Amrita School of Nanosciences and Molecular Medicine

Program in the

Bachelor of Science (B.Sc.)

Molecular Medicine

(Honours)

2024

Amrita Vishwa Vidyapeetham

B.Sc-(Honours) Molecular Medicine

Curriculum

Course categorization:

Disciplinary/Interdisciplinary major: (DIMa)
Disciplinary/Interdisciplinary minor: (DIMi)
Skill enhancement course: SEC
Ability enhancement course: AEC
Multi-disciplinary course: MDC
Value Added Course: VAC
Summer Internship: SI
Research Project/Dissertation: RP/D

SEMESTER 1

Course Code	Course category	Course Title	L T P	Credit
24ENG105	AEC	English I	3 0 0	3
24CHY106	DIMi	Chemistry-1	2 0 0	2
24MMD101	DIMa	Biochemistry	2 0 0	2
24MMD102	MDC	Cell biology	3 0 0	3
24CSA105	SEC	Computational Skills	2 0 0	2
24MMD182	MDC	Cell biology lab	0 0 6	2
24MMD181	DIMa	Biochemistry lab	0 0 6	2
24CHY186	DIMi	Chemistry lab	0 0 6	2
22ADM101	VAC	Foundations of Indian Heritage	2 0 1	2
		TOTAL		**20**

SEMESTER 2

Course Code	Course category	Course Title	L T P	Credit
24ENG115	AEC	English II	3 0 0	3
24MMD112	DIMa	Molecular biology	2 0 0	2
24MMD111	DIMi	Bio Physics	2 0 0	2
24MMD113	DIMa	Microbiology	2 0 0	2
24MMD184	DIMa	Microbiology lab	0 0 6	2
24MMD183	DIMi	Bio Physics lab	0 0 6	2
24MMD185	DIMi	Molecular biology lab	0 0 6	2
24MMD114	DIMi	Biostatistics	2 0 0	2
22AVP103	VAC	Mastery over Mind (MAOM)	1 0 2	2
22ADM111	VAC	Glimpses of Glorious India	2 0 1	2
		TOTAL		**21**
	Students can exit with **Certificate in molecular medicine (41credits)**			

SEMESTER 3

Course Code	Course category	Course Title	L T P	Credit
24MMD201	DIMa	Developmental Biology	2 0 0	2
24MMD202	DIMa	Immunology	2 0 0	2
24MMD203	DIMa	Molecular methods	2 0 0	2
24MMD281	DIMa	Molecular methods lab	0 0 6	2
24MMD204	DIMi	Computer programming	2 0 0	2
24MMD205	VAC	Ethics and Research Methodology	2 0 0	2
24MMD206	DIMa	Cancer Biology	3 0 0	3
24MMD282	DIMa	Immunology lab	0 0 6	2
23LSK201	SEC	Life Skills **I**	1 0 2	2
		Amrita Value Program I* (need to select from the list)	1 0 0	1
		TOTAL		20

SEMESTER 4

Course Code	Course category	Course Title	L T P	Credit
24MMD211	DIMa	Proteomes in Diseases	2 0 0	2
24MMD212	DIMa	Medical Physiology	2 0 0	2
24MMD213	DIMa	Metabolism in Diseases	2 0 0	2
24MMD214	DIMi	Bioinformatics	2 0 1	3
24MMD215	DIMa	Biotechniques	2 0 0	2
24MMD283	DIMa	Biotechniques lab	0 0 6	2
24IPR211	VAC	Intellectual Property Rights (IPR)	2 0 0	2
24MMD284	DIMa	Cell culture lab	0 0 6	2
23LSK211	SEC	Life Skills **II**	1 0 2	2
		Amrita Value Program II* (need to select from the list)	1 0 0	1
		TOTAL		**20**
	Students can exit with **Diploma in Molecular Medicine (81credits)**			

SEMESTER 5

Course Code	Course category	Course Title		L T P	Credit
24MMD301	MDC	Molecular Genetics and Personalized Medicine		3 0 0	3
24MMD302	DiMa	Principles of Pathology		3 0 0	3
24MMD303	DiMa	Regenerative Medicine		3 0 0	3
24MMD304	DIMa	Artificial Intelligence applications in Medicine		3 0 0	3
23LSK301	SEC	Life Skills **III**		1 0 2	2
	DIMa	Electives (Any Two.)			**6**
		Course Code	Course Ttle	L T P	
		24MMD331	Cell Therapy	3 0 0	
		24MMD332	Post-translational modifications in Biology and Medicine	3 0 0	

		24MMD333	Stem cell Biology	3 0 0	
		TOTAL			**20**

SEMSTER 6

Course Code	Course category	Course Title	L T P	Credit
24MMD311	DIMa	Fundamentals of Pharmacology	2 0 0	2
24MMD312	DIMa	Therapeutics in Medicine	2 0 0	2
24MMD313	SEC	Art of scientific writing	1 0 0	1
24MMD391	RP	Project		6
24MMD314	DIMi	Nanosciences in Biology	3 0 0	3
	DIMa	Electives (Any Two)		6
		Course code: 24MMD341 — Protein structure-function — 3 0 0		
		Course code: 24MMD342 — Biopolymers in Medicine — 3 0 0		
		Course code: 24MMD343 — Molecular Diagnostics — 3 0 0		
		TOTAL		**20**
	Students can exit with **Bachelor's Degree in Molecular Medicine (121 credits)**			

SEMESTER 7

Course Code	Course category	Course	L T P	Credit
24MMD401	DIMa	Microbial diseases and vaccine technology	2 0 0	2
24MMD402	DIMa	Immunotherapy	2 0 0	2
24MMD403	DIMa	Drug Delivery	2 0 0	2
24MMD404	VAC	Biosafety	1 0 0	1
24MMD498	RP/D	Dissertation project 1		13
		TOTAL		**20**

SEMESTER 8

Course Code	Course category	Course	L T P	Credit
24MMD411	DIMa	Gene Editing Technology	2 0 0	2
24MMD499	RP/D	Dissertation project 2		18
		TOTAL		**20**
	Students exit with **Degree in Molecular Medicine with Honors (161 credits)**			

Amrita Values Programmes I and II

Table 3 New names for Amrita Value Programmes for UG programmes			
Course Code	**Title**	**L-T-P**	**Credits**
22ADM201	Strategic Lessons from Mahabharatha	1-0-0	1
22ADM211	Leadership from Ramayana	1-0-0	1
22AVP210	Kerala Mural Art and Painting	1-0-0	1
22AVP201	Amma's Life and Message to the modern world	1-0-0	1
22AVP204	Lessons from the Upanishads	1-0-0	1
22AVP205	Message of the Bhagavad Gita	1-0-0	1
22AVP206	Life and Message of Swami Vivekananda	1-0-0	1
22AVP207	Life and Teachings of Spiritual Masters of India	1-0-0	1
22AVP208	Insights into Indian Arts and Literature	1-0-0	1
22AVP213	Traditional Fine Arts of India	1-0-0	1
22AVP214	Principles of Worship in India	1-0-0	1
22AVP215	Temple Mural Arts in Kerala	1-0-0	1
22AVP218	Insights into Indian Classical Music	1-0-0	1
22AVP219	Insights into Traditional Indian Painting	1-0-0	1
22AVP220	Insights into Indian Classical Dance	1-0-0	1
22AVP221	Indian Martial Arts and Self Defense	1-0-0	1
22AVP209	Yoga and Meditation	1-0-0	1

SEMESTER 1

24ENG105 English I 3 0 0 3

Unit-1 (20 lectures)

Adopting the platform of English for the expression of science. Understanding the English language for constructing meaningful sentences. Basics of English, Writing structured sentences, Articulating for clear and efficient delivery of concepts. Includes a) Ability to speak and write clearly in English b) Ability to listen to and follow scientific viewpoints and engage with audience. Develop strategies and skills to enhance their ability to read. Reading science related books and comprehension. Articulated presentation on books and scientific articles in layman's language. Writing exercise should contain sentence structure correctness, comprehending the concepts effectively. Developing capabilities to communicate science in layman's language through seminars.

Unit-2 (25 lectures)

Skill development: Critical Thinking: a) Ability to substantiate critical readings of scientific texts in order to persuade others. b) Ability to place scientific statements and themes in contexts and also evaluate them in terms of generic conventions. Problem Solving: a) Ability to closely observe the situation, and apply lateral thinking and analytical skills. Analytical Reasoning: a) Ability to evaluate the strengths and weaknesses in scholarly texts spotting flaws in their arguments. b) Ability to use critics and theorists to create a framework and to substantiate one's argument in one's reading of scientific texts.

Suggested Reading

1.H.G. Wells. ***A short History of the world***. Penguin Classics. U.K 2006. (A book recommended by Einstein).
2. Walter Isaacson. ***Einstein: His Life and Universe,*** Published by Simon & Schuster 2007.
3. Alexander Graham Bell ***How to Improve the Race***
4. Linus Pauling ***A Lifelong Quest for Peace*** Editor: Richard L. Gage 1990
5. Stephan Hawkings ***On the Shoulders of Giants*** by Running Press 2002Preamble

Evaluation Pattern: 50+50 = 100

Internal Assessment – 50%		
Periodical 1	Exam	20%
Periodical 2	Exam	20%
Continuous Assessment	Assignment/Test/Quiz	10%
		50%
End Semester Examination- 50%		
Theory Exam	50%	
		50%
	Total	**100%**

24CHY106 Chemistry-1 2 0 0 2

Preamble

This course deals with the basic introduction to organic chemistry emphasizing its significance in biology and its integral nature with biochemistry, the chemistry of living organisms. Focusing primarily on the basic principles to understand the structure and reactivity of organic molecules, emphasis is on substitution, elimination, alkanes, alkenes, alkynes and their related reactions, understanding of different reaction mechanism and methods used for organic compound preparation.

Unit-1 (**2 lectures)**

Physical Effects, Electronic Displacements: Inductive Effect, Electromeric Effect, Resonance and Hyperconjugation.

Unit-2 (**3 lectures)**

Cleavage of Bonds: Homolysis and Heterolysis.Structure, shape and reactivity of organic molecules: Nucleophiles and electrophiles.

Unit-3 (**5 lectures)**

Reactive Intermediates: Carbocations, Carbanions and free radicals. Strength of organic acids and bases: Comparative study with emphasis on factors affecting pK values.

Unit-4 (**2 lectures)**

Aromaticity: Benzenoids and Hückel's rule. Aliphatic Hydrocarbons: Functional group approach for the following reactions (preparations and reactions) to be studied in context to their structure.

Unit-5 (**5 lectures)**

Alkanes: Preparation: Catalytic hydrogenation, Wurtz reaction, Kolbe's synthesis and, from Grignard reagent. Reactions: Free radical Substitution: Halogenation.

Unit-6 (**9 lectures)**

Alkenes: Preparation: Elimination reactions: Dehydration of alcohols and dehydrohalogenation of alkyl halides (Saytzeff's rule); cis alkenes (Partial catalytic hydrogenation) and trans alkenes (Birch reduction). Reactions: cis-addition (alk. $KMnO_4$) and trans-addition (bromine), Addition of HX (Markownikoff's and anti-Markownikoff's addition), Hydration, Ozonolysis, oxymercuration-demercuration, Hydroboration-oxidation.

Unit-7 (**4 lectures)**

Alkynes: Preparation: Acetylene from CaC_2 and conversion into higher alkynes; by dehalogenation of tetra halides and dehydrohalogenation of vicinal-dihalides.Reactions: Formation of metal acetylides, addition of bromine and alkaline $KMnO_4$, ozonolysis and oxidation with hot alk. $KMnO_4$.

Text books:

(1) Graham Solomons, T.W., Fryhle, C.B. & Snyder, S.A. Organic Chemistry, John Wiley & Sons (2014);

(2) Sykes, P. A Guidebook to Mechanism in Organic Chemistry, Orient Longman, NewDelhi (1988);

(3) Finar, I.L. Organic Chemistry (Vol. I & II), E.L.B.S; Morrison, R.T. & Boyd, R.N. Organic Chemistry, Pearson, 2010;

(4) Bahl, A. &Bahl, B.S. Advanced Organic Chemistry, S. Chand, 2010.

Course Outcome

CO1 To understand the basic concepts of organic reaction mechanism and its intermediates.

