Bacterial growth Kinetics calculation.

Estimation of Citric acid from natural samples.

Isolation of industrially important microorganism from soil sample.

Production and analysis of amylase.

Production and analysis of ethanol using yeast.

Immobilization of microbial biomass.

SUGGESTED READINGS:

1. Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited.

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

3. Patel AH. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited.

4. Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. 2nd edition, Elsevier Science Ltd.

5. Laboratory Manual in Industrial Biotechnology by P. Chellapandi 2007

6. Bioreactors in Biotechnology: A Practical Approach by A.H. Scragg, 1991

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	3	3	3	3	-	-	-	-	-
CO2	3	3	3	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	3	2	-	-	-	-	-
CO4	3	3	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	2	2	3	3	-	-	-	-	-
Avg	3	3	3	2.8	2.8	3	2.8	-	-	-	-	-

1=weakly mapped

2= moderately mapped

3=strongly mapped

Course Title	Bioanalytical Tools	L	T	P	C
Course Code	BIT307	2	1	1	4
Contact Hours	75				
Pre-requisites/Exposure	10+2 level Biology. Basic knowledge of Molecular biology and Protein Biochemistry				

Course Objectives:

1. The primary objectives of this course are to develop the skills to explain the theory and practice of bioanalytical techniques
2. Additionally, an overview of the instruments used in isolation and separation of molecules will also be provided.
3. To provide scientific explaining of analytical techniques and detail interpretation of results
4. This will enable the students to explain all subjects of Biotechnology as these tools and techniques will be used therein.

Course outcome: The students will be able to

No.	Course Outcomes
CO1	**Recall** the key principles of bioanalytical tools and instruments
CO2	**Explain** the basic functionalities and working principles of bioanalytical tools
CO3	**Select** appropriate bio analytical tools for specific laboratory applications
CO4	**Compare** and contrast different bioanalytical tools and their applications
CO5	**Design** experimental protocols utilizing bioanalytical tools for various analytical tasks

Course Description:

The main aim of this module is to provide an explaining about the theoretical aspects of key analytical techniques and instruments used in biosciences, including centrifugation techniques, chromatographic techniques, spectrophotometric methods, electrophoretic methods and microscopy. The subject is going to develop an analytical mind set among students in order to develop to different types of samples and research objectives, including selection of the most appropriate techniques and instrumentation for their research project. The course also going to teach about processing and analysis of data from the chosen instruments and explain the explaining along with limitations and quality of the data. The students will gain an in depth explaining of this important techniques in order to design an analytical work-flow to acquire data and achieve the research objectives of their project.

Course Content:

Bioanalytical Tools (BIT307)

UNIT I **10 Lecture Hours**

Simple microscopy, phase contrast microscopy, florescence and electron microscopy (TEM and SEM), pH meter, absorption and emission spectroscopy

UNIT II **10 Lecture Hours**

Principle and law of absorption fluorimetry, colorimetry, spectrophotometry (visible, UV, infrared), centrifugation, cell fractionation techniques, isolation of sub-cellular organelles and particles.

UNIT III **10 Lecture Hours**

Introduction to the principle of chromatography. Paper chromatography, thin layer chromatography, column chromatography: silica and gel filtration, affinity and ion exchange chromatography, gas chromatography, HPLC.

UNIT IV **10 Lecture Hours**

Introduction to electrophoresis. Starch-gel, polyacrylamide gel (native and SDS-PAGE), agarose-gel electrophoresis, pulse field gel electrophoresis, immuno-electrophoresis, isoelectric focusing, Western blotting. Introduction to Nanotechnology and their applications.

UNIT V **35 Lecture Hours**

Applications of different bioanalytical tools.

List of experiments

- Handling of compound microscopes and visualization of specimen.
- Handling of phase contrast microscope and visualization of live unstained specimen.
- Native gel electrophoresis of proteins
- SDS-polyacrylamide slab gel electrophoresis of proteins under reducing conditions.
- Separation of plant pigments by paper chromatography.
- Separation of amino acids by thin layer chromatography.
- Demonstration of gel filtration & ion exchange chromatography
- Demonstration of HPLC

SUGGESTED BOOK:

1. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley& Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology. 8th edition. Lippincott Williams and Wilkins, Philadelphia.
3. Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
4. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2009. The World of the Cell. 7th edition. Pearson Benjamin Cummings Publishing, San Francisco.

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

Components	Internal	End Term
Weightage (%)	50	50

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

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	3	3	3	3	3	3	-	-	-	-	-
CO2	3	3	3	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	3	3	-	-	-	-	-
CO4	3	2	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	3	2	3	3	-	-	-	-	-
Avg	3	2.8	3	3	2.8	3	3	-	-	-	-	-

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

SEC138	Biostatistics	L	T	P	C
Version 1.0	**Contact Hours – 30**	1	0	1	2
Pre-requisites/Exposure	PLUS TWO LEVEL BIOLOGY				
Co-requisites	--				

Course Objectives

1. To provide those students with apt the knowledge to Biostatistics
2. It will also provide in depth knowledge of the collection of data, tabulation and presentation of data.
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. **Define** key statistical terms and concepts used in biostatistics

CO2. **Compare** and contrast different statistical methods and techniques used in biostatistical analysis

CO3. **Apply** appropriate statistical methods to analyze and interpret data in biostatistics

CO4. **Evaluate** the validity and reliability of statistical findings in biostatistics

CO5. **Develop** research hypotheses and design experimental studies in biostatistics

Catalog Description

The course of 'biostatistics will help to explain 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 **m**easures 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

UNIT I: (10 hr)

Definition - statistical methods - basic principles. Variables - measurements, functions, limitations and uses of statistics; plot and graph.

UNIT II: (10 hr)

Collection of data primary and secondary: Types and methods of data collection procedures - merits and demerits. Classification - tabulation and presentation of data - sampling methods.

UNIT III: (10 hr)

Measures of central tendency: Mean, median, mode, geometric mean - merits & demerits. Measures of dispersion - range, standard deviation, mean deviation, quartile deviation - merits and demerits; Co- efficient of variations.

UNIT IV: (9 hr)

4. Correlation: Types and methods of correlation, regression, simple regression equation, fitting prediction, similarities and dissimilarities of correlation and regression, Annova.

UNIT V: **(6 hr)**

Classification - tabulation and presentation of data - sampling methods.

Proposed list of practicals:

1. Calculation of mean, standard deviation and standard error.

2. Calculation of correlation coefficient values and finding out the probability.

3. Calculation of 'F' value and finding out the probability value for the F value.

4. Calculation of student't' test - chi square test- Hypothesis testing.

SUGGESTED BOOKS:

1. Le CT (2003) Introductory biostatistics. 1st edition, John Wiley, USA

2. Glaser AN (2001) High YieldTM Biostatistics. Lippincott Williams and Wilkins, USA

3. Edmondson A and Druce D (1996) Advanced Biology Statistics, Oxford University Press.

4. 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	**Mid Term**	**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	3	3	3	3	-	-	-	-	-
CO2	3	3	2	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	3	3	-	-	-	-	-
CO4	3	3	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	3	2	3	3	-	-	-	-	-
Avg	3	3	2.8	3	2.8	3	3	-	-	-	-	-

1=weakly mapped

2= moderately mapped

3=strongly mapped

BIT308	Project Work	L	T	P	C
Version 1.0	**CONTACT HOURS-60**	4	0	0	4
Pre-requisites/Exposure	Concept of /Biotechnology and allied subjects from previous semester				
Co-requisites	--				

Course Objectives

1. This will enable students to design and evaluate scientific investigations
2. Students will perceive the knowledge 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. **Memorize** key project management concepts and techniques.

CO2. **Apply** project management principles and methodologies to plan, organize, and implement a project work effectively.

CO3. **Analyze** project requirements, constraints, and risks to develop a comprehensive project plan.

CO4. **Assess** the impact of the project work on stakeholders, the organization, and the community.

CO5. **Integrate** knowledge and skills from various disciplines to develop a comprehensive project strategy and execution plan.

Catalog Description

The core-course of 'dissertation' will enable the students to nurture their research interest by compiling basic knowledge obtained during their education together with novel ideas from contemporary research. An idea about appropriate application of biochemical and biotechnological skill for industrial and research purpose can be developed. With the potential to design and evaluate scientific investigations to the students, who will perceive the knowledge 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	1	3	3	3	3	3	-	-	3
CO2	-	3	3	1	3	3	3	3	3	-	-	3
CO3	-	3	3	1	3	3	3	3	3	-	-	3
CO4	-	3	3	1	3	3	3	3	3	-	-	3
CO5	-	3	3	1	3	3	3	3	3	-	-	3
Avg	-	3	3	1	3	3	3	3	3	-	-	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:

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

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

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

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

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

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

Examination Scheme:

Components	CA	End Term
Weightage (%)	50	50

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

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

1=weakly mapped

2= moderately mapped

3=strongly mapped

ADAMAS UNIVERSITY

B.Sc. Biotechnology (Hons.)

SEMESTER-VII

BIT401	**Genomics and Proteomics**	**L**	**T**	**P**	**C**
Version 1.0	**Contact Hours - 75**	2	1	1	4
Pre-requisites/Exposure	UG level biochemistry and molecular biology				
Co-requisites	UG level Bioinformatics				

Course Objectives

1. The course aims to explain the students the fundamental concepts of technologies relevant to Genomics and Proteomics, their applications and illustrate skills to develop the knowledge to solve problems.
2. At the end of the course students should be able to explain fundamental methodologies of genomic and proteomic and they would be able to propose suitable methods for analysis of given sample with respect to purpose of study.

Course Outcomes

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

CO1. **Identify** different genome sequencing techniques

CO2. **Interpret** genomic data and its significance in various research fields

CO3. **Utilize** proteomic analysis methods to study protein expression patterns

CO4. Critically **evaluate** mass spectroscopy data for protein identification and characterization

CO5. Critically **evaluate** the reliability of proteomic analysis results for biomarker discovery

Course Description

Genomics & Proteomics deals with the rapidly evolving scientific area that introduces students into genomes and proteomes of different organisms and shows how to develop the information to solve critical problems genes, proteins, genomes and proteomes. This course provides an extensive overview of the goals, methods, and applications for genomics and proteomics in the life sciences field.

Course Content

Genomics & Proteomics

UNIT I (15 hr)

Introduction to Genomics, DNA sequencing methods – manual & automated: Maxam& Gilbert and Sangers method. Pyrosequencing, Whole Genome Sequencing: Shotgun & Hierarchical (clone contig) methods, Computer tools for sequencing projects: Genome sequence assembly software.

UNIT II (5 hr)

Managing and Distributing Genome Data: Web based servers and software for genome analysis: ENSEMBL, VISTA, UCSC Genome Browser, NCBI genome. Selected Model Organisms' Genomes and Databases.

UNIT III (10 hr)

Introduction to protein structure, Chemical properties of proteins. Physical interactions that determine the property of proteins. Short-range interactions, electrostatic forces, Van der waal interactions, hydrogen bonds, Hydrophobic interactions.

UNIT IV (5 hr)

Separation of proteins: Sedimentation analysis, chromatographic separation, SDS-PAGE; Native PAGE, Determination of peptide sequences – Edman degradation.

UNIT V (10 hr)

Introduction to Proteomics: Analysis of proteomes. 2D-PAGE. Sample preparation, solubilization, reduction, resolution. Reproducibility of 2D-PAGE. Mass spectrometry based methods for protein identification. *De novo* sequencing using mass spectrometric data.