CO2 To learn the concepts of aromaticity, non-aromaticity and antiaromaticity

CO3 To learn the preparation and specific reactions of alkanes

CO4 To learn the preparation and specific reactions of alkenes

CO5 To learn the preparation and specific reactions of alkenes

Program Outcome

PO1: Bioscience Knowledge

PO2: Problem Analysis

PO3: Design/Development of Solutions

PO4: Conduct Investigations of complex problems

PO5: Modern tools usage

PO6: Bioscientist and Society

PO7: Environment and Sustainability

PO8: Ethics

PO9: Individual & Team work

PO10: Communication

PO11: Project management & Finance

PO12: Lifelong learning

- / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	-	3	-	1	-	-	-	-	-	-	1	1
CO 2	-	2	3	1	-	-	-	-	-	-	1	-
CO 3	-	1	3	1	-	-	-	-	-	-	1	-
CO 4	-	1	3	1	-	-	-	-	-	-	1	-
CO 5	-	1	3	1	-	-	-	-	-	-	1	-

Program Specific Outcomes (PSO)

PSO 1 - Chemical and physical basis of biology

PSO 2 - Computational science in biology and medicine

PSO 3 - Biochemical and physiological complexity in biology and medicine

PSO 4 - Molecular technology in biology and medicine

PSO 5 - Cell based approaches in diagnosis and therapy

PSO 6 - Microorganisms in medicine

PSO 7 - Nanoscale entities and its significance in medicine
PSO 8 - Tissue architecture engineering in medicine
PSO 9 - Compounds as drugs and its efficacy
PSO 10 - Bioinformatics and artificial intelligence in medicine
PSO 11 –Technology in personalizing medicine
PSO 12 – Protein structural complexity in medicine
PSO 13 – Projecting science and medicine to public

- CO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12	PSO13
CO 1	1	-	-	--	-	-	-	-	-	-	-	-	1
CO 2	1	-	-	--	-	-	-	-	-	-	-	-	1
CO 3	1	-	-	-	-	-	-	-	-	-	-	-	1
CO 4	1	-	-	-	-	-	-	-	-	-	-	-	1
CO 5	1	-	-	-	-	-	-	-	-	-	-	-	1

Evaluation Pattern: 50+50 = 100

Internal Assessment – 50%		
Periodical 1	Exam	20%
Periodical 2	Exam	20%
Continuous Assessment	Assignment/Test/Quiz	10%
		50%
End Semester Examination- 50%		
Theory Exam	50%	
		50%
	Total	**100%**

24MMD101 Biochemistry 2 0 0 2

Preamble

Biochemistry is the branch of science that explores the chemical processes within and related to living organisms. Biochemistry -1 deals with the basic introduction, focusing primarily on the amino acids and proteins. The course will make the students understand the structure of amino acids, proteins, role of proteins in different biochemical context etc.

Unit-1 (6 lectures)

Foundations of biochemistry, cellular composition; chemical foundations; carbon compounds as functional groups in biomolecules; macromolecular constituents of cell; Conformation and configuration of macromolecules; Physical foundations, dynamic steady state in living organism, flow of electrons; Energy coupling link reactions

Unit-2 **(9 lectures)**

Composition of Amino acids; different types of amino acids; Amino acids and their properties - hydrophobic, polar and charged; Peptide bond; Amino acids as source for energy production; Amino acids are derivatives for various metabolites.

Unit-3 **(9 lectures)**

Protein as a biopolymer; covalent structure of proteins; Primary sequence of proteins; Three-dimensional structure of proteins; Protein denaturation and folding.

Unit-4 **(6 lectures)**

Role of proteins in different biochemical contexts – Enzymes, Receptors, Signaling molecules, Carriers of different cargos and elements. Fundamentals of signaling mechanisms.

Text Books:

1. 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:10:14641-0962-1.
2. Biochemistry (2010) 4th ed., Garret, R. H. and Grisham, C.M., Cengage Learning (Boston), ISBN-13:978-0-495-11464-2.
3. Principles of Biochemistry (2008) 3rd ed., Voet, D.J., Voet, J.G. and Pratt, C.W., John Wiley & Sons, Inc. (New York), ISBN:13: 978-0470-23396-2

Course outcome (CO)

CO1: Understand the basic foundations of biochemistry
CO2: Understand the transformation of energy and matter in steady state maintenance of living organism
CO3: Understand the basic structure of amino acids along with their classification
CO4: Basic understanding of different levels of protein structure and folding
CO5: Significance of enzymes, receptors, and signaling molecules in living organisms

Program outcome (PO)

PO1: Bioscience Knowledge
PO2: Problem Analysis
PO3: Design/Development of Solutions
PO4: Conduct Investigations of complex problems
PO5: Modern tools usage
PO6: Bioscientist and Society
PO7: Environment and Sustainability
PO8: Ethics
PO9: Individual & Team work
PO10: Communication
PO11: Project management & Finance
PO12: Lifelong learning

3 = High Affinity, 2 = Medium Affinity, 1 = Low Affinity, - = No Affinity

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	1	-	-	-	-	2	-	-	-	-	1
CO 2	3	1	-	-	-	-	3	-	-	-	-	1
CO 3	3	1	-	-	-	-	-	-	-	-	-	1
CO 4	3	2	3	-	2	-	-	-	-	-	-	1
CO 5	3	2	3	3	3	2	-	-	-	-	-	1

Program Specific Outcome (PSO)

PSO 1 - Chemical and physical basis of biology
PSO 2 - Computational science in biology and medicine
PSO 3 - Biochemical and physiological complexity in biology and medicine
PSO 4 - Molecular technology in biology and medicine
PSO 5 - Cell based approaches in diagnosis and therapy
PSO 6 - Microorganisms in medicine
PSO 7 - Nanoscale entities and its significance in medicine
PSO 8 - Tissue architecture engineering in medicine
PSO 9 - Compounds as drugs and its efficacy
PSO 10 - Bioinformatics and artificial intelligence in medicine
PSO 11 – Technology in personalizing medicine
PSO 12 – Protein structural complexity in medicine
PSO 13 – Projecting science and medicine to public

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12	PSO13
CO 1	3	-	1	-	-	-	-	-	-	-	-	-	-
CO 2	3	-	1	-	-	-	-	-	-	-	-	-	-
CO 3	3	-	2	-	-	-	-	-	-	-	-	-	-
CO 4	3	3	3	-	-	-	-	-	-	-	-	3	2
CO 5	3	2	3	1	2	-	-	-	2	2	-	3	2

Evaluation Pattern: 50+50 = 100

Internal Assessment – 50%		
Periodical 1	Exam	20%
Periodical 2	Exam	20%
Continuous Assessment	Assignment/Test/Quiz	10%
		50%
End Semester Examination- 50%		
Theory Exam	50%	
		50%
	Total	**100%**

24MMD102 Cell Biology 3 0 0 3

Preamble

This course is to introduce the cell as a basic unit of life to the students of molecular medicine. It will elaborate the basic structure of the eukaryotic cells and the differences between the prokaryotic and eukaryotic cells. Further, the course will make the students understand the basic organization of eukaryotic cells, the endomembrane system, structure and functions of cell organelle, intracellular transport, the cytoskeleton, communication of cells with its surroundings and other cells and how cells reproduce through cell division. The course is devised in such a manner that the students will get a basic idea on the cellular bases of diseases.

Unit 1 (6 lectures)

The Cell: Introduction to cell theory, Comparison of a generalized pro- and eukaryotic cell

Methods in Cell Biology: Elementary idea of microscopy and cell fractionation.

Unit 2 (8 lectures)

Organization of cell: Extranuclear (Elementary knowledge of structure and function of plasma membrane; Introduction to endomembrane system (endoplasmic reticulum, Golgi complex, lysosome, peroxisome; Introduction to cytoskeleton; Structure and functions of mitochondria); Nuclear (Nuclear envelope, nucleolus and biogenesis of ribosome).

Unit 3 (5 lectures)

Membrane transport: Principles of membrane transport, Channel proteins, carrier proteins**;** Passive and active transport.

Unit 4 (6 lectures)

Intracellular transport and protein sorting; Signal peptides and protein targeting**;** Entry and passage of proteins through endoplasmic reticulum**;** Processing and sorting of proteins in Golgi Apparatus**;** Endosomes and lysosomes**;** Nuclear pore complex and nuclear transport**.**

Unit 5 (5 lectures)

Mitochondria and energy transfer: Electron transport and oxidative phosphorylation.

Unit 6 (5 lectures)

Cytoskeleton: Organisation and functions**;** Microtubular organelles.

Unit 7 (5 lectures)

Cell-cell communication: Cell junctions; Cell adhesion and extracellular matrix; General principles of cell signaling.

Unit 8 (5 lectures)

Cell reproduction: Basic features of cell cycle**;** Mitosis, mitotic spindle and chromosome movement**;** Process and phases of meiosis and its significance**;** Genetic regulation of cell cycle.

Text Books:

(1) Karp: Cell and Molecular Biology (2008, John Wiley)
(2) Lodish et al: Molecular Cell Biology (2008, Freeman)

Course Outcome

CO1 To understand cell as the basic unit of life and the differences between eukaryotic and prokaryotic cells

CO2 To learn the basic organization of cells, plasma membrane, cell organelles and the endomembrane system

CO3 To know the principles governing membrane transport, different types of transport systems, intracellular trafficking and protein sorting

CO4 To learn about mitochondria and energy transfer, cytoskeleton, communication between cells and cell to cell as well as cell to matrix junctions

CO5 To learn how cells reproduce through cell cycles, mitosis and meiosis, contribution of mitotic spindle in chromosome movement and genetic regulation of cell cycle

Program Outcome

PO1: Bioscience Knowledge
PO2: Problem Analysis
PO3: Design/Development of Solutions
PO4: Conduct Investigations of complex problems
PO5: Modern tools usage
PO6: Bioscientist and Society
PO7: Environment and Sustainability
PO8: Ethics
PO9: Individual & Team work
PO10: Communication
PO11: Project management & Finance
PO12: Lifelong learning

3 = High Affinity, 2 = Medium Affinity, 1 = Low Affinity, - = No Affinity

c C O	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	1	2	2	2	3	2	-	-	-	-	3
CO 2	3	1	2	2	2	3	2	-	-	-	-	3
CO 3	3	1	2	2	2	3	2	-	-	-	-	3
CO 4	3	1	2	2	2	3	2	-	-	-	-	3

CO 5	3	1	2	2	2	3	2	-	-	-	-	3

Program Specific Outcomes. (PSO)

PSO 1 - Chemical and physical basis of biology
PSO 2 - Computational science in biology and medicine
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- / CO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12	PSO13
CO 1	3	1	3	2	3	-	1	2	1	-	2	-	3
CO 2	3	1	3	2	3	-	1	2	1	-	2	-	3
CO 3	3	1	3	2	3	-	1	2	3	-	2	-	3
CO 4	3	1	3	2	3	-	1	2	1	-	2	-	3
CO 5	3	1	3	2	3	-	1	2	1	-	2	-	3

Evaluation Pattern: 50+50 = 100

Internal Assessment – 50%		
Periodical 1	Exam	20%
Periodical 2	Exam	20%
Continuous Assessment	Assignment/Test/Quiz	10%
		50%
End Semester Examination- 50%		
Theory Exam	50%	
		50%
	Total	**100%**

24CSA105 Computational Skills 2 0 0 2

Preamble
Understanding computer and computer related skills is a must and the interface between biology and computer is intertwined. The course provides an introduction to beginners on different aspects of computer knowledge for tackling biology related aspect.

Unit-1 (10 lectures)
Introduction to Computers: Characteristics of Computers, Uses of computers, Types and generations of Computers, Basic Computer Organization Units of a computer, CPU, ALU, memory hierarchy, registers, I/O devices User Interface with the Operating System, System

Unit-2 (6 lectures)
Binary representation of integers and real numbers, 1's Complement, 2's Complement, Addition and subtraction of binary numbers, BCD, ASCII, Unicode

Unit-3 (8 lectures)
Networks terminology: Types of networks, router, switch, server client architecture Multimedia, Stepwise methodology of developing an algorithm, developing macros in spreadsheet; General Awareness IT Act, System Security (virus/firewall etc.)

Unit-4 (6 lectures)
Basics of machine learning and artificial intelligence, biological and medical case studies of machine learning and AI.

Text Books
[1] V Rajaraman, Fundamentals of Computers, Fourth Edition, PHI.
[2] Anita Goel, Fundamentals of Computers; Forthcoming title in Pearson Education.
[3] Introduction to Machine Learning, By Ethem Alpayd in, 4th Edition, MIT press, 2020

Course Outcomes (CO)
CO1: Basic understanding of computers, evolution, it's internal and external organization and operating system.
CO2 : Knowledge of computer data representation in different forms.
CO3 : Basic computer networks and its architecture details.
CO4 : Understanding the fundamentals of computer algorithms, IT awareness and security issues**.** machine learning and artificial intelligence

Program Outcomes (PO)
PO1: Bioscience Knowledge
PO2: Problem Analysis
PO3: Design/Development of Solutions
PO4: Conduct Investigations of complex problems
PO5: Modern tools usage
PO6: Bioscientist and Society
PO7: Environment and Sustainability
PO8: Ethics

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c C O	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	1	1	3	1	1	1	-	-	1	-	-	2
CO 2	1	2	3	1	2	1	-	-	1	-	-	2
CO 3	1	2	3	1	2	1	-	-	1	-	-	2
CO 4	1	1	3	1	2	1	-	-	1	-	-	2

Program Specific Outcomes (PSO)
PSO 1 - Chemical and physical basis of biology
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- C O	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12	PSO13
CO 1	1	2	-	-	-	-	-	-	-	1	1	-	-
CO 2	1	2	-	-	-	-	-	-	-	1	1	-	-
CO 3	1	2	-	-	-	-	-	-	-	2	-	-	-
CO 4	1	2	-	-	-	-	-	-	-	1	-	-	-

Evaluation Pattern: 50+50 = 100

Internal Assessment – 50%		
Periodical 1	Exam	20%
Periodical 2	Exam	20%
Continuous Assessment	Assignment/Test/Quiz	10%
		50%
End Semester Examination- 50%		
Theory Exam	50%	
		50%

Total	**100%**

24MMD182 Cell Biology Lab 0 0 6 2

This lab is aimed to demonstrate use of microscopy in the study of cells, the morphology and internal organization of various types of cells, permeability of plasma membrane and different phases in mitosis and meiosis.

(1) Drawing of ultrastructure of cell and different organelles (from photographs provided).
(2) Familiarization with the student's light microscope and stereobinocular microscope.
(3) Application of centrifuge – separation of sperm from other testicular cells by low speed centrifugation.
(4) Diversity of eukaryotic cells – methylene blue staining of buccal epithelium, sperm, neurons, striated muscle cells; Leishman staining of mammalian blood cells.
(5) Permeability of plasma membrane – effect of isotonic, hypotonic and hypertonic solutions on mammalian RBC.
(6) Staining of nucleolus (RNA) and chromatin (DNA) with methyl green-pyronin Y.
(7) Staining of mitochondria with Janus green in buccal epithelium.
(8) Mitosis using somatic cells.
(9) Meiosis using germ cells.

Text books:

(1) Karp: Cell and Molecular Biology (2008, John Wiley).
(2) Lodish et al: Molecular Cell Biology (2008, Freeman).

Course Outcomes

CO1 To learn about light microscope in deciphering the basic structure of cells
CO2 To learn how to use a centrifuge to separate different types of cells
CO3 To understand the ultrastructure of cells and observe the differences between various types of eukaryotic cells through different staining techniques
CO4 To observe the effect of isotonic, hypotonic and hypertonic solutions on membrane permeability
CO5 To differentiate mitotic and meiotic cells through observation under microscope

Program Outcome

PO1: Bioscience Knowledge
PO2: Problem Analysis
PO3: Design/Development of Solutions
PO4: Conduct Investigations of complex problems
PO5: Modern tools usage
PO6: Bioscientist and Society
PO7: Environment and Sustainability
PO8: Ethics
PO9: Individual & Team work
PO10: Communication
PO11: Project management & Finance
PO12: Lifelong learning

c C O	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	1	2	2	2	3	2	-	-	-	-	3
CO 2	3	1	2	2	2	3	2	-	-	-	-	3
CO 3	3	1	2	2	2	3	2	-	-	-	-	3
CO 4	3	1	2	2	2	3	2	-	-	-	-	3
CO 5	3	1	2	2	2	3	2	-	-	-	-	3

3 = High Affinity, 2 = Medium Affinity, 1 = Low Affinity, - = No Affinity

Program Specific Outcomes. (PSO)

PSO 1 - Chemical and physical basis of biology
PSO 2 - Computational science in biology and medicine
PSO 3 - Biochemical and physiological complexity in biology and medicine
PSO 4 - Molecular technology in biology and medicine
PSO 5 - Cell based approaches in diagnosis and therapy
PSO 6 - Microorganisms in medicine
PSO 7 - Nanoscale entities and its significance in medicine
PSO 8 - Tissue architecture engineering in medicine
PSO 9 - Compounds as drugs and its efficacy
PSO 10 - Bioinformatics and artificial intelligence in medicine
PSO 11 –Technology in personalizing medicine
PSO 12 – Protein structural complexity in medicine
PSO 13 – Projecting science and medicine to public

- C O	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8	PSO 9	PSO10	PSO11	PSO12	PSO 13
CO 1	3	1	3	2	3	-	1	2	1	-	2	-	3
CO 2	3	1	3	2	3	-	1	2	1	-	2	-	3

CO 3	3	1	3	2	3	-	1	2	3	-	2	-	3
CO 4	3	1	3	2	3	-	1	2	1	-	2	-	3
CO 5	3	1	3	2	3	-	1	2	1	-	2	-	3

Evaluation Pattern: 30+70 = 100

Internal Assessment – 30%		
Records	Evaluation	30%
		30%
End Semester Examination- 50%		
Practical	Exam	60%
Assessment	Viva	10%
		70%
	Total	**100%**

24MMD181 Biochemistry Lab 0 0 6 2

(1) Preparation of buffers;
(2) Determination of pKa value;
(3) Estimation of proteins by Biuret method;
(4) Estimation of proteins by Lowry's method;
(5) Separation of sugars by Thin Layer chromatography,
(6) Effect of pH and temperature on the activity of an enzyme,
(7) Progress curve of an enzyme.

Text book:

(1) Biochemistry in the Lab A Manual for Undergraduates by Benjamin F. Lasseter.

Course Outcomes (CO)

CO1 Develop basic understanding of chemical interactions helping in stabilizing the biological components.
CO2 Understanding the principles of protein analysis.
CO3 Exposing the students to how principles of biochemistry are translated to different techniques of protein analysis.
CO4 Understanding how the environment around enzymes influencing its activity and how and how it can be studied.
CO5 Enable students to realize the significance proteins as enzymes and its evaluation.

Program Outcomes (PO)

PO1: Bioscience Knowledge
PO2: Problem Analysis
PO3: Design/Development of Solutions
PO4: Conduct Investigations of complex problems
PO5: Modern tools usage

PO6: Bioscientist and Society
PO7: Environment and Sustainability
PO8: Ethics
PO9: Individual & Team work
PO10: Communication
PO11: Project management & Finance
PO12: Lifelong learning

3 = High Affinity, 2 = Medium Affinity, 1 = Low Affinity, - = No Affinity

c C O	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	1	3	1	-	-	-	-	1	-	-	2
CO 2	3	1	3	1	-	1	-	-	-	-	-	2
CO 3	3	2	3	1	2	1	-	-	1	-	-	2
CO 4	3	1	1	1	-	1	-	-	1	-	-	2
CO 5	3	1	-	2	-	1	-	-	-	-	-	2

Program Specific Outcomes (PSO)
PSO 1 - Chemical and physical basis of biology
PSO 2 -Computational science in biology and medicine
PSO 3 -Biochemical and physiological complexity in biology and medicine
PSO 4 -Molecular technology in biology and medicine
PSO 5 – Cell based approaches in diagnosis and therapy
PSO 6 -Microorganisms in medicine
PSO 7 -Nanoscale entities and its significance in medicine
PSO 8 - Tissue architecture engineering in medicine
PSO 9 - Compounds as drugs and its efficacy
PSO 10 - Bioinformatics and artificial intelligence in medicine
PSO 11 –Technology in personalizing medicine
PSO 12 – Protein structural complexity in medicine
PSO 13 – Projecting science and medicine to public

- C O	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12	PSO13
CO 1	3	-	-	1	-	-	-	-	-	-	-	-	2
CO 2	2	-	1	1	-	-	-	-	-	-	1	-	2
CO 3	1	-	1	3	-	-	-	-	-	2	2	-	2
CO 4	2	-	1	1	-	-	-	-	-	-	-	1	1
CO 5	1	-	2	1	-	-	-	-	-	-	-	1	2

Evaluation Pattern: 30+70 = 100

Internal Assessment – 30%		
Records	Evaluation	30%
		30%
End Semester Examination- 50%		
Practical	Exam	60%
Assessment	Viva	10%
		70%
	Total	**100%**

24CHY186 Chemistry Lab – 1 0 0 6 2

Reactions to determine specific functional groups

(1) Aldehydes
(2) Alcohols
(3) Amines
(4) Amides
(5) Ketones
(6) Acids
(7) Presence of nitrogen

Text Books:

(1) Practical organic chemistry by F. G. Mann and B. C. Saunders.
(2) A text-book of practical organic chemistry including qualitative organic analysis by A. I. Vogel.

Course Outcome

CO1 To understand qualitative analysis of organic compounds.
CO2 Learn the identification of organic functional by preliminary tests.
CO3 Learn specific reactions of carboxyl and alcohol functional group.
CO4 Learn specific reactions of ketone and aldehyde functional group.
CO5 Learns specific reactions of amine and amide functional group.

Program Outcome

PO1: Bioscience Knowledge
PO2: Problem Analysis
PO3: Design/Development of Solutions
PO4: Conduct Investigations of complex problems
PO5: Modern tools usage
PO6: Bioscientist and Society
PO7: Environment and Sustainability
PO8: Ethics
PO9: Individual & Team work
PO10: Communication
PO11: Project management & Finance
PO12: Lifelong learning

Program Specific Outcomes. (PSO)

c C O	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	-	1	2	1	1	-	-	-	-	-	2	1
CO 2	-	1	2	1	1	-	-	-	-	-	2	1
CO 3	-	1	2	1	1	-	-	-	-	-	2	1
CO 4	-	1	2	1	1	-	-	-	-	-	2	1
CO 5	-	1	2	1	1	-	-	-	-	-	2	1

PSO 1 - Chemical and physical basis of biology
PSO 2 - Computational science in biology and medicine
PSO 3 - Biochemical and physiological complexity in biology and medicine
PSO 4 - Molecular technology in biology and medicine
PSO 5 - Cell based approaches in diagnosis and therapy
PSO 6 - Microorganisms in medicine
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PSO 13 – Projecting science and medicine to public

- C O	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12	PSO13
CO 1	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 4	-	-	-	-	-	-	-	-	-	-	-	-	-

CO 5	-	-	-	-	-	-	-	-	-	-	-	-	-

Evaluation Pattern: 30+70 = 100

Internal Assessment – 30%		
Records	Evaluation	30%
		30%
End Semester Examination- 50%		
Practical	Exam	60%
Assessment	Viva	10%
		70%
	Total	**100%**

22ADM101 Foundations of Indian Heritage 2-0- 1-2 (P/F)

Course Objective

- The course is designed as an introductory guide to the variegated dimensions of Indian cultural and intellectual heritage, to enable students to obtain a synoptic view of the grandiose achievements of India in diverse fields.
- It will equip students with concrete knowledge of their country and the mind of its people and instill in them some of the great values of Indian culture

Course Outcomes:

CO1: Be introduced to the cultural ethos of Amrita Vishwa Vidyapeetham, and Amma's life and vision of holistic education.
CO2: Understand the foundational concepts of Indian civilization like puruśārtha-s, law of karma and varṇāśrama.
CO3: Gain a positive appreciation of Indian culture, traditions, customs and practices.
CO4: Imbibe spirit of living in harmony with nature, and principles and practices of Yoga.
CO5: Get guidelines for healthy and happy living from the great spiritual masters

Unit 1

Introduction to Indian Culture - Introduction to Amma's life and Teachings - Symbols of Indian Culture.

Unit 2

Science and Technology in Ancient India - Education in Ancient India - Goals of Life – Purusharthas - Introduction to Vedanta and Bhagavad Gita.

Unit 3

Introduction to Yoga - Nature and Indian Culture - Values from Indian History - Life and work of Great Seers of India.

TEXTBOOKS:

1. The Glory of India (in-house publication)
2. The Mother of Sweet Bliss, (Amma's Life & Teachings)

Evaluation Pattern:

Components	Weightage
Mid Term Exam (Internal)	30 marks
Quizzes and Assignments (Internal)	20 marks
End Semester Exam (External)	50 marks

SEMESTER 2

24ENG115 English II 3 0 0 3

Unit-1 (20 lectures)

Research-Related Skills: a) Ability to problematize; to formulate hypothesis and research questions, and to identify and consult relevant sources to find answers. b) Ability to plan and write a research paper. Teamwork and Time Management: a) Ability to participate constructively in class room discussions. b) Ability to contribute to group work. c) Ability to meet a deadline. Scientific Reasoning: a) Ability to analyze texts, evaluating ideas and scientific strategies. b) Ability to formulate logical and convincing arguments. Reflective Thinking: Ability to locate oneself and see the influence of location—regional, national, global— on critical thinking.

Unit-2 (25 lectures)

Self-Directing Learning: a) Ability to work independently in terms of organizing laboratory, and critically analyzing research literature. b) Ability to postulate hypothesis, questions and search for answers. Digital Literacy: a) Ability to use digital sources, and apply various platforms to convey and explain concepts of biochemistry. Multicultural Competence: a) Ability to engage with and understand cultures of various nations and respect and transcend differences.

Leadership Readiness: Ability to lead group discussions, to formulate questions related to scientific and social issues. Life-long Learning: a) Ability to retain and build on critical thinking skills, and use them to update scientific knowledge and apply them in day to day basis of learning.

Suggested Reading

1. Roger Holloway. C. V. ***Raman: 51 Success Facts*** - ***Everything You Need to Know About C. V. Raman***, Published by Lightning Source, 2014.
2. Carl Edward Sagan. ***Cosmos*** by Random House Publishers
3. Alexander Graham Bell ***How to Improve the Race*** or
4. Linus Pauling ***A Lifelong Quest for Peace.*** Editor: Richard L. Gage 1990
5. Stephan Hawkings ***On the Shoulders of Giants*** by Running Press 2002

24MMD112 Molecular Biology 2 0 0 2

Preamble

Molecular Biology encompasses the basic study and understanding of the execution of central dogma.

Unit 1 **(6 Lectures)**

Historical and conceptual background: Discovery of DNA as genetic material, Griffith's experiment, Hershy and Chase experiment, Chargaff's rule and DNA double helix. Genome organization: Structure of DNA, Types of DNA, Organization of Chromatin. Concept of Gene, Introns and Exons genome, chromosome. Structure of RNA and Protein. Nature and Properties of Genetic Code.

Unit 2 **(6 Lectures)**

The replication of DNA: Chemistry of DNA synthesis, Mechanism of Replication: Initiation, Elongation, synthesis of Leading and lagging strands, Termination. Enzymes and proteins involved in DNA replication.