List of proposed experiments:

1. Analysis of DNA-sequencing (manual and automated) data
2. Use of genome database
2. Use of SNP database
3. Use of OMIM database
4. Determination of physico-chemical parameter of a protein from given sequence
5. Analysis motif/domain of protein from given sequence
6. Detection of Open Reading Frame using ORF finder
7. Analysis of peptide sequencing data
8. Protein localization prediction
9. Dealing with 2D PAGE database
10. Analysis of MALDI data and identification of proteins

SUGGESTED READINGS:

1. Sukanta Mondal and Ram Lakhan Singh, **Advances in Animal Genomics**. 2020. Elesvier
2. Jeremy Dale, Malcolm von Schantz, Nick Plant, **From genes to genomes. Concepts and applications of DNA technology.** 2020. Wiley Blackwell
3. Gary Walsh, **Proteins: Biochemistry and Biotechnology.** 2014. Wiley Blackwell

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	3	3	3	3	-	-	-	-	-
CO2	3	3	2	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	3	3	-	-	-	-	-
CO4	3	3	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	3	2	3	3	-	-	-	-	-
Avg	3	3	2.8	3	2.8	3	3	-	-	-	-	-

1=weakly mapped

2= moderately mapped

3=strongly mapped

BIT402	Environmental Biotechnology	L	T	P	C
Version 1.0	Contact Hours - 75	2	1	1	4
Pre-requisites/Exposure	Basic Knowledge of Microbiology and Bioprocess Technology				
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 explain 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 develop the knowledge to judge the potability of water samples.

5. Students will be able to comprehend microbial bioremediation.

Course Outcomes

On completion of this course,

CO1. **Demonstrate** an understanding of the principles and processes involved in environmental biotechnology, including the use of microorganisms, enzymes, and bioinformatics for environmental remediation and conservation.

CO2. **Explain** the connections between environmental biotechnology and the conservation of natural resources, the mitigation of pollution, and the restoration of ecosystems.

CO3. **Apply** knowledge of environmental biotechnology to design and implement sustainable solutions for environmental challenges, such as waste management, water treatment, and soil remediation.

CO4. **Analyze** data and information related to environmental biotechnology to evaluate the effectiveness of different biotechnological interventions in addressing environmental issues.

CO5. Critically **assess** the ethical, social, and economic implications of using biotechnological approaches in environmental conservation and management, considering factors such as risk assessment, public perception, and policy implications.

Catalog Description

The student will be able to use the knowledge obtained from the core course "Environmental Microbiology" to explain different components of the ecosystem and the interrelationship between them along with the significance of ecological balance for existence of life. This course includes several topics pertaining with solutions to certain difficult environmental problems such as gene-environment interaction, detection of pollutants, elimination and treatment of toxic wastes, development of environment friendly products and improved energy sources.

Course Content

Environmental Biotechnology

UNIT I **(15 hrs)**

Conventional fuels and their environmental impact – Firewood, Plant, Animal, Water, Coal and Gas. Modern fuels and their environmental impact – Methanogenic bacteria, Biogas, Microbial hydrogen Production, Conversion of sugar to alcohol Gasohol.

UNIT II **(20 hrs)**

Bioremediation of soil & water contaminated with oil spills, heavy metals and detergents. Degradation of lignin and cellulose using microbes. Phytoremediation. Degradation of pesticides and other toxic chemicals by micro-organisms- degradation aromatic and chlorinates hydrocarbons and petroleum products.

UNIT III **(15 hrs)**

Treatment of municipal waste and Industrial effluents. Bio-fertilizers, Role of symbiotic and asymbiotic nitrogen fixing bacteria in the enrichment of soil. Algal and fungal biofertilizers (VAM).

UNIT IV **(15 hrs)**

Bioleaching, Enrichment of ores by microorganisms (Gold, Copper and Uranium). Environmental significance of genetically modified microbes, plants and animals.

UNIT V **(20 hrs)**

Application of Biotechnology in Environment: Biomarker, Bioenergy, Bioremediation, Biotransformation and Benefits.

List of Practicals

1. Calculation of Total Dissolved Solids (TDS) of water sample.
2. Calculation of BOD of water sample.
3. Bacterial Examination of Water by MPN Method using different water sample.
4. Isolation of microbes (bacteria & fungi) from rhizosphere and rhizoplane of surrounding environment.
5. Isolation of industrially important microorganism from natural resource.
6. Preparation of winogradsky column to create artificial ecosystem for bacteria.

Textbook:

1. Environmental Biotechnology – Concepts and Applications, Hans-Joachim Jordening and Jesef Winter

2. Waste Water Engineering, Metcalf and Eddy, Tata McGraw hill

3. Agricultural Biotechnology, S.S. Purohit

4. Environmental Microbiology: Methods and Protocols, Alicia L. Ragout De Spencer, John F.T. Spencer.

Reference books:

1. Environmental Science, S.C. Santra

2. Environmental Biotechnology, Pradipta Kumar Mohapatra.

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

1=weakly mapped

2= moderately mapped

3=strongly mapped

BIT403	Developmental Biology	L	T	P	C
Version 1.0	Contact Hours - 75	2	1	1	4
Pre-requisites/Exposure	PLUS TWO LEVEL BIOLOGY + Zoology				
Co-requisites	--				

Course Objectives

1. The objective of this course is to provide a comprehensive explaining of the concepts of early animal development. Students taking this course must develop a critical appreciation of methodologies specifically used to study the process of embryonic development in animals.
2. In this course a particular model system will not be discussed in detail. Instead, different concepts of animal development will be elaborated in one model system or the other. Once the concepts are taught the students will be made familiar with different approaches that have been used to study such concepts.
3. Further topics that will be discussed are stem cells and regeneration, the developmental basis of diseases as well as the developmental mechanisms of evolutionary change.

Course Outcomes

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

CO1. **Define** the key concepts and principles of developmental biology.

CO2. **Describe** the impact of genetic and environmental factors on development

CO3. **Apply** knowledge of developmental biology to analyze developmental disorders and diseases

CO4. **Analyze** the ethical implications of research in developmental biology.

CO5. **Design** experiments to test hypotheses related to developmental processes

Course Description

Developmental biology is a multidisciplinary field that integrates genetics, molecular biology, biochemistry, cell biology, anatomy, physiology and computer modeling, giving students a scope in a range of biological disciplines. In this course, use of stem cells to engineer replacement tissues and organs could revolutionize medicine. Continuation onto the modern language, integrated master's or industrial/professional experience course is dependent on certain academic criteria. All the lectures will be devoted on discussions of basic theories and advanced topics, focusing on practical implementation of knowledge. Classes will be conducted by lecture as well as power point presentation, audio visual virtual lab session as per requirement. The tutorials will familiarize the students with practical problem-solving techniques led by the course coordinator. Students will strongly grab the basic concepts of the subject via exercise and discussions with the coordinator.

Course Content

Developmental Biology

UNIT I: (25 hr)

Definition, scope & historical perspective of development Biology, Gametogenesis – Spermatogenesis, Oogenesis Fertilization - Definition, mechanism, types of fertilization. Different types of eggs on the basis of yolk.

UNIT II: (20 hr)

Cleavage: Definition, types, patterns & mechanism Blastulation: Process, types & mechanism. Gastrulation: Morphogenetic movements– epiboly, emboly, extension, invagination, convergence, de-lamination. Formation & differentiation of primary germ layers, Fate Maps in early embryos.

UNIT III: (15 hr)

Differentiation: Cell commitment and determination- the epigenetic landscape: a model of determination and differentiation, control of differentiation at the level of genome, transcription and post-translation level Concept of embryonic induction: Primary, secondary & tertiary embryonic induction, Neural induction and induction of vertebrate lens.

UNIT IV: (10 hr)

Neurulation, notogenesis, development of vertebrate eye. Fate of different primary germ layers.

UNIT V: (5 hr)

Developmental Biology **Applications**: **Analyse appraise** and **discuss** animal development to understand how evolution plays key role in developmental process using different tools and techniques

Proposed List of practicals:

1. Preparation of a temporary stained mount of chick embryo
2. Study of developmental stages of Chick embryo.
3. Study of different stages of Frog embryo.
4. Study of the developmental stages of *Drosophila* from photographs.
5. Drosophila culture in Lab
6. Study of different types of placenta.

Reference Books

1. Gilbert, S. F. (2006). Developmental Biology, VIII Edition, Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA.
2. Balinsky, B.I. (2008). An introduction to Embryology, International Thomson Computer Press.
3. Kalthoff, (2000). Analysis of Biological Development, II Edition, McGraw-Hill Professional.

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	1	1	1	1	3	1	-	-	-	-	-
CO2	3	3	3	1	3	3	1	-	-	-	-	-
CO3	3	1	1	1	3	3	1	-	-	-	-	-
CO4	3	1	1	1	1	1	1	-	-	-	-	-
CO5	3	1	1	1	1	1	1	-	-	-	-	-
Avg	3	1.4	1.4	1	1.8	2.2	1	-	-	-	-	-

1=weakly mapped

2= moderately mapped

3=strongly mapped

BIT404	RESEARCH METHODOLOGY	L	T	P	C
Version 1.0	**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. Describe the concept of research methodology.

CO2. Classify and differentiate between various types of research methodologies.

CO3. Apply appropriate research methodologies to different research scenarios.

CO4. Evaluate the effectiveness and appropriateness of research methodologies.

CO5: **Develop** a comprehensive research methodology plan.

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 (BIT2404)

Unit I [5 hrs]

Introduction to research; Definitions and characteristics of research; Types of research; Main components of any research work. Problem identification; Criteria for prioritizing problems for research. Analyzing the problem; formulating the problem statement. Literature review: Uses of literature review; Definitions and Formulation of the research objectives**.**

Unit II [10 hrs]

Research methodologies: Study population; Variables; Sampling; Sample size determination; Plan for data collection; Methods of data collection; Plan for data processing and analysis; Ethical considerations. Work Plan; Major components and outline of the different phases in a research process; Summary of the major components of a research proposal; Fieldwork; Writing a research report.

UNIT III [10 hrs]

Introduction to the WHO/TDR Handbook on GLP; Current Good Manufacturing Practices: Introduction, USC gmp Part 210 and Part 211.EC Principles of GMP (Directive 91/356/EEC) Article 6 to Article 14 and WHO cGMP guidelines GAMP-5; Medical device and IVDs Global Harmonization Task Force (GHTF) Guidance docs. Introduction, USFDA GLP Regulations (Subpart A to Subpart K), Controlling the GLP inspection process, Documentation, Audit, goals of Laboratory Quality Audit, Audit tools, Future of GLP regulations, relevant ISO and Quality Council of India (QCI)Standards,

UNIT IV [10 hrs]

Good Automated Laboratory Practices: Introduction to GALP, Principles of GALP, GALP Requirements, SOPs of GALP, Training Documentation,21 CFR Part 11, General check list of 21CFR Part 11, Software Evaluation checklist, relevant ISO and QCI Standards. Good Distribution Practices: Introduction to GDP, Legal GDP requirements put worldwide, Principles, Personnel, Documentation, Premises and Equipment, Deliveries to Customers, Returns, Self-Inspection, Provision of information, Stability testing principles, WHO GDP, USP GDP (Supply chain integrity), relevant CDSCO guidance and ISO standards

UNIT: V [10hrs]

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

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

Components	Class Assessment	End Term
Weightage (%)	50	50

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

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	3	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

BIT405	Ecology and Environment Management	L	T	P	C
Version 1.0	**Contact Hours - 75**	2	1	1	4
Pre-requisites/Exposure	PLUS TWO LEVEL BIOLOGY+ general Ecology				
Co-requisites	--				

Course Objectives

1. To provide students with a broad interdisciplinary liberal arts framework for explaining the relationship between humans and their environment;
2. To provide students with informed perspectives on biological and physical processes relevant to environmental problems, to help students explain responsible environmental policy and practice, and to engage students in ethical reflection regarding environmental problems in local, regional, national, and global communities.
3. To show students for careers, citizenship and environmental stewardship through experiential curricular and co-curricular opportunities.
4. To equip students with the knowledge and skills necessary to pursue professional careers and advanced study related to the multi-faceted nature of environmental studies; and to serve as an environmental resource, through service, outreach and engagement.