Unit 3 **(5 Lectures)**

The mutability and Repair of DNA: Replication Errors, DNA Damage and their repair: mismatch repair, SOS response, Excision Repair, Photoreactivation. Types of mutations.

Unit 4 **(6 Lectures)**

Information Transfer –I: Mechanism of Transcription: Basic transcription apparatus, Initiation, elongation and termination of transcription, Transcription of mRNA, tRNA and rRNA, types of RNA polymerases, transcription factors, Inhibitors of transcription-rifampicin and α-amanitin. Post-Transcriptional Modifications: Split Genes, Concept of introns and exons, RNA splicing, Spliceosomes, Gene regulation.

Unit 5 **(7 Lectures)**

Mechanism of Translation: Features of genetic code and exceptions in some systems, Ribosome structure- rRNA and proteins, Charging of tRNA, aminoacyl tRNA synthetases, Proteins involved in initiation, elongation and termination of polypeptides, Fidelity of translation, Inhibitors of protein synthesis – tetracyclins, aminoglycosides, chloramphenicol and aminoglycosides.

Text Books:

(1) Friefelder, D. Molecular Biology.2nd Edition.Narosa Book Distributors Pvt. Ltd. 2008.

(2) Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K. and Walter, P. Molecular Biology of the Cell. 5th Edition. Garland Science. 2007.

(3) Molecular Biology of the Gene, 6th edition (2007), Watson, J. D., Baker T. A., Bell, S. P., Gann, A., Levine, M., and Losick, R; Benjamin Cummings Publishers, ISBN-13: 978- 0805395921.

(4) The Cell: A Molecular Approach, 6th edition (2013), Cooper and Hausman; Sinauer Associates, Inc. ISBN-13: 978-1605351551.

Course Outcome

CO1 Understand the structure and function of DNA, RNA, proteins and genome organization in prokaryotes and eukaryotes. Understand the concept of Gene and the gene architecture

CO2 Understand the role of different enzymes and the molecular events in the DNA replication.

CO3 Understand the DNA-repair systems and consequences of different types of mutations

CO4 Understand the key molecular events of transcription, post-transcriptional processing of eukaryotic transcripts. Understand the basics of gene regulation.

CO5 Understand the molecular events of translation and post translational modification.

Program Outcome
PO1: Bioscience Knowledge
PO2: Problem Analysis
PO3: Design/Development of Solutions
PO4: Conduct Investigations of complex problems
PO5: Modern tools usage
PO6: Bioscientist and Society
PO7: Environment and Sustainability
PO8: Ethics
PO9: Individual & Team work
PO10: Communication
PO11: Project management & Finance
PO12: Lifelong learning

c / C O	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	1	-	-	-	-	-	-	-	-	-	2
CO 2	3	1	-	-	-	-	-	-	-	-	-	2
CO 3	3	2	-	-	-	-	-	-	-	-	-	2
CO 4	3	2	-	-	-	-	-	-	-	-	-	2
CO 5	3	2	-	-	-	-	-	-	-	-	-	2

Program Specific Outcomes. (PSO)
PSO 1 - Chemical and physical basis of biology
PSO 2 - Computational science in biology and medicine
PSO 3 - Biochemical and physiological complexity in biology and medicine
PSO 4 - Molecular technology in biology and medicine
PSO 5 - Cell based approaches in diagnosis and therapy
PSO 6 - Microorganisms in medicine
PSO 7 - Nanoscale entities and its significance in medicine
PSO 8 - Tissue architecture engineering in medicine
PSO 9 - Compounds as drugs and its efficacy
PSO 10 - Bioinformatics and artificial intelligence in medicine
PSO 11 –Technology in personalizing medicine
PSO 12 – Protein structural complexity in medicine
PSO 13 – Projecting science and medicine to public

- / C O	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12	PSO13
CO 1	3	2	3	1	-	-	-	-	-	-	-	2	1
CO 2	3	1	3	1	1	1	-	-	-	-	-	-	1

CO 3	3	2	3	1	1	1	-	-	-	1	-	2	1
CO 4	3	1	3	1	1	-	-	-	-	-	-	-	1
CO 5	3	1	3	1	1	-	-	-	-	-	-	-	1

Evaluation Pattern: 50+50 = 100

Internal Assessment – 50%		
Periodical 1	Exam	20%
Periodical 2	Exam	20%
Continuous Assessment	Assignment/Test/Quiz	10%
		50%
End Semester Examination- 50%		
Theory Exam	50%	
		50%
	Total	**100%**

24MMD111 Biophysics 2 0 0 2

Preamble

Connecting Physics to biology is an essential factor which eventually determines quantifying primary factors in a physical process that occur at cell level. Physics serves as a nanoscopic visualization tool to dissect such processes to reveal the information to students. This course introduces applications of Physics into Biology.

Introduction

Introduction to the Physics connection and its role in knowing and understanding Biology from cellular to whole organism.

Unit 1 (6 lectures)

Spectroscopy: Principle, instrumentation and application of spectroscopic instruments: UV Visible absorption spectroscopy, Colorimeter, IR spectroscopy, Raman spectroscopy.

Unit 2 (6 lectures)

Bioenergetics: Laws of thermodynamics. Concept of state functions, free energy change, equilibrium constant, coupled reactions, energy charge, ATP cycle, phosphorylation potential, and phosphoryl group transfers. Electron transport in membrane for oxidative phosphorylation, Chemical basis of hydrolysis of ATP and thioesters. Redox reactions, standard redox potentials and Nernst equation.

Unit 3 (6 lectures)

Microscopy: Principle, instrumentation and application of Microscopy, Optical Microscope, Fluorescent Microscope, Confocal Microscope,Electron Microscope, Applications of each microscopic method.

Unit 4 (6lectures)

Biophysics in Diagoinsitc Medicine: Principles of Medical-imaging, Instrumentation and Working principles and Medical applications of X-ray Imaging,CT, US and MRI, PET SPECT. Monitoring and recording bioelectric signals, Transducers in physiology.

Unit 5 (6lectures)

Biophysics in Theragnostics Medicine:

Diagnostic and Therapeutic Techniques: Cardiac pace makers, Blood flow monitors, Pulmonary function analyzers, Hemodialysis machines, Defibrillators, Short/ wave diathermy, Electrically stimulated pain management, Laser: operating principles, types, Biomedical applications in surgery.

Text books:

(1) Biophysics: An Introduction by Rodney M. J. Cotterill, Published by John Wiley & Sons Ltd, 2002.

Course outcome

CO1 Introduction to Physics and its importance and connection to biology
CO2 Thermodynamic laws applied to cellular respiration
CO3 Physics principles for Bio medical Imaging
CO4 Bio-physics of some of medical diagnostics and treatment tools.
CO5 Nanophotonics for Biology and Nanomedicine

Program Outcomes (PO) (As given by NBA and ABET)

PO1: Bioscience Knowledge
PO2: Problem Analysis
PO3: Design/Development of Solutions
PO4: Conduct Investigations of complex problems
PO5: Modern tools usage
PO6: Bioscientist and Society
PO7: Environment and Sustainability
PO8: Ethics
PO9: Individual & Team work
PO10: Communication
PO11: Project management & Finance
PO12: Lifelong learning

3 = High Affinity, 2 = Medium Affinity, 1 = Low Affinity, - = No Affinity

c / C O	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	1	1	1	-	2	2	2	1	1	2	-	3
CO 2	2	1	2	-	-	1	1	-	1	-	-	1
CO 3	2	1	1	-	3	1	-	-	1	-	-	-
CO 4	1				3							
CO 5	1	2			2							

Program Specific Outcomes.(PSO)

PSO 1 - Chemical and physical basis of biology
PSO 2 -Computational science in biology and medicine
PSO 3 -Biochemical and physiological complexity in biology and medicine
PSO 4 -Molecular technology in biology and medicine
PSO 5 - Cellbased approaches in diagnosis and therapy
PSO 6 -Microorganisms in medicine
PSO 7 -Nanoscale entities and its significance in medicine
PSO 8 - Tissue architecture engineering in medicine
PSO 9 - Compounds as drugs and its efficacy
PSO 10 - Bioinformatics and artificial intelligence in medicine
PSO 11 –Technology in personalizing medicine
PSO 12 – Protein structural complexity in medicine
PSO 13 – Projecting science and medicine to public

- / C O	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12	PS
CO 1	2	1	-	-	-	-	1	1	-	-	-	-	
CO 2	2	-	1	-	-	-	-	-	-	-	-	-	
CO 3	1	1	1	-	1	-	-	-	-	-	-	-	
CO 4	1	1	2	2	1	-	-	-	-	2	2	-	
CO 5	-	1	1	2	1	-	3	1	1	-	1	-	

Evaluation Pattern: 50+50 = 100

Internal Assessment – 50%		
Periodical 1	Exam	20%
Periodical 2	Exam	20%
Continuous Assessment	Assignment/Test/Quiz	10%
		50%
End Semester Examination- 50%		
Theory Exam	50%	
		50%
	Total	**100%**

24MMD113 Microbiology 2 0 0 2

Preamble

Microbiology deals with the organisms that are at micron range can only be seen through a microscope. They are highly adaptable to different environment and exist in symbiotic relationship with higher order organisms. Their biology is explained in detail.

Unit-1 **(10 lectures)**

History and classification of microorganisms. Morphology and cell structure of major groups of microorganisms eg. Bacteria, Algae, Fungi, Protozoa and Unique features of viruses.

Unit-2 **(10 lectures)**

Cultivation and Maintenance of microorganisms: Nutritional categories of micro-organisms, methods of isolation, Purification and preservation. Microbial growth: Growth curve, Generation time, measurement of growth and factors affecting growth of bacteria.

Unit-3 **(5 lectures)**

Bacterial Reproduction: Transformation, Transduction and Conjugation. Endospores and sporulation in bacteria.

Unit-4 **(5 lectures)**

Control of Microorganisms: By physical, chemical and chemotherapeutic Agents.

TEXT BOOK:

(1) Microbiology by Prescott, L.M., 6th Edition. McGraw-Hill Companies. 2002.

Course Outcome

CO1 Knowledge about the historical events in microbiology, contributions of Antonie Philips Leeuwenhoek, Louis Paster and Robert Koch etc; staining techniques used in microbiology.

CO2 Knowledge about the basic structure of microbes and bacterial reproduction.

CO3 Knowledge about the aseptic/sterilization techniques: Physical and chemical agents/methods for sterilization, dry and moist heat etc

CO4 The students will know about the disease-causing micro-organisms (bacteria, fungus, virus and parasites). Students will learn about microbial toxins and common hospital acquired infections, and method for disposing hospital wastes.

CO5 Students will also learn the composition of human microbiome and their role in maintaining normal gut function, and probiotics.

Program Outcome

PO1: Bioscience Knowledge
PO2: Problem Analysis
PO3: Design/Development of Solutions
PO4: Conduct Investigations of complex problems
PO5: Modern tools usage
PO6: Bioscientist and Society
PO7: Environment and Sustainability
PO8: Ethics
PO9: Individual & Team work
PO10: Communication
PO11: Project management & Finance
PO12: Lifelong learning

c C O	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12

CO 1	3	-	-	-	-	2	-	-	-	-	-	3
CO 2	3	-	-	-	-	2	-	-	-	-	-	3
CO 3	3	1	1	1	1	2	-					3
CO 4	3	1	1	1	-	2	-	-	-	-	-	3
CO 5	3	-	-	-	1	2	-	-	-	-	-	3

Program Specific Outcomes.(PSO)

PSO 1 - Chemical and physical basis of biology
PSO 2 -Computational science in biology and medicine
PSO 3 -Biochemical and physiological complexity in biology and medicine
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- C O	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12	PSO13
CO 1	3	-	1	-	-	3	-	-	-	-	-	-	-
CO 2	3	-	1	-	-	3	-	-	-	-	-	-	-
CO 3	-	-	1	-	-	3	-	-	-	-	-	-	-
CO 4	-	-	1	-	-	3	-	-	-	-	-	-	-
CO 5	-	-	1	1	-	3	-	-	-	-	-	-	-

Evaluation Pattern: 50+50 = 100

Internal Assessment – 50%		
Periodical 1	Exam	20%
Periodical 2	Exam	20%
Continuous Assessment	Assignment/Test/Quiz	10%
		50%
End Semester Examination- 50%		
Theory Exam	50%	
		50%

Total	**100%**

24MMD114 **Biostatistics** **2 0 0 2**

Biostatistics

Preamble

Strategy to execute research is central to the successful completion and execution of a scientific endeavour. Based on the literature, several methodologies have been developed to tailor a particular strategy and the appropriate use of sample numbers for reliable results and meaningful outcome.

Unit-1 (10 lectures)

Introduction to Biostatistics-Need for Statistical Methods in Medicine, Public Health, Biology, Biotechnology & Nano Sciences – Their uses and Misuses, Types of Variables, Data collection Methods, Population and Sample. Linear Algebra – Set Theory - Sets and operations on sets.

Unit-2 (10 lectures)

Descriptive Data Analysis Methods - Statistical Tables, Diagrams & Graphs, Measures of Averages, Measures of Dispersion, Correlation Analysis Methods, Regression Analysis Methods. Theory of probability and Standard Distributions- Frequency and classical definition of probability, Axiomatric definition of probability, Addition and multiplication theorems, Conditional probability and independence, Random Variables.