Course Outcomes

On completion of this course, the students will be able

CO1. **Explain** key concepts in ecology, such as ecosystems, biodiversity, and energy flow.

CO2. **Analyze** current environmental challenges and their ecological impacts.

CO3. **Apply** ecological management strategies to mitigate environmental problems.

CO4. **Evaluate** the impact of national and global environmental policies and regulations.

CO5. **Design** a comprehensive environmental management plan that promotes sustainability.

Course Description

This course introduces to the terms, concepts, and practices in the broad domain of Ecology, Environment Management and the terms such as Nature Deficit Disorder, Timeline of Life, Concepts of Environment, the System Concepts, Ecosystem, Ecosystem Services, Natural Capital, Biological Footprint, the Nature Compass, Environment Impact Assessment. Global warming, Climate negotiations and Global Climate strikes are also discussed. A few quizzes are given with every lecture and a terminal quiz is included to consolidate perceive the knowledge & experiences. All the lectures will be devoted on discussions of basic theories and advanced topics. Classes will be conducted by lecture as well as power point presentation, audio visual virtual lab session as per requirement. The tutorials will familiarize the students with practical problem-solving techniques led by the course coordinator. Students will strongly grab the basic concepts of the subject via exercise and discussions with the coordinator.

Course Content

Ecology and Environment Management

UNIT I: (20 hr)

Our Environment: Geological consideration of Atmosphere, Hydrosphere, Lithosphere Scope of Ecology. Development & Evolution of Ecosystem. Principles & Concepts of Ecosystem. Structure of ecosystem. Strata of an ecosystem. Types of ecosystem including habitats. Cybernetics & Homeostasis. Biological control of chemical environment.

UNIT II: (20 hr)

Energy transfer in an Ecosystem. Food chain, food web, Energy budget, Production & decomposition in a system. Ecological efficiencies, Trophic structure & energy pyramids, Ecological energetic, principles pertaining to limiting factors; Biogeochemical cycles (NCP cycles).

UNIT III: (15 hr)

Pollution & environmental Health related to Soil, Water, Air, Food, Pesticides, Metals, Solvents, Radiations, Carcinogen, and Poisons. Detection of Environmental pollutant. Indicators & detection systems. Bio-transformation, Plastic, Aromatics, Hazardous wastes

Biotechnologies in protection and preservation of environment. Bioremediation, Waste disposal. Environmental cleanup: Case studies; Case studies.

UNIT IV: (15 hr)

Environmental biotechnologies, Biotechnologies in protection and preservation of environment. Bioremediation, Waste disposal.

UNIT V: (5 hr)

Ecology and Environment management Applications: **Analyse** appraise and **discuss** the topic through different tools, mathematical modeling and field-based techniques

Proposed list of practicals:

1. Field study in ecology using both qualitative and quantitative studies (Checklist/Quadrat /Transect) from any one of the following bio-geographical area (coastal/ forest/ Hills) with report submission.
2. Study of the life table and fecundity table, plotting of the three types of survivorship curves from the hypothetical data.
3. Acidity, Alkalinity (PA & TA), Total Hardness of water
4. Soil moisture, Soil pH, Soil electrical conductivity.
5. Water Holding Capacity of the soil.
6. Review paper preparation/ presentation on topics related to Environmental Biotechnology

Reference Books

1. Chapman, J.L., Reiss, M.J. 1999. Ecology: Principles and applications (2nd edition) CambridgeUniversity Press.

2. Divan Rosencraz, Environmental laws and policies in India, Oxford Publication.

3. Ghosh, S.K., Singh, R. 2003. Social forestry and forest management. Global Vision PublishingHouse

4. Joseph, B., Environmental studies, Tata Mc Graw Hill.

5. Michael Allabay, Basics of environmental science, Routledge Press.

6. Miller, G.T. 2002. Sustaining the earth, an integrated approach. (5thedition) Books/Cole,ThompsonPerceive the knowledgeing, Inc.

7. Mohapatra Textbook of environmental biotechnology IK publication.

8. Rana SVS, Environmentalpollution – health and toxicology, Narosa Publication

9. Sinha, S. 2010. Handbook on Wildlife Law Enforcement in India. TRAFFIC, India.

10. Thakur, I S, Environmental Biotechnology, I K 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	1	1	1	1	1	3	1	1	1	1
CO2	3	1	3	1	1	3	1	1	1	1	1	1
CO3	3	3	1	1	3	1	1	3	1	1	1	1
CO4	3	3	1	1	1	3	1	3	1	3	1	1
CO5	1	1	1	1	3	3	3	1	1	3	3	1
Avg	2.6	2.2	1.4	1	1.8	2.2	1.4	2.2	1	1.8	1.4	1

1=weakly mapped

2= moderately mapped

3=strongly mapped

PDC401	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-4 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:

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

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

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

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

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

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

Examination Scheme:

Components	CA	End Term
Weightage (%)	50	50

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

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

1=weakly mapped

2= moderately mapped

3=strongly mapped

ADAMAS UNIVERSITY

B.Sc. Biotechnology (Hons.)

SEMESTER-VIII

BIT406	**Molecular Modelling and Drug Design**	**L**	**T**	**P**	**C**
Version 1.0	**Contact Hours - 75**	2	1	1	4
Pre-requisites/Exposure	Basic knowledge of Organic Chemistry and Protein Biochemistry, Bioinformatics				
Co-requisites	--				

Course Objectives:

1. The main focus of the course is the use of ligand based approaches to target proteins which are lacking highly resolved 3D crystal structures.
2. It will present drug development as a process involving target selection, lead discovery using computer-based methods and combinatorial chemistry/high-throughput screening.
3. This course aims at application of modern *in silico* tools or information technology in different phases of drug discovery and design of new drug candidates by explaining the molecular basis of the interaction of small molecules with their targets.
4. The course will teach fundamental aspects about molecular modelling and modern drug discovery by rational drug designing methods like virtual screening of inhibitors using 3-D protein structures.

Course outcome:

The students will be able

1. **Describe** the basic principles and techniques used in molecular modelling.
2. **Illustrate** the stages of the drug design process, including target identification and lead optimization.
3. **Apply** computational techniques to model molecular structures and predict their properties.
4. **Evaluate** the binding affinity and efficacy of drug candidates using molecular docking and simulation data.
5. **Design** novel drug candidates using structure-based drug design principles.

Course Description:

The subject is designed to impart knowledge about recent advances in the field of medicinal chemistry at the molecular level including different techniques for the rational drug design. At completion of this course it is expected that students will be able to develop various strategies important for designing and development of new drug like molecules. The course is also going to teach different techniques for drug discovery, their role in medicinal chemistry research, different stages involved in drug discovery with an explaining of peptidomimetics and biological targets. This subject is designed to impart the knowledge on preclinical evaluation of drugs and recent experimental techniques in the drug discovery and development. It will teach the students in developing drug safety data in Pre -clinical, Clinical phases of Drug development

Course Content

Molecular Modeling and Drug Design

UNIT I **(20 hr)**

Introduction-coordinate systems – molecular structure and internal energy – Born-Oppenheimer approximation, coordinate systems, potential energy surfaces, local and global energy minima. Molecular mechanics: general features of molecular mechanics- force field, bond stretching, angle bending, torsional terms, non-bonded interactions; force field parametrisation and transferability; energy minimization: derivative and non-derivative methods, applications of energy minimization**.**

UNIT II **(10 hr)**

Introduction to the concept of molecular modelling, applications of molecular graphics, Molecular dynamics simulation methods. Introduction to computer hardware and software.

UNIT III **(20 hr)**

Recent advances in drug design methodologies. Biomolecular structure, Structure activity relationship, Pharmacokinetics, Pharmacophoric pattern, ADME Properties, quantitative structure activity relationship, Use of genetic algorithms and principle component analysis in the QSAR equations.

UNIT IV **(20 hr)**

Macromolecular modeling Software tools for modelling bio-molecules. Molecular electrostatic potentials, charge analyses. Protein conformations, folding and mutation through modelling-design of ligands for known macro molecular target sites. Drug-receptor interaction, classical SAR/QSAR studies and their implications to the 3-D modeler, 2-D and 3-D database searching, pharmacophore identification and novel drug design.

UNIT V **(20 hr)**

Molecular Modelling and Drug Designing Applications: **Analyse appraise** and **discuss** the topic with different tools and techniques

Proposed list of practicals

1. Analysis of protein structure from PDB file from RCSB
2. Visualisation and analysis of protein structure using PyMOL
3. Secondary structure prediction from protein sequence
4. Molecular modeling – template based
5. Molecular modeling – *ab initio* based
6. Study of the lead compound: identification and optimization.
7. Drawing chemical compounds using computer software
8. Molecular docking - blind
9. Molecular docking - local
10. ADMET analysis

SUGGESTED READINGS:

1. Andrew Leach, Molecular Modelling: Principles and Applications (2nd Edition), Addison Wesley Longman, Essex, England. 1996.

2. Alan Hinchliffe, Molecular Modelling for Beginners, John-Wiley and Sons New York, 2003

3. Cohen, N. (Ed.). Guide Book on Molecular Modelling in Drug Design, Academic Press, San Diego, 1996.

4. Frenkel D., and Smith B.Explaining Molecular Simulations, From Algorithms to Applications, Academic Press, San Diego, California. 1996.

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

Examination Scheme:

Components	**Internal**	**End Term**
Weightage (%)	**50**	**50**

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

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	3	3	3	3	3	3	-	-	-	-	-
CO2	3	3	2	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	3	3	-	-	-	-	-
CO4	3	3	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	3	2	3	3	-	-	-	-	-
Avg	3	3	2.8	3	2.8	3	3	-	-	-	-	-

1=weakly mapped

2= moderately mapped

3=strongly mapped

BIT407	MEDICAL MICROBIOLOGY	L	T	P	C
Version 1.0	**Contact Hours - 75**	2	1	1	4
Pre-requisites/Exposure	Intermediate level science + general microbiology				
Co-requisites	--				

Course Objectives:

1. To provide basic explaining of pathogenic and symbiotic microorganism.
2. To provide basic explaining of infectious diseases caused by bacteria, fungi, parasite, and virus
3. To provide basic explaining of the virulence factors, and host-pathogen interaction.

Course Outcomes

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

CO1. **Recognize** the signs and symptoms of viral, fungal, and protozoal infections and normal flora

CO2. **Explain** the mechanisms of pathogenesis employed by pathogenic bacteria, viruses, fungi, and protozoa

CO3. **Apply** knowledge of microbial flora to evaluate the potential risk of infection in different clinical scenarios and interpret laboratory test results to identify the causative agent of infectious diseases.

CO4. **Compare** and contrast the pathogenesis of different types of microbial infections.

CO5. Critically **evaluate** emerging trends in the field of medical microbiology and their implications for healthcare and propose strategies for preventing the transmission of microbial infections.

Catalog Description:

Medical Microbiology describes the process of infection by the major human pathogens - viruses, fungi, bacteria, protozoans and helminths; the molecular mechanisms utilised by these organisms for their survival; and how these organisms are able to invade and interact with various host tissues. All the lectures will be devoted on discussions of basic theories and advanced topics, focusing on practical implementation of knowledge. Classes will be conducted by lecture as well as power point presentation, audio visual virtual lab session as per requirement. The tutorials will familiarize the students with practical problem-solving techniques led by the course coordinator. Students will strongly grab the basic concepts of the subject via exercise and discussions with the coordinator. Students will also learn skills and knowledge by doing experiment with different procedures to know the basics of medical microbiology

Course Content:

Medical Microbiology

UNIT I 15 Lecture Hours

Introduction:

Normal microflora of human body, nosocomial infections, carriers, septic shock, septicemia, pathogenicity, virulence factors, toxins, biosafety levels.

UNIT II 15 Lecture Hours

Morphology, pathogeneis, symptoms, laboratory diagnosis, preventive measures and chemotherapy caused by Gram positive bacteria and Gram negative bacteria.

UNIT III 15 Lecture Hours

Diseases caused by viruses- Picornavirus, Orthomyxoviruses, Paramyxoviruses, Rhabdoviruses, Reoviruses, Pox virus, Herpes virus, Papova virus, Retro viruses (including HIV/AIDS) and Hepatitis viruses, SARS, EBOLA COVID19.

UNIT IV 15 Lecture Hours

Fungal and Protozoan infections. Dermatophytoses (*Trichophyton, Microsporun and Epidermophyton*) Subcutaneous infection (*Sporothrix*, *Cryptococcus*), systemic infection (*Histoplasma*, *Coccidoides)* and opportunistic fungal infections (*Candidiasis, Aspergillosis*), gastrointestinal infections (Amoebiasis, Giardiasis), Blood-borne infections (Leishmaniasis, Malaria)

UNIT V 15 Hours

Medical microbiology Applications: **Analyse appraise** and **discuss** the different tools and techniques; Media, staining and diagnostic techniques

List of practical to learn skills and knowledge about medical microbiology

1. Identification of pathogenic intracellular and extracellular parasites based on cultural, morphological and biochemical characteristics.
2. Gram staining
3. Growth curve of a bacterium.
4. To show permanent slides of *Leishmania* infected macrophages, liver and spleen
5. Widal test
6. RPR test
7. To perform antibacterial testing by Kirby-Bauer method.

Reference Books

1. Brooks GF, Carroll KC, Butel JS and Morse SA. (2013). Jawetz, Melnick and Adelberg's Medical Microbiology. 24th edition. McGraw Hill Publication.
2. Medical Microbiology by Greenwood 4th edition. Elsevier Health sciences
3. Microbiology - 5th Edition - 2023-24/Ed. by Michale J. Pelczar Jr., E.C.S. Chan , Noel R. Krieg
4. Laboratory Manual of Experimental Microbiology (1995) by R.M. Atlas, A.E.Brown and L.C. Parks, Mosby, St. Louis.
5. Manual of clinical laboratory immunology by Rose NR, 2002
6. Laboratory Immunology by Bradshaw LJ.1997

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	2	3	3	3	3	2	2	2	2	2	2
CO2	3	3	3	3	3	3	2	2	2	2	2	2
CO3	3	3	2	3	3	3	3	3	2	2	2	2
CO4	3	3	2	3	3	3	3	3	3	3	3	3
CO5	3	3	2	2	3	3	3	3	3	3	3	3
Avg	3	2.8	2.4	2.8	3	3	2.6	2.6	2.4	2.4	2.4	2.4

1=weakly mapped

2= moderately mapped

3=strongly mapped

BIT408	NANOTECHNOLOGY	L	T	P	C
Version 1.0	**Contact Hours – 75**	2	1	1	4
Pre-requisites/Exposure	Basic Knowledge of Biology, application of biotechnology and concept of innovation				
Co-requisites	--				

Course Objectives

- To understand the fundamental principles of nanoscience and classify nanomaterials
- To apply various top-down methods for synthesis of nanomaterials
- To apply various bottom-up approaches for synthesis of nanomaterials
- To characterize synthesized nanomaterials
- To acquire knowledge on different biological applications of nanotechnology

Course Outcomes

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

No.	Course Outcomes
CO1	**Define** nanotechnology and its applications in various fields such as medicine, electronics, and energy.
CO2	**Interpret** the potential benefits and risks associated with the use of nanotechnology in society.
CO3	**Apply** the concepts of nanotechnology to solve real-world problems in areas such as healthcare, environmental remediation, and energy storage.
CO4	**Analyze** the interactions between nanoparticles and biological systems in terms of toxicity and biocompatibility.
CO5	**Assess** the societal implications of nanotechnology in terms of economic, social, and environmental factors.

CO = Course Outcomes

Catalogue Description:

Nanotechnology is an interdisciplinary field and attracts students from various disciplines. This course provides basic overview of nanomaterials and their applications. This course begins with a review of various types of nanomaterials and an introduction to general terminologies. Subsequently the course covers physical, chemical, ad biological synthesis methodologies and methods of characterization of nanomaterials. Finally, case studies illustrating application of nanomaterials in biology and allied fields will be discussed.

Course Content:

Nanotechnology

UNIT I **(15 hours)**

Introduction- Interconversion of unit, concept of surface area to volume ratio and aspect ratio. Difference between surface area to volume ratio of bulk materials and nanomaterials (sphere, hollow sphere, rods, hollow rods, cubes and hollow cubes) and related numerical problems. Classification of nanomaterials: 0D, 1D, 2D and 3D. Different classes of nanomaterials: Quantum dots, Quantum wires, Carbon nanotubes, Bucky balls, Fullerenes.

UNIT II **(10 hours)**

Top-Down fabrication methods –Types of Top-Down fabrication methods: mechanosynthesis, thermal energy, lithography-concepts with examples.

UNIT III **(10 hours)**

Bottom-Up fabrication methods-Types of Bottom-Up fabrication methods: chemical and biological methods of nanomaterial synthesis-concepts with examples. Concept of reducing and capping agents, introduction to biomolecules as reducing and capping agents.

UNIT IV **(20 hours)**

Characterization techniques- X-ray diffraction (XRD) technique, Applications of XRD, EDX spectroscopy, Dynamic light scattering, Scanning Electron Microscopy, Transmission Electron Microscopy, Atomic Force Microscopy, UV visible spectroscopy, Infrared Spectroscopy and Fourier Transform Infrared Spectroscopy.

UNIT V **(20 hours)**

Biological applications of nanotechnology- Biological nanomaterials, nanomedicine, nanoparticles for photodynamic/ photothermal therapy, nanodiagnostics and nanobiosensors, nanofertilizers, nanopesticides, nanopackaging for enhanced shelf life of food, nanotoxicology.

List of Practicals

- ✓ Physical synthesis of nanoparticles by bead homogenization and size estimation
- ✓ Chemical synthesis of gold/silver nanoparticles
- ✓ Biological synthesis of gold/silver nanoparticles
- ✓ Spectroscopic characterization of nanoparticles
- ✓ Evaluation of antimicrobial activity of nanoparticles

SUGGESTED READINGS:

1. Introduction to nanoscience and nanotechnology. Gabor L. Hornyak, H.F. Tibbals, Joydeep Dutta, John J. Moore
2. Guozhong Cao, Nanostructures & Nanomaterials Synthesis, Properties G; Z, Applications, World Scientific Publishing Pvt. Ltd., Singapore 2004
3. Nanotechnology: Principles and Practices, 3rd ed., Sulabha K. Kulkarni.

4. Nanomaterials for Biosensors, Cs. Kumar, Wiley – VCH, 2007.

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

Components	Internal	End Term
Weightage (%)	50	50

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

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	3	3	3	3	3	3	-	-	-	-	-
CO2	3	3	3	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	2	3	-	-	-	-	-
CO4	3	3	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	3	2	3	3	-	-	-	-	-
Avg	3	3	3	3	2.8	2.8	3	-	-	-	-	-

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

BIT409	Project/Dissertation	L	T	P	C
Version 1.0	**CONTACT HOURS-180**	12	0	0	12
Pre-requisites/Exposure	Concept of Biotechnology and allied subjects from previous semester				
Co-requisites	--				

Course Objectives

1. This will enable students to design and evaluate scientific investigations
2. Students will perceive the knowledge 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. **Memorize** key project management concepts and techniques.

CO2. **Apply** project management principles and methodologies to plan, organize, and implement a project work effectively.

CO3. **Analyze** project requirements, constraints, and risks to develop a comprehensive project plan.

CO4. **Assess** the impact of the project work on stakeholders, the organization, and the community.

CO5. **Integrate** knowledge and skills from various disciplines to develop a comprehensive project strategy and execution plan.

Catalog Description

The core-course of 'dissertation' will enable the students to nurture their research interest by compiling basic knowledge obtained during their education together with novel ideas from contemporary research. An idea about appropriate application of biochemical and biotechnological skill for industrial and research purpose can be developed. With the potential to design and evaluate scientific investigations to the students, who will perceive the knowledge 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	1	3	3	3	3	3	-	-	3
CO2	-	3	3	1	3	3	3	3	3	-	-	3
CO3	-	3	3	1	3	3	3	3	3	-	-	3
CO4	-	3	3	1	3	3	3	3	3	-	-	3
CO5	-	3	3	1	3	3	3	3	3	-	-	3
Avg	-	3	3	1	3	3	3	3	3	-	-	3

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

Minor Syllabus

BIT151	**Biochemistry**	L	T	P	C
Version 1.0	**Contact Hours: 75**	2	1	1	4
Pre-requisites/Exposure	Knowledge of Organic Chemistry at 10+2 level				
Co-requisites	-				

Course Objectives

To gain a deeper understanding structure of different types of carbohydrates.

2. To acquire the knowledge structures of different types of aminoacids.

3. To acquire the knowledge about the different classes of lipids

4. To gain the knowledge about different types of nucleic acid.

5. To understand the properties of water and its essentiality in biochemistry.

Course Outcomes

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

CO1. **Define** the concepts of solvents and solutes in biochemistry and describe their role in various metabolic processes

CO2. **Identify** the different types of lipids, amino acids, enzymes and their functions in the human body.

CO3. **Evaluate** the role of nucleic acids in protein synthesis and genetic information transfer

CO4. **Describe** the different types of carbohydrates and their importance in energy production.

CO5. **Demonstrate** the ability to perform basic biochemical experiments and analyze the results.

Catalog Description

Life is a condition through which living organisms can be differentiated from non-living matters. For example, growth, reproduction are the essential physiological phenomena of living organism. To support those physiological characteristics, some molecules are very much essential, which are considered as “molecules of life”. The learning of the detailed structures of those molecules are necessary for understanding the key of the life. So, the course consists of the structure of carbohydrates (energy source), amino acids (structural unit of protein), water (a major part of protoplasm of the cell), lipids (building block of the cell) and nucleotides (responsible for construction of energy currency and genetic material).