Unit-3 (15 lectures)

Probability Distributions :- Definition of discrete and continuous random variables, Probability density functions and distribution functions, Standard univariate discrete distributions – Binomial, Poisson, Standard univariate continuous distributions – Normal, standard normal. Logic of Statistical Inference- Concept of parameter and statistic ‘, Estimators and its properties, point and Interval estimation of parameters, Confidence intervals, concept of standard error. Principles of statistical tests of significance, Methods of tests of Significance of Significance of Statistical Hypotheses- Concept of Statistical Hypotheses – Null and Alternative hypotheses, Type I and Type II errors, Significance level, Critical region and Power of a test , p-value and its interpretation; Large and Small Sample Test – Normal test, Student’s ‘t’ test, Chi-square tests, Analysis of variance.

Program Specific Outcomes. (PSO)

PSO 1 - Chemical and physical basis of biology
PSO 2 - Computational science in biology and medicine
PSO 3 - Biochemical and physiological complexity in biology and medicine
PSO 4 -Molecular technology in biology and medicine
PSO 5 - Cell based approaches in diagnosis and therapy

PSO 6 - Microorganisms in medicine
PSO 7 -Nanoscale entities and its significance in medicine
PSO 8 - Tissue architecture engineering in medicine
PSO 9 - Compounds as drugs and its efficacy
PSO 10 - Bioinformatics and artificial intelligence in medicine
PSO 11 –Technology in personalizing medicine
PSO 12 – Protein structural complexity in medicine
PSO 13 – Projecting science and medicine to public
PSO 14 – Advanced knowledge in statistical techniques for medical research
PSO 15 – Skills in handling research data and presentation of results

- / C O	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO14	PSO15
CO 1	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 4	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 5	-	-	-	-	-	-	-	-	-	-	-	3	3

24MMD185 **Molecular Biology Lab** **0 0 6 2**

1. Preparation of various stock solutions required for Molecular Biology Laboratory.
2. Preparation of culture medium (LB) for E. coli (both solid and liquid) and raise culture of E. coli.
3. Isolation of chromosomal DNA from bacterial cultures and visualization on Agarose Gel Electrophoresis.
4. Quantitative estimation of DNA.
5. Separation of DNA by Agarose gel Electrophoresis
6. Polymerase Chain Reaction (PCR) technique
7. Evaluation of the effects of ultraviolet light on bacterial growth.

Text books:
(1) Cell and Molecular Biology: Concepts and Experiments, 7th edition (2013), Gerald Karp; Wiley Publishers ISBN-13: 978-1118206737.
(2) Molecular Cloning: A Laboratory Manual, 4th edition (2012), Michael R. Green and Joseph Sambrook; Cold Spring Harbor Laboratory Press, ISBN-13: 978-1936113422.

Course Outcome
CO1 Can prepare stock solutions and media components for bacterial culture
CO2 Can explain the principles behind the DNA isolation methods, PCR, agarose gel electrophoresis and UV mutagenesis.

CO3 Can isolate genomic DNA, estimate its quantity and purity. Can perform agarose gel electrophoresis and UV mutagenesis.
CO4 Can follow general safety routines for laboratory work in molecular biology.
CO5 Can plan experimental work based on a protocol and critically evaluate and discuss experimental results.

Program Outcome
PO1: Bioscience Knowledge
PO2: Problem Analysis
PO3: Design/Development of Solutions
PO4: Conduct Investigations of complex problems
PO5: Modern tools usage
PO6: Bioscientist and Society
PO7: Environment and Sustainability
PO8: Ethics
PO9: Individual & Team work
PO10: Communication
PO11: Project management & Finance
PO12: Lifelong learning

c C O	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	-	-	-	1	1	-	-	3	-	-	1
CO 2	3	3	3	3	1	1	-	-	3	-	-	1
CO 3	3	2	3	3	3	1	-	-	3	-	-	1
CO 4	3	1	-	-	-	1	-	-	-	-	-	1
CO 5	3	3	2	2	-	2	-	-	-	-	-	1

Program Specific Outcomes. (PSO)
PSO 1 - Chemical and physical basis of biology
PSO 2 - Computational science in biology and medicine
PSO 3 - Biochemical and physiological complexity in biology and medicine
PSO 4 - Molecular technology in biology and medicine
PSO 5 - Cell based approaches in diagnosis and therapy
PSO 6 - Microorganisms in medicine
PSO 7 - Nanoscale entities and its significance in medicine
PSO 8 - Tissue architecture engineering in medicine
PSO 9 - Compounds as drugs and its efficacy
PSO 10 - Bioinformatics and artificial intelligence in medicine
PSO 11 –Technology in personalizing medicine
PSO 12 – Protein structural complexity in medicine
PSO 13 – Projecting science and medicine to public

- C O	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12	PSO13

CO 1	1	-	1	2	-	1	-	-	-	-	1	-	-
CO 2	2	-	3	2	-	1	-	-	-	-	1	-	-
CO 3	3	-	3	3	-	1	-	-	-	-	1	-	1
CO 4	-	-	1	1	-	-	-	-	-	-	-	-	1
CO 5	-	-	1	1	-	-	-	-	-	-	-	-	1

Evaluation Pattern: 30+70 = 100

Internal Assessment – 30%		
Records	Evaluation	30%
		30%
End Semester Examination- 50%		
Practical	Exam	60%
Assessment	Viva	10%
		70%
	Total	**100%**

24MMD183 Biophysics lab 0 0 6 2

1. Acquire the absorption spectrum of the given sample using spectrophotometer.
2. Effect of temperature, pH and solvents on UV absorption spectra of proteins using Spectrophotometry.
3. Determination of the absorption maxima of pNitro phenol, DNA and protein (BSA/Egg Albumin) from absorption spectrum and calculate molar absorbance.
4. Determination of the concentrations of given test samples using Beer Lambert Law.
5. Determination of the concentrations of given test samples using calibration curve.
6. Determination of the specific rotation of sugar solution by using Laurent's Half Shade Polarimeter.
7. Determination of the concentrations of given test samples using Laurent's Half Shade Polarimeter.
8. Determination of the refractive index of the given samples using Abbe Refractometer.
9. Determination of the concentrations of given test samples using calibration curve using Abbe Refractometer.

Text Books:
Biophysical Chemistry (2013), Schimmel, C.R.C., Macmillan Higher Education, ISBN : 0716738619, 9780716738619.

CO1 Standard curve for concentration analysis
CO2 UV -Vis Absorption Spectroscopy for concentration analysis
CO3 Effect of pH and temperature on UV-Vis Absorption Spectrum of proteins
CO4 Refractive index of solutions for concentration analysis

CO5 Optical rotation of solutions for concentration analysis

Program Outcomes (PO) (As given by NBA and ABET)

PO1: Bioscience Knowledge
PO2: Problem Analysis
PO3: Design/Development of Solutions
PO4: Conduct Investigations of complex problems
PO5: Modern tools usage
PO6: Bio Scientist and Society
PO7: Environment and Sustainability
PO8: Ethics
PO9: Individual & Team work
PO10: Communication
PO11: Project management & Finance
PO12: Lifelong learning

3 = High Affinity, 2 = Medium Affinity, 1 = Low Affinity, - = No Affinity

c C O	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	1	2	2	1	2	2	-	-	2	-	-	1
CO 2	2	1	2	-	3	1	-	-	2	-	-	1
CO 3	2	1	1	-	3	1	-	-	2	-	-	-
CO 4	1	2	2		2				2		-	1
CO 5	1	2	2	1	2	-	-	-	2		-	1

Program Specific Outcomes.(PSO)

PSO 1 - Chemical and physical basis of biology
PSO 2 -Computational science in biology and medicine
PSO 3 -Biochemical and physiological complexity in biology and medicine
PSO 4 -Molecular technology in biology and medicine
PSO 5 – Cell based approaches in diagnosis and therapy
PSO 6 -Microorganisms in medicine
PSO 7 -Nanoscale entities and its significance in medicine
PSO 8 - Tissue architecture engineering in medicine
PSO 9 - Compounds as drugs and its efficacy
PSO 10 - Bioinformatics and artificial intelligence in medicine
PSO 11 –Technology in personalizing medicine
PSO 12 – Protein structural complexity in medicine
PSO 13 – Projecting science and medicine to public

-	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12	PSO13
C O													
CO 1	-	1	-	-	-	-	-	-	1	1	1	-	-
CO 2	1	1	-	-	-	-	-	-	1	1	1	1	-
CO 3	2	1	-	-	-	-	-	-	1	1	1	1	1
CO 4	2	1	-	-	-	-	-	-	1	1	1	-	1
CO 5	2	1	-	-	-	-	-	-	1	1	1	-	1

Evaluation Pattern: 30+70 = 100

Internal Assessment – 30%		
Records	Evaluation	30%
		30%
End Semester Examination- 50%		
Practical	Exam	60%
Assessment	Viva	10%
		70%
	Total	**100%**

24MMD184 Microbiology Lab 0 0 6 2

1. Isolation of bacteria
2. Simple staining
3. Gram Staining
4. Acid fast Staining
5. Spore Staining
6. Negative Staining
7. Preparation of media & sterilization methods
8. Demonstration of microflora in air by plate exposure
9. Enumeration of microorganisms – viable count
10. Antimicrobial activity assays – Agar diffusion
11. Antimicrobial activity assays – Broth dilution
12. Alamar blue method for viability determination
13. Bacteriophage isolation

Text Books:

(1) Bailey & Scott's Diagnostic Microbiology, 14th Edition.

CO1 Apply the knowledge to isolate and identify microorganisms.
CO2 The students will learn to perform antibiotic susceptibility assays.

CO3 The students will learn to perform mutagenesis experiment for the identification of potential carcinogenic/mutagenic compounds.
CO4 The students will learn to perform microbial viability assays.
CO5 They will learn different bacterial staining procedures.

Program Outcome
PO1: Bioscience Knowledge
PO2: Problem Analysis
PO3: Design/Development of Solutions
PO4: Conduct Investigations of complex problems
PO5: Modern tools usage
PO6: Bioscientist and Society
PO7: Environment and Sustainability
PO8: Ethics
PO9: Individual & Team work
PO10: Communication
PO11: Project management & Finance
PO12: Lifelong learning

c C O	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	-	-	-	-	2	-	-	-	-	-	3
CO 2	3	-	-	-	-	2	-	-	-	-	-	3
CO 3	3	1	1	1	1	2	-					3
CO 4	3	1	1	1	-	2	-	-	-	-	-	3
CO 5	3	-	-	-	1	2	-	-	-	-	-	3

Program Specific Outcomes. (PSO)
PSO 1 - Chemical and physical basis of biology
PSO 2 - Computational science in biology and medicine
PSO 3 - Biochemical and physiological complexity in biology and medicine
PSO 4 - Molecular technology in biology and medicine
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PSO 11 –Technology in personalizing medicine
PSO 12 – Protein structural complexity in medicine
PSO 13 – Projecting science and medicine to public

- C O	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12	PSO13
CO 1	-	-	-	-	1	3	-	-	-	-	-	-	-

CO 2	-	-	-	-	2	3	-	-	3	-	-	-	-
CO 3	-	-	-	-	2	3	-	-	-	-	-	-	-
CO 4	-	-	-	-	2	3	-	-	-	-	-	-	-
CO 5	-	-	-	-	2	3	-	-	-	-	-	-	-

Evaluation Pattern: 30+70 = 100

Internal Assessment – 30%		
Records	Evaluation	30%
		30%
End Semester Examination- 50%		
Practical	Exam	60%
Assessment	Viva	10%
		70%
	Total	**100%**

22AVP103 Mastery Over Mind (MAOM) 1-0-2 2

1. Course Overview

Master Over the Mind (MAOM) is an Amrita initiative to implement schemes and organise university-wide programs to enhance health and wellbeing of all faculty, staff, and students (UN SDG -3). This program as part of our efforts for sustainable stress reduction gives an introduction to immediate and long-term benefits and equips every attendee to manage stressful emotions and anxiety facilitating inner peace and harmony.

With a meditation technique offered by Amrita Chancellor and world-renowned humanitarian and spiritual leader, Sri Mata Amritanandamayi Devi (Amma), this course has been planned to be offered to all students of all campuses of AMRITA, starting off with all first years, wherein one hour per week is completely dedicated for guided practical meditation session and one hour on the theory aspects of MAOM. The theory section comprises lecture hours within a structured syllabus and will include invited guest lecture series from eminent personalities from diverse fields of excellence. This course will enhance the understanding of experiential learning based on university's mission: "Education for Life along with Education for Living", and is aimed to allow learners to realize and rediscover the infinite potential of one's true Being and the fulfilment of life's goals.

2. Course Syllabus Unit 1 (4 hours)

Causes of Stress: The problem of not being relaxed. Need for meditation -basics of stress management at home and workplace. Traditions and Culture. Principles of meditation– promote a sense of control and autonomy in the Universal Human Value System. Different stages of Meditation. Various Meditation Models. Various practices of Meditation techniques in different schools of philosophy and Indian Knowledge System.

Unit 2 (4 hours)

Improving work and study performance. Meditation in daily life. Cultivating compassion

Internal			**External**	**Total**
Components	*Weightage*		Practical (attendance and class participation) 60%	100%
Quizzes(based on the reading material)	20%	40%		
Assignments (Based on webinars and lecture series)	20%			

and good mental health with an attitude of openness and acceptance. Research and Science of Meditation: Significance of practising meditation and perspectives from diverse fields like science, medicine, technology. philosophy, culture, arts, management, sports, economics, healthcare, environment etc. The role of meditation for stress and anxiety reduction in one's life with insights based on recent cutting-edge technology. The effect of practicing meditation for the wholesome wellbeing of an individual.

Unit 3 (4 hours)

Communications: principles of conscious communication. Relationships and empathy: meditative approach in managing and maintaining better relationships in life during the interactions in the world, role of MAOM in developing compassion, empathy and responsibility, instilling interest, and orientation to humanitarian projects as a key to harness intelligence and compassion in youth. Methodologies to evaluate effective awareness and relaxation gained from meditation. Evaluating the global transformation through meditation by instilling human values which leads to service learning and compassion driven research.

TEXT BOOKS:

1.Mata Amritanandamayi Devi, "Cultivating Strength and vitality," published by Mata Amritanandamayi Math, Dec 2019

2.Swami Amritaswarupananda Puri ,"The Color of Rainbow " published by MAM, Amritapuri.

REFERENCES:

1.Craig Groeschel, "Winning the War in Your Mind: Change Your Thinking, Change Your Life" Zondervan Publishers, February 2019

2.R Nagarathna et al, "New Perspectives in Stress Management "Swami Vivekananda Yoga Prakashana publications, Jan 1986

3. Swami Amritaswarupananda Puri "Awaken Children Vol 1, 5 and 7 - Dialogues with Amma on Meditation", August 2019
4. Swami Amritaswarupananda Puri "From Amma's Heart - Amma's answer to questions raised during world tours" March 2018
5. Secret of Inner Peace- Swami Ramakrishnananda Puri, Amrita Books, Jan 2018.
6. Mata Amritanandamayi Devi "Compassion :The only way to Peace:Paris Speech", MA Center, April 2016.
7. Mata Amritanandamayi Devi "Understanding and collaboration between Religions", MA Center, April 2016.
8. Mata Amritanandamayi Devi "Awakening of Universal Motherhood: Geneva Speech" M A center, April 2016.

3. Evaluation and Grading

4. Course Outcomes (CO)

CO1: Relate to the causes of stress in one's life.
CO2: Experiment with a range of relaxation techniques
CO3: Model a meditative approach to work, study, and life.
CO4: Develop appropriate practice of MA-OM technique that is effective in one's life
CO5: Inculcate a higher level of awareness and focus.
CO6: Evaluate the impact of a meditation technique

***Programme Outcomes(PO)**(As given by NBA and ABET)
PO1: Engineering Knowledge
PO2: Problem Analysis
PO3: Design/Development of Solutions
PO4: Conduct Investigations of complex problems
PO5: Modern tools usage
PO6: Engineer and Society
PO7: Environment and Sustainability
PO8: Ethics
PO9: Individual & Team work
PO10: Communication
PO11: Project management & Finance
PO12: Lifelong learning

CO – PO Affinity Map

P O / C O	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PSO2	PSO3
CO 1	3	3	3	2		-	2	3	-	3	-	3	-	-	-
CO 2	3	3	3	2	2	_	2	3	3	3	-	3	-	-	-
CO 3	3	3	2	2	2	2	2	3	3	3	-	3	-	-	-
CO 4	3	3	3	2	-	2	3	3	3	3	-	3	-	-	-
CO 5	3	2	2	2	-	2	-	3	2	2	-	2	-	-	-
CO 6	3	2	2	2	3	2	_	3	2	2	-	2	-	-	-

22ADM111 Glimpses of glorious India 2-0-1- 2

Course Objective

• To deepen students' understanding and further their knowledge about the different aspects ofIndian culture and heritage.
• To in still into students a dynamic awareness and understanding of their country's achieve mentsand civilizing influences in various fields and at various epochs.Course Outcome

Unit 1

1. Relevance of Sri Rama and Sri Krishna in this Scientific Age
2. Lessons from the Epics of India
3.Ramayana & Mahabharata

Unit 2

4.Who is a Wise Man?

5.A Ruler's Dharma
6.The Story of King Shibi

Unit 3

7.Introduction to the Bhagavad Gita
8.Bhagavad Gita – Action without Desire

Unit 4

9.Role and Position of Women in India
10.The Awakening of Universal Motherhood

Unit 5

11.Patanjali'sAstanga - Yoga System for Personality Refinement
12.Examples of Heroism and Patriotism in Modern India

CO1: Get an overview of Indian contribution to the world in the field of science and literature.
CO2: Understand the foundational concepts of ancient Indian education system.
CO3: Learn the important concepts of Vedas and Yogasutra-s and their relevance to daily life.
CO4: Familiarize themselves with the inspirational characters and anecdotes from the Mahābhārata and Bhagavad-Gītā and Indian history.
CO5: Gain an understanding of Amma's role in the empowerment of women

Evaluation pattern:

Components	Weightage
Mid Term Exam (Internal)	30 marks
Quizzes and Assignments(Internal)	15 marks
Meditation(MaOm)	5 marks
End Semester Exam (External)	50 marks

TEXTBOOKS:

Common Resource Material II (in-house publication)
Sanatana Dharma - The Eternal Truth (A compilation of Amma's teachings on Indian Culture

SEMESTER 3

24MMD201 Developmental Biology 2-0-0-2

Preamble

This course will describe the general patterns and mechanisms involved in the development of bilateral organisms including the mammals. Specifically, the course will deal with sex determination, gametogenesis, developmental organization, axis formation, 3 germ layer formation, organogenesis and implications of development in health and disease. The course is expected to provide the students a deeper understanding about the developmental origin of health and disease in adulthood.

Unit-1 (10 lectures)

Patterns and Processes of Becoming: A Framework for Understanding Animal Development (Making New Bodies: Mechanisms of Developmental Organization;

Specifying Identity: Mechanisms of Developmental Patterning; Differential Gene Expression: Mechanisms of Cell Differentiation; Cell-to-Cell Communication: Mechanisms of Morphogenesis).

Unit-2 **(5 lectures)**

Gametogenesis and Fertilization: The Circle of Sex (Sex Determination and Gametogenesis; Fertilization: Beginning a New Organism).

Unit-3 **(5 lectures)**

Early Development: Cleavage, Gastrulation, and Axis Formation (The Genetics of Axis Specification in Mammals).

Unit 4 **(5 Lectures)**

Building with Ectoderm: Neural Tube Formation and Patterning; Brain Growth; Neural Crest Cells and Axonal Specificity.

Unit 5 **(5 Lectures)**

Building with Mesoderm and Endoderm: Organogenesis; Paraxial Mesoderm: The Somites and Their Derivatives; Intermediate and Lateral Plate Mesoderm: Heart, Blood, and Kidneys; The Endoderm: Tubes and Organs for Digestion and Respiration

Unit 6 **(5 Lectures)**

Postembryonic Development: Regeneration; Aging and Senescence

Unit 7 **(10 Lectures)**

Development in Wider Contexts: Development in Health and Disease: Birth Defects; Development and the Environment: Biotic, Abiotic, and Symbiotic Regulation of Development; Development and Evolution: Developmental Mechanisms of Evolutionary Change.

Text Books:

(1) Gilbert: Developmental Biology (11th ed., 2006, Sinauer);
(2) Balinsky: An Introduction to Embryology (1981, CBS);
(3) Wolpert: Principles of Development (3rd ed. 2007, Oxford).

Course Outcome

CO1 To understand the journey of an animal embryo from a single cell to a multicellular organism and development of personhood

CO2 To learn about sexual development of an organism and how a preexisting organism makes a new organism through reproduction

CO3 To learn about the three germ layers, ectoderm, mesoderm and endoderm, and building of organs from each germ layer

CO4 To learn about post embryonic development, regeneration, aging and senescence

CO5 To have a perspective about development in wider contexts like health and disease, environmental regulation of development and developmental mechanisms underlying evolutionary changes

Program outcome

PO1: Bioscience Knowledge
PO2: Problem Analysis
PO3: Design/Development of Solutions
PO4: Conduct Investigations of complex problems
PO5: Modern tools usage
PO6: Bioscientist and Society
PO7: Environment and Sustainability

PO8: Ethics
PO9: Individual & Team work
PO10: Communication
PO11: Project management & Finance
PO12: Life long learning

3 = High Affinity, 2 = Medium Affinity, 1 = Low Affinity, - = No Affinity

c C O	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	1	2	2	2	3	2	-	-	-	-	3
CO 2	3	1	2	2	2	3	2	-	-	-	-	3
CO 3	3	1	2	2	2	3	2	-	-	-	-	3
CO 4	3	1	2	2	2	3	2	-	-	-	-	3
CO 5	3	1	2	2	2	3	3	-	-	-	-	3

Program Specific Outcomes. (PSO)

PSO 1 - Chemical and physical basis of biology
PSO 2 - Computational science in biology and medicine
PSO 3 - Biochemical and physiological complexity in biology and medicine
PSO 4 - Molecular technology in biology and medicine
PSO 5 - Cell based approaches in diagnosis and therapy
PSO 6 - Microorganisms in medicine
PSO 7 - Nanoscale entities and its significance in medicine
PSO 8 - Tissue architecture engineering in medicine
PSO 9 - Compounds as drugs and its efficacy
PSO 10 - Bioinformatics and artificial intelligence in medicine
PSO 11 –Technology in personalizing medicine
PSO 12 – Protein structural complexity in medicine
PSO 13 – Projecting science and medicine to public

- C O	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12	PSO13
CO 1	3	-	3	2	1	-	-	3	-	-	-	-	3
CO 2	3	-	3	2	1	-	-	3	-	-	-	-	3
CO 3	3	-	3	2	1	-	-	3	-	-	-	-	3
CO 4	3	-	3	2	1	-	-	3	-	-	-	-	3

CO 5	3	-	3	2	1	-	-	3	-	-	-	-	3

Evaluation Pattern: 50+50 = 100

Internal Assessment – 50%		
Periodical 1	Exam	20%
Periodical 2	Exam	20%
Continuous Assessment	Assignment/Test/Quiz	10%
		50%
End Semester Examination- 50%		
Theory Exam	50%	
		50%
	Total	**100%**

24MMD202 Immunology 2 0 0 2

Preamble

Understanding the players of defense mechanism and how it functions as a system in protecting humans are extremely important in the keeping up the homeostasis and has immense significance in diseases including cancer. Here students are exposed to these aspects contextually for a better understanding of the subject and its implications in developing therapies.

Syllabus

Unit 1 (5 Lectures)

Immune system, Concept of Innate and Adaptive immunity; Immune Cells and Organs. Antigens; Adjuvants; Antibodies; Antigenic determinants on antibodies; VDJ rearrangements; Monoclonal and Chimeric antibodies.

Unit 2 (10 Lectures)

Major Histocompatibility (Organization of MHC locus (Mice & Human); Structure and Functions of MHC I & II molecules; Antigen processing and presentation. Cytokines, Cross talk between immune cells and the role of cytokines.

Unit 3 (5 Lectures)

Complement System. Generation of Immune Response, Introduction to tolerance, Immunological Disorders and Tumor Immunity.

Unit 4 (5 Lectures)

Types of autoimmunity and hypersensitivity with examples; Immunodeficiencies - Animal models (Nude and SCID mice), SCID, DiGeorge syndrome, Chediak- Higashi syndrome.

Unit 5 (5 Lectures)

Immunological Techniques (Principles of Precipitation, Agglutination, Immunodiffusion, Immunoelectrophoresis, ELISA, ELISPOT, Western blotting, Immunofluoresence, Flow cytometry, Immunoelectron microscopy).

Text book:

(1) Janeway's Immunobiology, Ken Murphy, Paul Travers, Mark Walport, 9th edition, Garland science publishing, 2007.

Course Outcome

CO1 Gain knowledge about cellular and molecular basis of immunity and immune systems.

CO2 The students will learn the role of the immune system in maintaining balance in healthy versus diseased conditions.

CO3 The students will learn about the molecular events involved in generating innate, humoral and cell-mediated immunity

CO4 They will learn regarding the basis of allergic diseases and autoimmunity.