Course Content

Biochemistry

UNIT I: Carbohydrates [12 Lecture hours]

Major elements and minor elements, Structure of atoms, molecules and chemical bonds, Stabilizing interactions, Monosaccharides - structure of aldoses and ketoses, ring structure of sugars, conformations of sugars, mutarotation, anomers, epimers and enantiomers, structure of biologically important sugar derivatives, oxidation of sugars. Formation of disaccharides, reducing and nonreducing disaccharides. Polysaccharides – homo- and heteropolysaccharides, structural and storage polysaccharides. Structure and role of proteoglycans, glycoproteins and glycolipids (gangliosides and lipopolysaccharides). Carbohydrates as informational molecules, working with carbohydrates.

UNIT II: Lipids [12 Lecture hours]

Building blocks of lipids - fatty acids, glycerol, ceramide. Storage lipids - triacyl glycerol and waxes. Structural lipids in membranes – glycerophospholipids, galactolipids and sulpho lipids, sphingolipids and sterols, structure, distribution and role of membrane lipids. Plant steroids. Lipids as signals, cofactors and pigments.

UNIT III Amino acids [12 Lecture hours

Structure and classification, physical, chemical and optical properties of amino acids and proteins.

UNIT IV Nucleic acids [12 Lecture hours]

Nucleotides - structure and properties. Nucleic acid structure – Watson-Crick model of DNA. Structure of major species of RNA - mRNA, tRNA and rRNA. Nucleic acid chemistry - UV absorption, effect of acid and alkali on DNA. Other functions of nucleotides - source of energy, component of coenzymes, second messengers.

UNIT V: Water & Enzymes [12 Lecture hours]

Safety measures in laboratories and Properties of Water. Preparation of normal and molar solutions Preparation of Buffer. Qualitative Analysis of Carbohydrates Qualitative Analysis of Proteins. Qualitative Analysis of Lipids. Assay of Alkaline Phosphatase. Nucleic acid Estimation.

Reference Books

6. 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:10:1-42923414-8.
7. Biochemistry (2011) 4th ed., Donald, V. and Judith G.V., John Wiley & Sons AsiaPvt.
Ltd. (New Jersey), ISBN:978-1180-25024.
8. Biochemistry,LubertStryer, 8th Edition.
9. Organic Chemistry, Vol 1 &2., IL Finar.
10. Chemistry of Nucleic acids,Adams.
6. Organic Chemistry,Nasipuri.
7. Biochemical Calculations, IrwinSegel

8. Introduction to Practical Biochemistry: by Sawhney and Singh Biochemistry (2011) 4th ed

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	3	3	3	3	3	-	-	-	-	-
CO2	3	3	2	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	3	3	-	-	-	-	-
CO4	3	3	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	3	2	3	3	-	-	-	-	-
Avg	3	3	2.8	3	2.8	3	3	-	-	-	-	-

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

BIT152	Basic Animal Science	L	T	P	C
Version 1.0	**Contact Hours - 75**	2	1	1	4
Pre-requisites/Exposure	PLUS TWO LEVEL BIOLOGY				
Co-requisites	--				

Course Objectives

1. To provide those students with some biology background with an introduction to zoology and the study of animals. This course is designed for students of any major, but will especially benefit biology majors, as well as secondary science education majors.
2. It will also provide an informative elective for 5-8 math/science education majors.
3. Gathering information about other organisms' structure and function, and how that compares to human beings, enables us to live a more knowledgeable, involved, and environmentally aware life in a science-conscious age.

Course Outcomes

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

1. **Explain** the fundamental principles of animal biology, including anatomy, physiology, and classification of animals.
2. **Analyze** the growth patterns, developmental stages, and reproductive strategies of animals.
3. **Apply** knowledge of animal nutrition and health management to maintain and improve animal welfare.
4. **Evaluate** the role of animals in agricultural systems and their ecological significance in ecosystems.
5. **Design** animal husbandry practices that promote sustainable production, animal welfare, and environmental conservation.

Course Description

Animal Science course will help to explain the behavior structure and evolution of animals. This course includes diverse approaches by studying animals and develops a better explaination of how we function and interact with the world around us. All the lectures will be devoted on discussions of basic theories and advanced practical topics, focusing on proper implementation of the knowledge. Classes will be conducted by lecture, practical classes as well as power point presentation, audio visual virtual lab session as per requirement. The tutorials will familiarize the

students with practical problem-solving techniques led by the course coordinator. Students will strongly grab the basic concepts of the subject via exercise and discussions with the coordinator.

Course Content

Basic Animal Science

UNIT 1: (5 hr)

Outline of classification of Chordates and non-chordates up to sub classes and general features of all the major phyla. Protochordates: outline of classification, general features.

UNIT 2: (10 hr)

Special topics on non-chordates: Conjugation in Paramoecium, canal system in Porifera, polymorphism in Cnidaria, Lifecycle of Taeniasolium, Parasitic adaptations of helminthes, Metamerism, Torsion in gastropoda, Water Vascular system in Starfish.

UNIT 3: (5 hr)

Special topics on chordates: Parental care in Fish, Neoteny and Paedogenesis, Flight adaptations in birds, Dentition in mammals.

UNIT 4: (15 hr)

Comparative anatomy of vertebrates: integumentary system, respiratory system, heart and aortic arches, kidney and urinogenital system.

UNIT 5: (10 hr)

Animal biology Applications: Analyse appraise and discuss the different tools and techniques: Microscopy, Spectroscopy, Gel Electrophoresis, PCR, X Ray, ECG, MRI.

Proposed list of practicals:

1. Identification and Classification of the following:

Non-chordate specimens: Scypha, Obelia, Sea-anaemone, Ascaris, Hirudinaria, Scorpion, Bombyxmori, Achatina, Loligo, Starfish, Balanoglossus.

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

2. Visit to any national park/museum/zoological garden and prepare an ecological Note.

3. Models of dissection of Cockroach - Cockroach: Digestive, Reproductive, Nervous System.

4. Observation and identification of five butterfly species available in your locality with pictures.

5. Dissection of a common fish to become familiar with the internal organs of a fish.

6. Measuring the wings and tail father length and count their numbers. Also analyze their ratio in different bird species available.

7. Prepare a food chain pyramid that you can observe in your locality with pictorial views.

8. Prepare a comparative analysis on available birds species in your locality based on their habitat and food intake.

SUGGESTED READING:

4. Barnes, R.D. (1992). Invertebrate Zoology. Saunders College Pub. USA.
5. Campbell & Reece (2005). Biology, Pearson Education, (Singapore) Pvt. Ltd.
6. Kardong, K. V. (2002). Vertebrates Comparative Anatomy. Function and Evolution. Tata McGraw Hill Publishing Company. New Delhi.
7. Ruppert, Fox and Barnes (2006) Invertebrate Zoology. A functional Evolutionary Approach 7th Edition, Thomson Books/Cole
8. Raven, P. H. and Johnson, G. B. (2004). Biology, 6th edition, Tata McGraw Hill Publications. New Delhi

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

Examination Scheme:

Components	**Mid Term**	**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	1	1	1	1	1	1	-	-	-	-	-
CO2	3	3	1	1	3	1	1	-	-	-	-	-
CO3	3	3	1	1	3	3	1	-	-	-	-	-
CO4	3	3	1	3	1	1	3	-	-	-	-	-
CO5	3	1	3	1	3	1	3	-	-	-	-	-
Avg	3	2.2	1.4	1.4	2.2	1.4	1.8	-	-	-	-	-

1=weakly mapped

2= moderately mapped

3=strongly mapped

BIT251	Basic Plant Science	L	T	P	C
Version 1.0	**Contact Hours - 75**	2	1	1	4
Pre-requisites/Exposure	PLUS, TWO (12^{th}) LEVEL BIOLOGY				
Co-requisites	Proficiency in English				

Course Objectives

5. The main objective of this course is to emphasize for the development of the fundamental knowledge in basic and applied plant science.
6. Students should acquire details knowledge in external and internal structure of higher plants.
7. The students should be able to understand plant ecosystem and their economic importance.
8. To provide students modern view about plant-based industry.

Course Outcomes

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

CO1: **Understand** the implementation of algal biotechnology for commercial purposes including biofuel production, pharmaceuticals, food supplements, and wastewater treatment.

CO2: **Categorize** the commercial importance of fungi in industries such as food, medicine, bioremediation, and agriculture, as well as their harmful effects on human health and agriculture.

CO3. **Evaluate** the economic importance of lichens in industries such as medicine, dye production, environmental monitoring, and soil stabilization.

CO4 **Summarize** the application of plant pathology knowledge in fields such as agriculture, horticulture, forestry, and plant quarantine for disease identification, control, and prevention.

CO5. **Implement** this knowledge in the commercial uses of economically important plants in sectors such as agriculture, horticulture, floriculture, and agro-based industries for sustainable production and economic growth.

Catalog Description

The course is designed as an introduction to the basic and applied fundamentals found in plant systems. The course provides a foundation of the external and internal structure of the higher group of plants, those are mainly used commercially for maintaining our livelihoods. 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

Basic Plant Science

UNIT I: Fundamentals of higher group of plants: (8 hour)

Classification and diversity of plants, Introduction to different parts of a typical angiosperm plant, Alternation of generations, reproduction, and development of higher group of plants.

UNIT II: Internal structure of higher group of plants (8 hour)

Plant Cells and Tissues: Structure and function of plant cells, tissues, and organs. Anatomical structure of various parts of angiosperm plants.

UNIT III: Plant Diversity and Ecology (8 hour)

Origin and evolutionary history of plants, Plant adaptations to different environments, Interactions between plants and their environment, Structure and dynamics of plant communities.

UNIT IV: Economic Importance of Plants: **(6 hour)**

Plants as sources of food, medicine, fibre, and other products.

UNIT V: Fundamentals of applied plant science: **(15 hour)**

Crop Science and Agronomy**:** Principles of crop production, agronomic practices, and crop improvement; Plant Pathology: Identification and management of plant diseases; Plant breeding: Basic principle and techniques in plant breeding, industrial application of plant breeding; Plant Pathology: Overview of Plant Diseases**:** Definition, types, and importance in agriculture**,** Causes of Plant Diseases**:** Pathogens (fungi, bacteria, viruses, nematodes), abiotic factors, and interactions, Disease Management Strategies: Cultural practices, chemical control, biological control, and integrated disease management.

List of Practical:

9. Basic understanding and operation of light microscopy.
10. Measurement and analysis of growth parameters (e.g., leaf area, plant height, biomass)
11. Preparation of stained mounts of anatomy of monocot and dicot's root, stem & leaf.
12. Demonstration on basic plant breeding techniques.
13. Identification of pathological diseases in crop plants.
14. Basic seed technological experiments.

SUGGESTED READING:

1. Fahn, A. Plant Anatomy (4th ed.), 1990, Wiley Eastern.
2. Futuyma., D. Evolution. 2015. (3rd Ed.) Sinauer Associates.
3. Odum, F.P. Fundamentals of Ecology, Latest Ed., Saunders.
4. Ganguli,H.C., Das, K.S.K. & Dutta, C.T. College Botany, Vol. I, latest Ed., New Central Book Agency.
5. Ganguli,H.C. and Kar, A.K. College Botany, Vol. II, latest Ed., New Central Book Agency.
6. Chatterjee, T., Santra,S.C. and Das, A. Practical College Botany, New Central Book Agency

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	3	3	3	3	-	-	-	-	-
CO2	3	3	3	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	3	3	-	-	-	-	-
CO4	3	2	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	3	2	3	3	-	-	-	-	-
Avg	3	2.8	3	3	2.8	3	3	-	-	-	-	-

1=weakly mapped

2= moderately mapped

3=strongly mapped

Course Title	Elementary Molecular Biology	L	T	P	C
Course Code	BIT252	2	1	1	4
Contact Hours	75				
Pre-requisites/Exposure	12th level biology				

Course objective: The aim is to extend the understanding of molecular mechanisms of cell through which genetic information is stored, expressed and transmitted among generations.

Course Outcomes

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

No.	Course Outcomes
CO1	**Explain** the structure of nitrogen bases and nucleic acids, the replication process, and the repair mechanism in molecular biology.
CO2	**Illustrate** the transcription process in both prokaryotes and eukaryotes, as well as the post-transcriptional events in the eukaryotic system.
CO3	**Compare** and contrast the translation process in prokaryotes and eukaryotes.
CO4	**Analyze** the process of regulation of gene expression in prokaryotes, identifying key regulatory mechanisms and their impact on cellular function.
CO5	**Demonstrate** and practice applications of molecular biology, using their knowledge to design experiments, develop research projects, and solve research problems in the field.

Course Content

Elementary Molecular Biology

UNIT 1: (10hrs)

Types of genetic materials; Nucleic acids: Structure and functions: Physical & chemical properties of Nucleic acids, Nucleosides & Nucleotides, Purines & Pyrimidines. Biologically important nucleotides, Double helical model of DNA structure and forces responsible for A, B & Z DNA. -

Experiments of Griffith, Avery, MacLeod and McCarty, Hershey and chase, John Cairns experiment, Meselson Stahl experiment, Central dogma of life.

UNIT- II (10 hrs)

Replication of DNA, Models of DNA replication, Mechanism of DNA replication in prokaryotes (initiation, elongation, replication fork, replication machinery, termination), Enzymes and proteins involved in DNA replication (nucleases, DNA polymerases, DNA helicases, gyrases, SSBP, topoisomerase, primase).

UNIT - III (15 hrs)

Mechanism of transcription in prokaryotes and eukaryotes. Enzymes and proteins involved in transcription, post transcriptional modifications. Inhibitors of transcription.

UNIT- IV (15 hrs)

Genetic code - characteristics and properties, Wobble hypothesis. Protein biosynthesis in prokaryotes and eukaryotes, post translational modifications, protein degradation, Inhibitors of protein synthesis. Regulation of gene expression (lac, trp and gal operons).

UNIT- V (10 hrs)

Mutation and its types- spontaneous, induced, reverse, suppressor mutations; chemical mutagens- alkylating agent, nitrous acid, hydroxylamine; physical mutagen- radiation. DNA repair- mismatch repair, base excision repair, nucleotide excision, direct repair and SOS repair.

MOLECULAR BIOLOGY PRACTICALS (1 Credit)

1. Preparation of buffers and chemicals for DNA isolation
2. DNA isolation from prokaryotes- *E.coli*
3. DNA isolation from eukaryotes- Saccharomyces cerevisiae
4. Protein extraction from plant
5. Molecular weight determination of DNA
6. Physical mutations: UV irradiation
7. Quantification of DNA
8. Total RNA isolation from bacteria
9. Melting curve analysis of DNA

Text books

- Lodish. H, Berk. A, Lawrence, A, Matsudaira. A, Baltimore. D and Dernell. J. Molecular Cell Biology (Fourth Edition). – W.H.Freeman and Company. 2009
- Cooper G M & Hausman E, The Cell - A Molecular Approach. (6th edition), Sinauer Associates 2013 Further readings
- P.S. Verma and V.K. Agarwal, 2012, Concepts of Cell Biology. S.Chand & Company Ltd., New Delhi. 2012
- Lewin. B , GENES X, (10th edition), Jones & Bartlett Learning, 2011

- David L. Nelson & Michael M. Cox. (2017) Lehninger principles of biochemistry (7th Edition) W H Freeman & Co.
- Molecular Biology of the Gene - By Watson, Hopkins, Goberts, Steitz and Weiner (Pearson Education)

Suggested Readings

1. Cell and Molecular Biology - By Robertis&Robertis, Publ: Waverly

2. Genes - By B. Lewin - Oxford Univ. Press

3. Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. VI Edition. John Wiley & Sons. Inc.

4. De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and Molecular Biology. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.

5. Fundamentals of Molecular Biology. Jayant K Pal and SS Ghaskadbi, Oxford University Press.

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

Examination Scheme:

Components	Internal	End Term
Weightage (%)	50	50

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

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	3	3	3	3	3	3	-	-	-	-	-
CO2	3	3	3	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	2	3	-	-	-	-	-
CO4	3	3	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	3	2	3	3	-	-	-	-	-
Avg	3	3	3	3	2.8	2.8	3	-	-	-	-	-

1=weakly mapped

2= moderately mapped

3=strongly mapped

BIT353	Basics of IPR and Biosafety	L	T	P	C
Version 1.0	**Contact Hours – 75**	2	1	1	4
Pre-requisites/Exposure	Basic Knowledge of Biology, application of biotechnology and concept of innovation				
Co-requisites	--				

Course Objectives

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

9. Students should acquire knowledge in the domain of IPR.
10. Students will be able to differentiate between various components of IPR.
11. 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. **Recognize** the importance of Intellectual Property Rights (IPR) and Biosafety regulations in the fields of science, technology, and innovation.

CO2. **Explain** the key concepts and principles of IPR and Biosafety, including patents, copyrights, and the regulatory framework.

CO3. **Evaluate** the relevance and implications of IPR and Biosafety regulations in scientific research, product development, and commercialization.

CO4. Critically **assess** the impact of IPR and Biosafety on technology transfer, public health, and environmental protection.

CO5. Design effective communication and training programs to raise awareness and ensure compliance with IPR and Biosafety regulations in research institutions and industry**.**

Catalog Description

The course is designed as an elementary course on IPR. The course further discusses all types of IPR to a moderate level of depth. Patent, copyright, trademark, industrial design and GI, their criteria, application, process, duration and application has been dealt in the course.

Course Content

UNIT I: 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 II: 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 III: 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 IV: 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)

15. Basic Patent Search: Indian, European, US.
16. Reading/ Analyzing granted patent
17. Basic drafting of patent

18. IP awareness and sensitization

19. Patent application process

SUGGESTED READING:

8. Intellectual Property Right, Bharat Publisher, 2nd Ed 2024

9. Ganguli, Prabuddha. *Intellectual Property Rights: Unleashing the Knowledge Economy*. Tata McGraw-Hill Education, 2001.

10. Narayanan, P. *Intellectual Property Law*. Eastern Law House, 2017.

11. 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

BIT352	Introduction to Bioinformatics	L	T	P	C
Version XX	Contact Hours - 75	2	1	1	4
Pre-requisites/Exposure	PLUS TWO LEVEL BIOLOGY				
Co-requisites	--				

Course Objectives

1. To provide those students with adopt the basic knowledge of bioinformatics
2. It will also provide knowledge of the general biological sequence and other biological databases.
3. Elaborating on the sequence alignments
4. Explore the knowledge of bioinformatics applications and perform research activities in bioinformatics.

Course Outcomes (COs)

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

1. Students will be able to **recall** and identify key concepts, tools, and techniques used in bioinformatics, including sequence alignment, phylogenetics, and protein structure prediction.
2. Students will be able to **explain** the principles and theories behind bioinformatics methods, processes, and algorithms, and demonstrate comprehension of the relationships between bioinformatics and other related disciplines.
3. Students will be able to **utilize** bioinformatics software tools and databases to analyze biological data, interpret results, and make informed decisions in solving biological problems.
4. Students will be able to **evaluate** and compare different bioinformatics methods and approaches, assess the quality of bioinformatics data, and identify limitations and biases in bioinformatics analyses.
5. Students will be able to **critique** research articles, experimental designs, and bioinformatics methodologies, and provide constructive feedback on the validity and reliability of bioinformatics research

Description

The core curriculum or course of 'Bioinformatics' will help to understand the introductory knowledge of bioinformatics tools, techniques, and biological databases. This course is the beginning of bioinformatics, the application of different bioinformatics methods to biological data analysis, and some current research activities in bioinformatics. Furthermore, the possible applications of bioinformatics will also be illuminated. All the lectures will be devoted to discussions of fundamental theories and advanced topics, focusing on the practical implementation of knowledge. Classes will be conducted by lecture, PowerPoint presentation, and audiovisual virtual lab session as required. The tutorials will enable the students with problem-solving abilities led by the course coordinator. Students will perceive the basic concepts of the subject via exercise and discussions with the coordinator. The practical demonstration will help the students perform

different modern bioinformatics activities using tools, techniques, and databases and perform research activities in bioinformatics.

Course Content

Introduction to Bioinformatics [BIT352]

UNIT I **(Contact Hours – 10)**

Introduction to Bioinformatics and basic Concepts of Biological Databases:

Introduction, Branches of Bioinformatics, Aim, Scope and Research areas of Bioinformatics

The concept of artificial intelligence and its applications in varied fields are discussed in this subject

UNIT II

Biological Sequence Databases: **(Contact Hours – 12)**

Introduction and types of Biological Databases, Classification of Biological Databases (Nucleotide Database, Protein Database, Gene Expression Database) National Center for Biotechnology Information (NCBI): Tools and Databases of NCBI, Database Retrieval from NCBI; GenBank, DNA Data Bank of Japan (DDBJ): Introduction, different tools and Salient Features; Protein Information Resource (PIR):

UNIT IIII **(Contact Hours – 13)**

Sequence Alignments and Molecular Phylogeny:

Introduction, Concept of Alignment, Pairwise-Alignment, Multiple Sequence Alignment (MSA), MSA by CLUSTAL Omega,

Methods of Phylogeny, Software for Phylogenetic Analyses, Consistency of Molecular Phylogenetic Prediction.

UNIT VI **(Contact Hours – 10)**

Applications of Bioinformatics: Bioinformatics in Drug Discovery and Drug Design, Applications of Bioinformatics in Medical sector, Microbial applications

UNIT V

Bioinformatics Lab

1. Nucleic acid and protein databases.
2. Sequence retrieval from structural databases.
3. Sequence alignment.
4. Sequence homology
5. Construction of phylogenetic tree.

SUGGESTED BOOKS:

1. Ghosh Z. and Bibekanand M, Bioinformatics: Principles and Applications. OxfordUniversity Press. (2008)

2. Pevsner J, Bioinformatics and Functional Genomics. II Edition. Wiley-Blackwell. (2009)

3. Campbell A. M., Heyer L. J. Discovering Genomics, Proteomics and Bioinformatics. IIEdition. Benjamin Cummings. (2006)

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

Components	Class Assessment	End Term
Weightage (%)	50	50

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

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	3	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

BIT451	Elementary Genomics and Proteomics	L	T	P	C
Version 1.0	**Contact Hours - 75**	2	1	1	4
Pre-requisites/Exposure	PLUS TWO (12^{th}) LEVEL BIOLOGY				
Co-requisites	--				

Course Objectives

The objective of an elementary genomic and proteomic course is to provide students with a. The course aims to equip. Below are the specific objectives of such a course:

12. The main objective of this course is to emphasize the detailed knowledge and importance of genomic and proteomic concepts.
13. Students should be equipped with foundational understanding of the principles, techniques, and applications of genomics and proteomics.
14. Students will be able to utilize their knowledge and skills necessary to comprehend the molecular basis of biological processes at the genomic and proteomic levels.
15. Students will have a modern approach based on big data analysis for biotechnological interventions in research, healthcare, and agriculture etc. sectors.