CO5 The students will learn about various immunological diagnostic techniques

Program Outcome

PO1: Bioscience Knowledge
PO2: Problem Analysis
PO3: Design/Development of Solutions
PO4: Conduct Investigations of complex problems
PO5: Modern tools usage
PO6: Bioscientist and Society
PO7: Environment and Sustainability
PO8: Ethics
PO9: Individual & Team work
PO10: Communication
PO11: Project management & Finance
PO12: Lifelong learning

3 = High Affinity, 2 = Medium Affinity, 1 = Low Affinity, - = No Affinity

c / C O	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	1	1	2	-	1	-	-	-	-	-	3
CO 2	3	1	1	2	-	1	-	-	-	-	-	3
CO 3	3	1	1	2	-	1	-	-	-	-	-	3
CO 4	3	1	1	2	-	1	-	-	-	-	-	3
CO 5	3	1	1	2	-	1	-	-	-	-	-	3

Program Specific Outcomes. (PSO)

PSO 1 - Chemical and physical basis of biology
PSO 2 - Computational science in biology and medicine
PSO 3 - Biochemical and physiological complexity in biology and medicine
PSO 4 - Molecular technology in biology and medicine
PSO 5 - Cell based approaches in diagnosis and therapy
PSO 6 - Microorganisms in medicine
PSO 7 - Nanoscale entities and its significance in medicine
PSO 8 - Tissue architecture engineering in medicine
PSO 9 - Compounds as drugs and its efficacy

PSO 10 - Bioinformatics and artificial intelligence in medicine
PSO 11 –Technology in personalizing medicine
PSO 12 – Protein structural complexity in medicine
PSO 13 – Projecting science and medicine to public

- CO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12	PSO13
CO 1	-	-	3	-	-	1	-	-	-	-	-	-	-
CO 2	-	-	3	-	-	1	-	-	-	-	-	-	-
CO 3	-	-	3	-	-	1	-	-	-	-	-	-	-
CO 4	-	-	3	-	-	1	-	-	-	-	-	-	-
CO 5	-	-	3	-	2	1	-	-	-	-	-	-	-

Evaluation Pattern: 50+50 = 100

Internal Assessment – 50%		
Periodical 1	Exam	20%
Periodical 2	Exam	20%
Continuous Assessment	Assignment/Test/Quiz	10%
		50%
End Semester Examination- 50%		
Theory Exam	50%	
		50%
	Total	**100%**

24MMD203 Molecular Methods 2 0 0 2

Preamble

This course offers a comprehensive exploration of molecular methods crucial in molecular biology. Across five units, students will delve into PCR, cloning, molecular markers, hybridization techniques, and DNA sequencing. From foundational principles to cutting-edge technologies, students will gain practical skills and theoretical understanding to contribute effectively to molecular research. This syllabus serves as a roadmap for students to navigate the complexities of molecular biology with confidence and proficiency.

Syllabus

Unit 1 (10 Lectures)

Polymerase Chain Reaction (PCR): Introduction to PCR principles and components. Detailed exploration of different PCR types: conventional PCR, real-time PCR, quantitative PCR, reverse transcription PCR. Primer design strategies for efficient PCR. Troubleshooting common problems encountered in PCR.

Unit 2 **(5 Lectures)**

Advanced Cloning Techniques: Principles of DNA cloning. Vector selection and construction strategies. Applications of cloning in research and biotechnology.

Unit 3 **(5 Lectures)**

Molecular Markers: Introduction to RFLP, RAPD, and AFLP markers. Understanding the characteristics, advantages, and disadvantages of each marker type. Applications of molecular markers in various research fields (e.g., genetic diversity analysis, plant breeding)

Unit 4 **(5 Lectures)**

Hybridization Techniques: Fundamental principles of nucleic acid hybridization. Southern blotting: detecting specific DNA sequences. Northern blotting: analyzing RNA expression patterns. In-situ hybridization: visualizing DNA or RNA within cells.

Unit 5 **(5 Lectures)**

DNA Sequencing Techniques: Maxam-Gilbert sequencing method: understanding the chemical principles; Sanger sequencing method: dideoxy termination.

TEXTBOOK

Molecular Biology Techniques, 4th Edition- A Classroom Laboratory Manual by Sue Carson Heather Miller Melissa Srougi D. Scott Witherow. ISBN: 9780128157756

Course Outcome

CO1 Understand the principles behind various basic and advanced PCR techniques.
CO2 Understand the fundamentals of molecular cloning.
CO3 Understand how to use the RFLP, RAPD, AFLP PCR based molecular markers for identifying genetic variations.
CO4 Understand the principles behind the different sequencing techniques.
CO5 Understand the technical know-how on versatile hybridization (basic and advanced) techniques.

Program Outcome

PO1: Bioscience Knowledge
PO2: Problem Analysis
PO3: Design/Development of Solutions
PO4: Conduct Investigations of complex problems
PO5: Modern tools usage
PO6: Bioscientist and Society
PO7: Environment and Sustainability
PO8: Ethics
PO9: Individual & Team work
PO10: Communication
PO11: Project management & Finance
PO12: Lifelong learning

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

C O												
CO 1	3	2	2	2	3	1	-	-	-	-	-	2
CO 2	3	2	2	2	3	1	1	-	-	-	-	2
CO 3	3	2	2	2	3	1	-	-	-	-	-	2
CO 4	3	2	2	2	3	1	-	-	-	-	-	2
CO 5	3	2	2	2	3	1	-	-	-	-	-	2

Program Specific Outcomes. (PSO)

PSO 1 - Chemical and physical basis of biology
PSO 2 - Computational science in biology and medicine
PSO 3 - Biochemical and physiological complexity in biology and medicine
PSO 4 - Molecular technology in biology and medicine
PSO 5 - Cell based approaches in diagnosis and therapy
PSO 6 - Microorganisms in medicine
PSO 7 - Nanoscale entities and its significance in medicine
PSO 8 - Tissue architecture engineering in medicine
PSO 9 - Compounds as drugs and its efficacy
PSO 10 - Bioinformatics and artificial intelligence in medicine
PSO 11 –Technology in personalizing medicine
PSO 12 – Protein structural complexity in medicine
PSO 13 – Projecting science and medicine to public

- C O	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12	PSO13
CO 1	1	-	-	3	-	-	-	-	-	3	1	-	1
CO 2	1	1	3	3	1	2	-	-	-	3	-	-	1
CO 3	1	1	-	3	-	-	-	-	-	1	-	-	1
CO 4	1	-	-	3	-	-	-	-	-	3	1	-	1
CO 5	1	-	-	3	-	-	-	-	-	2	1	-	1

Evaluation Pattern: 50+50 = 100

Internal Assessment – 50%		
Periodical 1	Exam	20%
Periodical 2	Exam	20%
Continuous Assessment	Assignment/Test/Quiz	10%
		50%
End Semester Examination- 50%		
Theory Exam	50%	
		50%

Total	**100%**

24MMD204 COMPUTER PROGRAMMING 2 0 0 2

Preamble

The main objective of this course is to familiarize the student with Python programming concepts, syntax, semantics, and the runtime environment, as well as with general coding techniques and object-oriented programming.

Syllabus

Unit 1

Basic concepts in Python: Python runtime environment, Python variables, Python basic Operators, Understanding python blocks. Python Data Types, Declaring and using Numeric data types and functions. Conditional statements and loop statements in Python.

Unit 2

Python Complex data types: Strings and string functions, List and Tuple manipulation, Dictionary and Set operations.

Unit 3

Functions and modules in Python: defining functions, scope, types of arguments, the anonymous function(lambda), map, filter, reduce and zip functions. Introduction to Python modules and creating own modules.

Unit 4

Exception handling in Python. Python File Operations: Reading files, Writing files in python. Python directories.

Object oriented programming in Python: Defining classes and instantiating objects. Python Constructors and destructors. Inheritance and polymorphism in Python.

Unit 5

Pthon-mysql connectivity, Establishing Connection, CURD operations.

Fundamentals for data science: Introduction to Jupyter notebook, Programming using Numpy, Pandas and matplotlib libraries.

Textbooks / References:

1. Wesley J. Chun, —Core Python Applications Programming‖, 3rd Edition , Pearson Education, 2016
2. Charles Dierbach, —Introduction to Computer Science using Python‖, Wiley, 2015
3. Jeeva Jose & P. Sojan Lal, —Introduction to Computing and Problem Solving with PYTHON‖, Khanna Publishers, New Delhi, 2016.
4. Downey, A. et al., "How to think like a Computer Scientist: Learning with Python", John Wiley, 2015.
5. Wes McKinney, —Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython‖, 2nd edition, O'Reilly Publication, ISBN-13: 978-1491957660, ISBN-10: 1491957662
6. Mark Lutz, —Learning Python‖, 5th edition, O'Reilly Publication, 2013, ISBN 978-1449355739
7. John Zelle, —Python Programming: An Introduction to Computer Science‖, Second edition, Course Technology Cengage Learning Publications, 2013, ISBN 978- 1590282410
8. Michel Dawson, —Python Programming for Absolute Beginners‖, Third Edition, Course Technology Cengage Learning Publications, 2013, ISBN 978-1435455009

9. David Beazley, Brian Jones., —Python Cookbookll, Third Edition, O'Reilly Publication, 2013, ISBN 978-1449340377

Course Outcomes

CO1 Understand Python variables, operators and data types
CO2 Get an idea about Python control structures and loops
CO3 Understand Python complex datatypes
CO4 Understand Python functions
CO5 Get an idea about NumPy and Pandas

Program outcome (PO)

PO1: Bioscience Knowledge
PO2: Problem Analysis
PO3: Design/Development of Solutions
PO4: Conduct Investigations of complex problems
PO5: Modern tools usage
PO6: Bioscientist and Society
PO7: Environment and Sustainability
PO8: Ethics
PO9: Individual &Team work
PO10: Communication
PO11: Project management & Finance
PO12: Lifelong learning

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PSO2	PSO3
CO 1	1	3	2	-	-	-	-	-	-	-	-	-	-	-	-
CO 2	2	3	3	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	2	3	3	-	-	-	-	-	-	-	-	-	-	-	-
CO 4	2	3	3	-	-	-	-	-	-	-	-	-	-	-	-
CO 5	2	3	3	-	1	-	-	-	-	-	-	-	-	-	-

Evaluation Pattern: 40+60 = 100

Internal Assessment – 40%		
Periodical 1	Exam	15%
Periodical 2	Exam	15%
Continuous Assessment	Assignment/Test/Quiz	10%
		40%
End Semester Examination- 60%		
Theory Exam	30%	
Lab Exam	30%	
		60%
	Total	**100%**

Program Specific Outcome (PSO)

PSO 1 - Chemical and physical basis of biology

PSO 2 - Computational science in biology and medicine
PSO 3 - Biochemical and physiological complexity in biology and medicine
PSO 4 - Molecular technology in biology and medicine
PSO 5 - Cell based approaches in diagnosis and therapy
PSO 6 - Microorganisms in medicine
PSO 7 - Nanoscale entities and its significance in medicine
PSO 8 - Tissue architecture engineering in medicine
PSO 9 - Compounds as drugs and its efficacy
PSO 10 - Bioinformatics and artificial intelligence in medicine
PSO 11 – Technology in personalizing medicine
PSO 12 – Protein structural complexity in medicine
PSO 13 – Projecting science and medicine to public

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12	PSO13
CO 1	-	2	-	-	-	-	-	-	-	3	-	-	2
CO 2	-	2	-	-	-	-	-	-	-	3	-	-	2
CO 3	-	2	-	-	-	-	-	-	-	3	-	-	2
CO 4	-	2	-	-	-	-	-	-	-	3	-	-	2
CO 5	-	2	-	-	-	-	-	-	-	3	-	-	2

24MMD205 Ethics and Research Methodology 2-0-0-2

Preamble

The recent advances in the field of biotechnology/biomedical technologies have brought into focus several ethical issues. The inventions in the field of genetic engineering, molecular medicine and related fields of molecular biology not only affect us but also the plants, microorganisms, animals and the entire environment and the way we practice agriculture, medicine and food processing. An increase in our ability to change life forms in recent years has given rise to the new science of bioethics. The present course focus on the bioethical issues the modern society confronts. Topics such as biomedical technologies its health and human rights perspectives, Clinical ethics, emerging trends in biomedical and genetic technologies and regulatory frame works, legal and ethical implications of cryonics, cloning and its ethical legal and scientific aspects, regulation of biobanks and responsible conduct of biomedical research will be discussed in the curriculum.

Unit I (3 Lectures)

Foundation of Bioethics: Definition, historic evolution, codes and guidelines, universal principles.

Unit 2 (2 Lectures)

Clinical ethics: Describe the sanctity of human life and the need to preserve human life, what makes research involving human subjects ethical, explain about issues related to prenatal screening, clinical trials (Phase I/II/III/IV) studies. Biomedical ethics.

Unit 3 **(2 lectures)**

Legal and ethical implications of cryonics: Introduction, origin of cryonic preservation in humans, procedure, meaning of death, its suspension and legal implications, its position in India.

Unit 4 **(2 lectures)**

CRISPER Revolution, its future and legal issues: Introduction, advances in genomic research and its legal aspects, ethical and human rights issues in human DNA editing, genome editing technology its legal and regulatory challenges

Unit 5 **(2 lectures)**

Ethics and regulation of biobanks: Introduction, types of biobanks, barriers of biobanking, biobanking framework in India, ethical issues of biobanks

Unit 6 **(4 lectures)**

Biomedical research: Introduction to responsible conduct of research, advising and mentoring, treatment of data, data falsification, fabrication and plagiarism, competing interests, commitments and values.

Unit 7 **(2 lectures)**

Ethical use of animals in the laboratory: Introduction to animal ethics, bioethics and animals, animal rights, animal use in biological research

Unit : 8 **(lectures 15)**

Identifying a scientific problem and collecting data to address the problem, development of a hypothesis, addressing the hypothesis with research question driven experiment strategy, experiment design, choosing appropriate controls, adoption of experimental techniques to address the hypothesis, sample collection and processing strategies with examples.

Unit : 9 **(lectures 13)**

Significance of developing protocols for experiments, execution of the experiments, generation of data, principles of data documentation. Interpreting data, significance of critical evaluation, how to discuss and conclude your finding.

Text books:

(1) The Cambridge Textbook of Bioethics, 1st edition (2008), Peter A. Singer and A. M. Viens; Cambridge University Press, ISBN-13: 978-0511545566.