Course Outcomes

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

CO1. **Identify** different genome sequencing techniques

CO2. **Interpret** genomic data and its significance in various research fields

CO3. **Utilize** proteomic analysis methods to study protein expression patterns

CO4. Critically **evaluate** mass spectroscopy data for protein identification and characterization

CO5. Critically **evaluate** the reliability of proteomic analysis results for biomarker discovery

Catalog Description

This course provides an introduction to the principles, techniques, and applications of genomics and proteomics. The course has been designed with an inclusion of basic concepts of molecular biology precisely which would help students to understand the advanced genomic and proteomic applications. Topics include genome organization, sequencing technologies, protein structure, mass spectrometry, and bioinformatics tools for data analysis. Emphasis is placed on understanding the molecular basis of biological processes and the integration of genomic and proteomic data in modern biology. 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

Elementary Genomics and Proteomics

UNIT I: Introduction to Molecular Biology

Introduction to structure and function of DNA, RNA, and proteins; Central dogma of molecular biology: DNA replication, transcription, and translation.

UNIT II: Basics of Genomics and Proteomics

Structure of the genome: chromosomes, genes, and non-coding regions; Genome organization: prokaryotic vs. eukaryotic genomes; Overview of proteomics and its significance; Searching databases for genomic and proteomic data

UNIT III: Techniques in genomics and proteomics

Techniques in genomics: PCR, DNA sequencing, and genome editing (CRISPR/Cas9); Techniques in functional genomics: microarrays, RNA sequencing (RNA-seq). Genome mapping techniques: physical and genetic mapping; Next-generation sequencing (NGS) technologies; Techniques in proteomics: Protein identification: SDS-PAGE Gel separation; 2D-SDS PAGE Gel Separation, Enzyme-Linked Immunosorbent Assay (ELISA), Western Blotting (Immunoblotting), Protein Microarrays; mass spectrometry; Protein separation chromatographic techniques

UNIT IV: Genome and Proteome analysis

Introduction to bioinformatics tools and databases; Sequence analysis (BLAST, multiple sequence alignment); Structural bioinformatics and protein modeling (KEGG ORGANISMS; EXPASY, PSIPRED)

UNIT V: Applications and future aspects

Applications of genome sequencing in research and medicine, agriculture, and biotechnology. Proteome profiling in health and disease; Applications of proteomics in drug discovery and personalized medicine; Future directions and emerging trends in the field.

List of Practical:

20. Isolation of Plasmid and Genomic DNA
21. Polymerase chain reaction
22. Agarose Gel electrophoresis.
23. Isolation of Proteins.
24. SDS-Gel Electrophoresis.
25. Spectrophotometric analysis of DNA, RNA and Proteins
26. Application of NCBI database for sequence analysis, genome browsing
27. Application of KEGG Organisms and Expasy for proteomic analysis

SUGGESTED READING:

12. Lehninger Principles of Biochemistry Edition 4, Nelson, David L. Cox, Michael M. Lehninger, Albert L. W H Freeman & Co.

13. Brown, T. A. (2023). Genomes 5. CRC Press.

14. Twyman, R. (2004). Principles of proteomics. Taylor & Francis.

15. "Bioinformatics: Sequence and Genome Analysis" by David W. Mount

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	3	3	3	3	-	-	-	-	-
CO2	3	2	3	3	3	3	3	-	-	-	-	-
CO3	3	3	3	2	3	3	3	-	-	-	-	-
CO4	3	3	3	3	2	3	3	-	-	-	-	-
CO5	3	3	3	3	3	3	2	-	-	-	-	-
Avg	3	2.8	3	2.8	2.8	3	2.8	-	-	-	-	-

1=weakly mapped

2= moderately mapped

3=strongly mapped

BIT452	Basic Medical Microbiology	L	T	P	C
Version 1.0	Contact Hours - 75	2	1	1	4
Pre-requisites/Exposure	PLUS TWO (12th) LEVEL BIOLOGY				
Co-requisites	--				

Course Objectives

16. The main objective of this course is to emphasize the detailed knowledge and importance of Microbes and their functionality.
17. Students should acquire knowledge in the of different types of microbial interactions and their role in disease propagation.
18. They will study about the anti-microbials and the resistance mechanisms of the anti-microbials.
19. The students will gain understandings of host-pathogen interactions.

Course Outcomes

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

CO1. **Recognize** the signs and symptoms of viral, fungal, and protozoal infections and normal flora

CO2. **Explain** the mechanisms of pathogenesis employed by pathogenic bacteria, viruses, fungi, and protozoa.

CO3. **Apply** knowledge of microbial flora to evaluate the potential risk of infection in different clinical scenarios and interpret laboratory test results to identify the causative agent of infectious diseases.

CO4. **Compare** and contrast the pathogenesis of different types of microbial infections.

CO5. Critically **evaluate** emerging trends in the field of medical microbiology and their implications for healthcare and propose strategies for preventing the transmission of microbial infections

Catalog Description

The course is designed as an introduction to the clinical importance of understanding the microbial world. It will describe the intricacies and paradigms of microbial interactions with their hosts which ultimately may result in a disease. Moreover the curriculum will also illustrate the prevention techniques and methodologies. 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

Basic Medical Microbiology

UNIT I: Microbial characteristics

Introduction to microbiology and microbes; history & scope of microbiology; morphology, structure,

growth and nutrition of bacteria

UNIT II: Microbial diversity

Microbial taxonomy and evolution of diversity; classification of microorganisms; criteria for classification; classification of bacteria: Pseudomonads, lactic and propionic acid bacteria; endospore forming bacteria; Mycobacteria and Mycoplasma; Pathogenic Bacteria; Pathogenic Fungi; Pathogenic protozoa

UNIT III: Control of Microorganisms

Sterilization, disinfection and antisepsis, physical and chemical methods for control of microorganisms; Antimicrobial agents and their mode of action; Antimicrobial resistance

UNIT IV: Virology

Virus and bacteriophages; general properties of viruses, viral structure, taxonomy of virus, viral replication cultivation and identification of viruses; sub-viral particles — viroids and prions; Pathogenic Virus.

UNIT V: Host Pathogen interaction

Host-pathogen interaction; microbes and nutrient cycles; Microbial communication system; bacterial quorum sensing; Microbial fuel cells

List of Practical:

1. Sterilization, disinfection and safety in microbiological laboratory
2. Preparation of media for cultivation of bacteria.
3. Isolation of bacteria in pure culture by streak plate method
4. Enumeration of bacteria: standard plate count.
5. Study of colony and growth characteristics of some common bacteria:

6. Bacillus, E. coli, Staphylococcus, Streptococcus, etc.

7. Preparation of bacterial smear and Gram's staining

8. Antimicrobial sensitivity test

9. Determination of Minimum Inhibitory Concentration (MIC)

SUGGESTED READING:

1. Alexopoulos CJ, Mims CW, and Blackwell M. (1996). Introductory Mycology. 4 th edition. John and Sons, Inc.

2. Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGraw Hill Book Company.

3. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. (2005). General Microbiology. 5th edition. McMillan.

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

8. Willey JM, Sherwood LM, and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. 7th edition. McGraw Hill Higher Education.

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	2	3	3	3	3	2	2	2	2	2	2
CO2	3	3	3	3	3	3	2	2	2	2	2	2
CO3	3	3	2	3	3	3	3	3	2	2	2	2
CO4	3	3	2	3	3	3	3	3	3	3	3	3
CO5	3	3	2	2	3	3	3	3	3	3	3	3
Avg	3	2.8	2.4	2.8	3	3	2.6	2.6	2.4	2.4	2.4	2.4

1=weakly mapped

2= moderately mapped

3=strongly mapped

CO-PO Mapping for the program B.Sc (Hons) Biotechnology

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
BIT101												
CO1	3	3	3	3	3	3	3	-	-	-	-	-
CO2	3	3	2	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	3	3	-	-	-	-	-
CO4	3	3	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	3	2	3	3	-	-	-	-	-
BIT102												
CO1	3	3	3	3	3	3	3	-	-	-	-	-
CO2	3	3	3	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	3	3	-	-	-	-	-
CO4	3	2	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	3	2	3	3	-	-	-	-	-
BIT105												
CO1	3	2	2	3	3	2	-	-	-	-	-	-
CO2	3	3	2	3	3	3	-	-	-	-	-	-
CO3	3	3	2	3	3	3	-	-	-	-	-	-
CO4	3	2	2	2	2	3	-	-	-	-	-	-
CO5	3	2	2	2	3	3	-	-	-	-	-	-
AEC101												
CO1	3	1	3	-	-	-	-	3	-	3	-	3
CO2	3	1	3	-	-	-	-	3	-	3	-	3
CO3	3	1	3	-	-	-	-	3	-	3	-	3
CO4	3	1	3	-	-	-	-	3	-	3	-	3
BIT107												
CO1	3	1	1	1	1	1	1	1	-	-	-	-
CO2	3	3	1	1	3	1	1	1	-	-	-	-
CO3	3	3	1	1	3	3	1	1	-	-	-	-
CO4	3	3	1	3	1	1	3	1	-	-	-	-
CO5	3	1	3	1	3	1	3	3	-	-	-	-
BIT104												
CO1	3	3	3	3	3	3	3	-	-	-	-	-
CO2	3	3	3	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	2	3	-	-	-	-	-
CO4	3	2	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	3	2	3	3	-	-	-	-	-
BIT106												
CO1	3	3	3	3	3	3	3	-	-	-	-	-

CO2	**3**	**3**	**2**	**3**	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**-**
CO3	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**-**
CO4	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**-**
CO5	**3**	**3**	**3**	**3**	**2**	**3**	**3**	**-**	**-**	**-**	**-**	**-**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
SEC134												
CO1	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**-**
CO2	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**-**
CO3	**3**	**3**	**3**	**3**	**3**	**2**	**3**	**-**	**-**	**-**	**-**	**-**
CO4	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**-**
CO5	**3**	**3**	**3**	**3**	**2**	**3**	**3**	**-**	**-**	**-**	**-**	**-**
AEC102												
CO1	**3**	**1**	**3**	**-**	**-**	**-**	**-**	**3**	**-**	**3**	**-**	**3**
CO2	**3**	**1**	**3**	**-**	**-**	**-**	**-**	**3**	**-**	**3**	**-**	**3**
CO3	**3**	**1**	**3**	**-**	**-**	**-**	**-**	**3**	**-**	**3**	**-**	**3**
CO4	**3**	**1**	**3**	**-**	**-**	**-**	**-**	**3**	**-**	**3**	**-**	**3**
BIT207												
CO1	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**-**
CO2	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**-**
CO3	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**-**
CO4	**3**	**2**	**3**	**3**	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**-**
CO5	**3**	**3**	**3**	**3**	**2**	**3**	**3**	**-**	**-**	**-**	**-**	**-**
BIT202												
CO1	**3**	**1**	**1**	**3**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**
CO2	**3**	**3**	**3**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**
CO3	**3**	**3**	**1**	**1**	**1**	**3**	**1**	**1**	**1**	**1**	**1**	**1**
CO4	**3**	**3**	**1**	**3**	**1**	**3**	**3**	**1**	**1**	**1**	**1**	**1**
CO5	**3**	**3**	**1**	**1**	**1**	**3**	**3**	**1**	**1**	**1**	**1**	**1**
BIT206												
CO1	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**-**
CO2	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**-**
CO3	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**-**	**-**	**-**	**-**	**-**
CO4	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**-**
CO5	**3**	**3**	**3**	**3**	**2**	**2**	**3**	**-**	**-**	**-**	**-**	**-**
SEC135												
CO1	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**-**
CO2	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**-**
CO3	**3**	**3**	**3**	**3**	**3**	**2**	**3**	**-**	**-**	**-**	**-**	**-**

CO4	**3**	**2**	**3**	**3**	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**-**
CO5	**3**	**3**	**3**	**3**	**2**	**3**	**3**	**-**	**-**	**-**	**-**	**-**
PDC201												
CO1	**-**	**3**	**3**	**1**	**3**	**3**	**3**	**3**	**-**	**3**	**-**	**2**
CO2	**-**	**3**	**3**	**1**	**3**	**3**	**3**	**3**	**-**	**3**	**-**	**2**
CO3	**-**	**3**	**3**	**1**	**3**	**3**	**3**	**3**	**-**	**3**	**-**	**2**
CO4	**-**	**3**	**3**	**1**	**3**	**3**	**3**	**3**	**-**	**3**	**-**	**2**
CO5	**-**	**3**	**3**	**1**	**3**	**3**	**3**	**3**	**-**	**3**	**-**	**2**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
BIT208												
CO1	**3**	**3**	**3**	**3**	**2**	**3**	**3**	**3**	**3**	**3**	**2**	**2**
CO2	**3**	**3**	**2**	**3**	**2**	**3**	**2**	**2**	**2**	**2**	**2**	**2**
CO3	**3**	**3**	**2**	**3**	**3**	**3**	**3**	**3**	**2**	**2**	**2**	**3**
CO4	**3**	**2**	**2**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**3**
CO5	**3**	**2**	**2**	**2**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**
BIT209												
CO1	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**-**
CO2	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**-**
CO3	**3**	**3**	**3**	**3**	**3**	**2**	**3**	**-**	**-**	**-**	**-**	**-**
CO4	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**-**
CO5	**3**	**3**	**3**	**3**	**2**	**3**	**3**	**-**	**-**	**-**	**-**	**-**
BIT205												
CO1	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**-**
CO2	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**-**
CO3	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**-**	**-**	**-**	**-**	**-**
CO4	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**-**
CO5	**3**	**3**	**3**	**2**	**2**	**3**	**3**	**-**	**-**	**-**	**-**	**-**
SEC136												
CO1	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**-**
CO2	**3**	**3**	**2**	**3**	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**-**
CO3	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**-**
CO4	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**-**
CO5	**3**	**3**	**3**	**3**	**2**	**3**	**3**	**-**	**-**	**-**	**-**	**-**
PDC202												
CO1	**-**	**3**	**3**	**1**	**3**	**3**	**3**	**3**	**-**	**3**	**-**	**2**
CO2	**-**	**3**	**3**	**1**	**3**	**3**	**3**	**3**	**-**	**3**	**-**	**2**
CO3	**-**	**3**	**3**	**1**	**3**	**3**	**3**	**3**	**-**	**3**	**-**	**2**
CO4	**-**	**3**	**3**	**1**	**3**	**3**	**3**	**3**	**-**	**3**	**-**	**2**

CO5	-	3	3	1	3	3	3	3	-	3	-	2
BIT301												
CO1	3	3	3	3	2	3	3	3	3	3	2	2
CO2	3	3	3	3	2	3	2	2	2	2	2	2
CO3	3	3	2	3	3	3	3	3	2	2	2	3
CO4	3	2	2	3	3	3	3	3	3	3	2	3
CO5	3	2	2	2	3	3	3	3	3	3	3	3
BIT302												
CO1	3	3	3	3	3	3	3	-	-	-	-	-
CO2	3	3	3	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	2	3	-	-	-	-	-
CO4	3	3	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	3	2	3	3	-	-	-	-	-

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
BIT303												
CO1	3	3	3	3	2	3	3	3	3	3	2	2
CO2	3	3	3	3	2	3	2	2	2	2	3	2
CO3	3	3	2	3	3	3	3	3	2	2	3	3
CO4	3	2	2	3	3	3	3	3	3	3	3	3
CO5	3	2	2	2	3	3	3	3	3	3	3	3
SEC137												
CO1	3	3	3	3	3	3	3	-	-	-	-	-
CO2	3	3	2	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	3	2	-	-	-	-	-
CO4	3	3	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	2	2	3	3	-	-	-	-	-
BIT304												
CO1	-	3	3	1	3	3	3	3	3	-	-	3
CO2	-	3	3	1	3	3	3	3	3	-	-	3
CO3	-	3	3	1	3	3	3	3	3	-	-	3
CO4	-	3	3	1	3	3	3	3	3	-	-	3
CO5	-	3	3	1	3	3	3	3	3	-	-	3
PDC301												
CO1	-	3	3	1	3	3	3	3	-	3	-	2
CO2	-	3	3	1	3	3	3	3	-	3	-	2
CO3	-	3	3	1	3	3	3	3	-	3	-	2
CO4	-	3	3	1	3	3	3	3	-	3	-	2
CO5	-	3	3	1	3	3	3	3	-	3	-	2

BIT305												
CO1	-	3	3	1	3	3	3	3	-	3	-	3
CO2	-	3	3	1	3	3	3	3	-	3	-	3
CO3	-	3	3	1	3	3	3	3	-	3	-	3
CO4	-	3	3	1	3	3	3	3	-	3	-	3
CO5	-	3	3	1	3	3	3	3	-	3	-	3
BIT306												
CO1	3	3	3	3	3	3	3	-	-	-	-	-
CO2	3	3	2	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	3	2	-	-	-	-	-
CO4	3	3	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	2	2	3	3	-	-	-	-	-
BIT307												
CO1	3	3	3	3	3	3	3	-	-	-	-	-
CO2	3	3	2	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	3	3	-	-	-	-	-
CO4	3	3	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	2	2	3	3	-	-	-	-	-

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
SEC138												
CO1	3	3	3	3	3	3	3	-	-	-	-	-
CO2	3	3	2	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	3	3	-	-	-	-	-
CO4	3	3	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	3	2	3	3	-	-	-	-	-
BIT308												
CO1	-	3	3	1	3	3	3	3	-	3	-	3
CO2	-	3	3	1	3	3	3	3	-	3	-	3
CO3	-	3	3	1	3	3	3	3	-	3	-	3
CO4	-	3	3	1	3	3	3	3	-	3	-	3
CO5	-	3	3	1	3	3	3	3	-	3	-	3
PDC302												
CO1	-	3	3	1	3	3	3	3	-	3	-	2
CO2	-	3	3	1	3	3	3	3	-	3	-	2
CO3	-	3	3	1	3	3	3	3	-	3	-	2
CO4	-	3	3	1	3	3	3	3	-	3	-	2
CO5	-	3	3	1	3	3	3	3	-	3	-	2
BIT401												

CO1	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**-**
CO2	**3**	**3**	**2**	**3**	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**-**
CO3	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**-**
CO4	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**-**
CO5	**3**	**3**	**3**	**3**	**2**	**3**	**3**	**-**	**-**	**-**	**-**	**-**
BIT402												
CO1	**-**	**3**	**3**	**1**	**3**	**3**	**3**	**3**	**-**	**3**	**-**	**3**
CO2	**-**	**3**	**3**	**1**	**3**	**3**	**3**	**3**	**-**	**3**	**-**	**3**
CO3	**-**	**3**	**3**	**1**	**3**	**3**	**3**	**3**	**-**	**3**	**-**	**3**
CO4	**-**	**3**	**3**	**1**	**3**	**3**	**3**	**3**	**-**	**3**	**-**	**3**
CO5	**-**	**3**	**3**	**1**	**3**	**3**	**3**	**3**	**-**	**3**	**-**	**3**
BIT403												
CO1	**3**	**1**	**1**	**1**	**1**	**3**	**1**	**-**	**-**	**-**	**-**	**-**
CO2	**3**	**3**	**3**	**1**	**3**	**3**	**1**	**-**	**-**	**-**	**-**	**-**
CO3	**3**	**1**	**1**	**1**	**3**	**3**	**1**	**-**	**-**	**-**	**-**	**-**
CO4	**3**	**1**	**1**	**1**	**1**	**1**	**1**	**-**	**-**	**-**	**-**	**-**
CO5	**3**	**1**	**1**	**1**	**1**	**1**	**1**	**-**	**-**	**-**	**-**	**-**
BIT404												
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**	**3**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
BIT405												
CO1	**3**	**3**	**1**	**1**	**1**	**1**	**1**	**3**	**1**	**1**	**1**	**1**
CO2	**3**	**1**	**3**	**1**	**1**	**3**	**1**	**1**	**1**	**1**	**1**	**1**
CO3	**3**	**3**	**1**	**1**	**3**	**1**	**1**	**3**	**1**	**1**	**1**	**1**
CO4	**3**	**3**	**1**	**1**	**1**	**3**	**1**	**3**	**1**	**3**	**1**	**1**
CO5	**1**	**1**	**1**	**1**	**3**	**3**	**3**	**1**	**1**	**3**	**3**	**1**
PDC401												
CO1	**-**	**3**	**3**	**1**	**3**	**3**	**3**	**3**	**-**	**3**	**-**	**2**
CO2	**-**	**3**	**3**	**1**	**3**	**3**	**3**	**3**	**-**	**3**	**-**	**2**
CO3	**-**	**3**	**3**	**1**	**3**	**3**	**3**	**3**	**-**	**3**	**-**	**2**
CO4	**-**	**3**	**3**	**1**	**3**	**3**	**3**	**3**	**-**	**3**	**-**	**2**
CO5	**-**	**3**	**3**	**1**	**3**	**3**	**3**	**3**	**-**	**3**	**-**	**2**
BIT406												
CO1	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**-**

CO2	**3**	**3**	**2**	**3**	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**-**
CO3	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**-**
CO4	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**-**
CO5	**3**	**3**	**3**	**3**	**2**	**3**	**3**	**-**	**-**	**-**	**-**	**-**
BIT407												
CO1	**3**	**2**	**3**	**3**	**2**	**3**	**2**	**2**	**2**	**2**	**2**	**2**
CO2	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**2**	**2**	**2**	**2**	**2**
CO3	**3**	**3**	**2**	**3**	**3**	**3**	**3**	**3**	**2**	**2**	**2**	**3**
CO4	**3**	**3**	**2**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**
CO5	**3**	**3**	**2**	**2**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**
BIT408												
CO1	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**-**
CO2	**3**	**3**	**2**	**3**	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**-**
CO3	**3**	**3**	**3**	**3**	**3**	**2**	**3**	**-**	**-**	**-**	**-**	**-**
CO4	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**-**
CO5	**3**	**3**	**3**	**3**	**2**	**3**	**3**	**-**	**-**	**-**	**-**	**-**
BIT409												
CO1	**-**	**3**	**3**	**1**	**3**	**3**	**3**	**3**	**-**	**3**	**-**	**3**
CO2	**-**	**3**	**3**	**1**	**3**	**3**	**3**	**3**	**-**	**3**	**-**	**3**
CO3	**-**	**3**	**3**	**1**	**3**	**3**	**3**	**3**	**-**	**3**	**-**	**3**
CO4	**-**	**3**	**3**	**1**	**3**	**3**	**3**	**3**	**-**	**3**	**-**	**3**
CO5	**-**	**3**	**3**	**1**	**3**	**3**	**3**	**3**	**-**	**3**	**-**	**3**

PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
2.98	**2.74**	**2.72**	**2.23**	**2.73**	**2.86**	**2.79**	**2.73**	**2.43**	**2.64**	**2.17**	**2.43**