(2) Foundation of Bioethics, 2nd edition (1996), E. H Tristram; Oxford University Press, ISBN-13: 9780195057362.

24MMD206 **Cancer Biology** **3 0 0 3**

Preamble:
Cancer is defined as uncontrollable cell growth. The complexities of the causes and the different types of cells that give rise to this disease have underscored the need for a better understanding of the basic biology of cancer. Advancements in basic and biomedical research have led to more effective treatments, enhanced detection

methods, and better prevention strategies. This course aims to provide a comprehensive overview of the biology and pathology of cancer. This course will cover the genetic and molecular basis of cancer, role of mutations in cancer cells, and how they lead to the dysregulation of essential biological properties like programmed cell death, cell proliferation and differentiation, invasion and metastases, cancer etiology and epidemiology.

Unit 1: **(3 lectures)**

Introduction: Introduction to carcinogenesis; Clonal origins of cancer, Clinical data.

Unit 2: **(3 lectures)**

Pathology of Cancer: Defining a neoplasm; Classification of cancers.

Unit 3: **(6 lectures)**

Epidemiology: Identifying causes for human cancers; Criteria required to establish causality; Biomarkers; Molecular epidemiology; Factors influencing carcinogenesis in humans.

Unit 4: **(3 lectures)**

Genetic Basis of Cancer: Oncogenes; Tumour suppressor genes; Genetic instability in cancers; Clinical evidence linking DNA repair and carcinogenesis.

Unit 5: **(5 lectures)**

Chemical and Radiation Carcinogenesis: Chemical carcinogenesis; Radiation carcinogenesis; Predicting the type of carcinogen by mutational spectrum analysis.

Unit 6: **(3 lectures)**

Familial cancers: Cancers with strong and weak familial links; Connection with sporadic cancers.

Unit 7: **(7 lectures)**

Growth of Cancers: Balancing cell proliferation, death and differentiation; Growth regulation and signal transduction; Hydrophobic growth regulatory molecules; Interaction between cell and its environment.

Unit 8: **(4 lectures)**

Invasion and metastasis: Invasion; Intravasation, Transport in the bloodstream, Extravasation; Angiogenesis, Genes involved in metastasis.

Unit 9: **(5 lectures)**

Cancer therapy: Principles behind the treatment of cancer; Different modalities of treatment; New forms of treatment.

Unit 10: **(6 lectures)**

Cancer prevention: Various approaches to cancer prevention; Statutory regulation of physical and chemical carcinogens, Preventable causes in certain types of cancers.

Text book:

(1) Roger J. B. King & Mike W. Robins. Cancer Biology, 3rd Edition, Pearson and Prentice Hall, 2006.

(2) Robin Hesketh. Introduction to Cancer Biology, Cambridge University Press, 2012 (ISBN: 9781107601482).

(3) Weinberg, Robert A. The Biology of Cancer, Second Edition. New York: Garland Science, 2013.

Course outcome (CO)

CO1: To understand the basic aspects of carcinogenesis, clonal origin and pathology of cancers and epidemiology of cancers

CO2: To understand how genetics contributes to predisposition and progression of cancer as well as familial cancers

CO3: To understand chemical carcinogenesis and radiation carcinogenesis

CO4: To understand significance of apoptotic cell death pathways and growth factor signaling pathways in cancer

CO5: To understand concerted events underlying invasion and metastasis of cancer, therapeutic modalities and preventable causes of cancers

Program outcome (PO)

PO1: Bioscience Knowledge
PO2: Problem Analysis
PO3: Design/Development of Solutions
PO4: Conduct Investigations of complex problems
PO5: Modern tools usage
PO6: Bioscientist and Society
PO7: Environment and Sustainability
PO8: Ethics
PO9: Individual & Team work
PO10: Communication
PO11: Project management & Finance
PO12: Lifelong learning

3 = High Affinity, 2 = Medium Affinity, 1 = Low Affinity, - = No Affinity

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	1	1	1	1	2	-	-	-	-	-	1
CO 2	3	3	3	3	3	3	-	-	-	-	-	1
CO 3	3	-	-	-	-	-	-	-	-	-	-	1
CO 4	3	-	-	-	-	-	-	-	-	-	-	1
CO 5	3	-	1	3	-	2	-	-	-	-	-	1

Program Specific Outcome (PSO)

PSO 1 - Chemical and physical basis of biology
PSO 2 - Computational science in biology and medicine
PSO 3 - Biochemical and physiological complexity in biology and medicine

PSO 4 - Molecular technology in biology and medicine
PSO 5 - Cell based approaches in diagnosis and therapy
PSO 6 - Microorganisms in medicine
PSO 7 - Nanoscale entities and its significance in medicine
PSO 8 - Tissue architecture engineering in medicine
PSO 9 - Compounds as drugs and its efficacy
PSO 10 - Bioinformatics and artificial intelligence in medicine
PSO 11 – Technology in personalizing medicine
PSO 12 – Protein structural complexity in medicine
PSO 13 – Projecting science and medicine to public

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12	PSO13
CO 1	3	-	2	-	-	-	-	-	-	-	-	-	2
CO 2	3	2	-	3	-	-	-	-	-	2	-	-	-
CO 3	3	-	2	-	-	-	-	-	-	-	-	-	-
CO 4	3	-	3	-	-	-	-	-	-	-	-	-	-
CO 5	3	-	3	-	-	-	-	3	2	-	1	-	2

Evaluation Pattern: 50+50 = 100

Internal Assessment – 50%		
Periodical 1	Exam	20%
Periodical 2	Exam	20%
Continuous Assessment	Assignment/Test/Quiz	10%
		50%
End Semester Examination- 50%		
Theory Exam	50%	
		50%
	Total	**100%**

24MMD282 Immunology Lab 0 0 6 2

(1) Separation of serum & plasma,
(2) Blood staining,
(3) Blood grouping,
(4) Antigen-Antibody reactions: agglutination, precipitation, immuno-electrophoresis, Coomb's test,
(5) ELISA,
(6) RIA,
(7) WIDAL.

Text Book:

1. Manual of Molecular and Clinical Laboratory Immunology, Eighth Edition by Barbara Detrick, John L Schmitz, Robert G Hamilton.

Course Outcome

CO1: The students will learn to identify various immune cells and enumerate them.
CO2: They will learn to stain blood samples and perform blood grouping.
CO3: The students will gain knowledge about different antigen-antibody interaction methods.
CO4: They will learn to detect and measure antibodies from biological samples.
CO5: They will learn to perform agglutination tests and radio-immunoassays for immunological disease diagnosis.

Program outcome (PO)

PO1: Bioscience Knowledge
PO2: Problem Analysis
PO3: Design/Development of Solutions
PO4: Conduct Investigations of complex problems
PO5: Modern tools usage
PO6: Bioscientist and Society
PO7: Environment and Sustainability
PO8: Ethics
PO9: Individual & Team work
PO10: Communication
PO11: Project management & Finance
PO12: Lifelong learning
3 = High Affinity, 2 = Medium Affinity, 1 = Low Affinity, - = No Affinity

c C O	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	-	-	-	1	-	-	-	1	-	-	3
CO 2	3	-	-	1	1	-	-	-	1	-	-	3
CO 3	3	-	-	1	1	-	-	-	1	-	-	3
CO 4	3	-	-	1	1	-	-	-	1	-	-	3
CO 5	3	-	-	1	1	-	-	-	1	-	-	3

Program Specific Outcome (PSO)

PSO 1 - Chemical and physical basis of biology
PSO 2 - Computational science in biology and medicine
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PSO 11 – Technology in personalizing medicine
PSO 12 – Protein structural complexity in medicine
PSO 13 – Projecting science and medicine to public

- C O	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12	PSO13
CO 1	-	-	-	-	3	-	-	-	-	-	-	-	-
CO 2	-	-	-	-	3	-	-	-	-	-	-	-	-
CO 3	-	-	-	-	3	1	-	-	-	-	-	-	-
CO 4	-	-	-	-	3	1	-	-	-	-	-	-	-
CO 5	-	-	-	-	3	1	-	-	-	-	-	-	-

Evaluation Pattern: 30+70 = 100

Internal Assessment – 30%		
Records	Evaluation	30%
		30%
End Semester Examination- 50%		
Practical	Exam	60%
Assessment	Viva	10%
		70%
	Total	**100%**

24MMD281 Molecular Methods Lab 0 0 6 2

1. Preparation of media and antibiotics for bacterial culture
2. Isolation of plasmid DNA from bacteria
3. RAPD PCR
4. Agarose gel electrophoresis
5. Preparation of competent cells
6. Bacterial Transformation methods.
7. Screening of the clones.

Text books:

(1) Cell and Molecular Biology: Concepts and Experiments, 7th edition (2013), Gerald Karp; Wiley Publishers ISBN-13: 978-1118206737.

(2) Molecular Cloning: A Laboratory Manual, 4th edition (2012), Michael R. Green and Joseph Sambrook; Cold Spring Harbor Laboratory Press, ISBN-13: 978-1936113422.

Course Outcome

CO1 Can prepare stock solutions and media components for bacterial culture

CO2 Can explain the principles behind the plasmid DNA isolation methods, RAPD PCR, and agarose gel electrophoresis.

CO3 Can isolate plasmid DNA, prepare competent cells, perform transformation experiments and screen for positive clones.

CO4 Can follow general safety routines for laboratory work in molecular biology.

CO5 Can plan experimental work based on a protocol and critically evaluate and discuss experimental results.

PO1: Bioscience Knowledge
PO2: Problem Analysis
PO3: Design/Development of Solutions
PO4: Conduct Investigations of complex problems
PO5: Modern tools usage
PO6: Bioscientist and Society
PO7: Environment and Sustainability
PO8: Ethics
PO9: Individual & Team work
PO10: Communication
PO11: Project management & Finance
PO12: Lifelong learning

c C O	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	-	-	-	1	1	-	-	3	-	-	1
CO 2	3	3	3	3	1	1	-	-	3	-	-	1
CO 3	3	2	3	3	3	1	-	-	3	-	-	1
CO 4	3	1	-	-	-	1	-	-	-	-	-	1
CO 5	3	3	2	2	-	2	-	-	-	-	-	1

Program Specific Outcomes. (PSO)
PSO 1 - Chemical and physical basis of biology
PSO 2 - Computational science in biology and medicine
PSO 3 - Biochemical and physiological complexity in biology and medicine
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PSO 12 – Protein structural complexity in medicine
PSO 13 – Projecting science and medicine to public

- C O	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12	PSO13
CO 1	1	-	1	2	-	1	-	-	-	-	1	-	-
CO 2	2	-	3	2	-	1	-	-	-	-	1	-	-
CO 3	1	-	2	3	-	1	-	-	-	-	1	-	1
CO 4	-	-	1	1	-	-	-	-	-	-	-	-	1

CO 5	-	-	1	1	-	-	-	-	-	-	-	-	1

Evaluation Pattern: 30+70 = 100

Internal Assessment – 30%		
Records	Evaluation	30%
		30%
End Semester Examination- 50%		
Practical	Exam	60%
Assessment	Viva	10%
		70%
	Total	**100%**

23LSK201 Life Skills I 1 0 2 2

Pre-requisite: An open mind and the urge for self-development, basic English language skills, knowledge of high school level mathematics.

Course Objective: To assist students in inculcating soft skills, developing a strong personality, empowering them to face life's challenges, improving their communication skills and problem-solving skills.

Course Outcomes

CO1: Soft Skills - To develop greater morale and positive attitude to face, analyze, and manage emotions in real life situations, like placement process.
CO2: Soft Skills - To empower students to create better impact on a target audience through content creation, effective delivery, appropriate body language and overcoming nervousness, in situations like presentations, Group Discussions and interviews.
CO3: Aptitude – To analyze, understand and solve questions in arithmetic and algebra by employing the most suitable methods.
CO4: Aptitude - To investigate and apply suitable techniques to solve questions on logical reasoning.
CO5: Verbal – To infer the meaning of words & use them in the right context. To have a better understanding of the nuances of English grammar and become capable of applying them effectively.
CO6: Verbal - To identify the relationship between words using reasoning skills. To develop the capacity to communicate ideas effectively.
Skills: Communication, self-confidence, emotional intelligence, presentation skills and problem-solving Skills.

CO-PO Mapping

PO / CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	-	-	-	-	-	-	-	2	3	3	-	3
CO2	-	-	-	-	-	-	-	3	2	3	-	3
CO3	-	3	-	-	-	-	-	-	-	-	-	3
CO4	-	3	-	-	-	-	-	-	-	-	-	3
CO5	-	-	-	-	-	-	-	-	-	3	-	3
CO6	-	-	-	-	-	-	-	-	3	3	-	3

Syllabus

Soft Skills

Soft Skills and its importance: Pleasure and pains of transition from an academic environment to work-environment. New-age challenges and distractions. Learning to benefit from constructive criticisms and feedback. Need for change in mindset and up-skilling to keep oneself competent in the professional world.

Managing Self: Knowing oneself, Self-perception, Importance of positive attitude, Building and displaying confidence, Avoiding being overconfident, Managing emotions, stress, fear. Developing Resilience and handling failures. Self-motivation, Self-learning, and continuous knowledge up-gradation / Life-long learning. Personal productivity - Goal setting and its importance in career planning, Self-discipline, Importance of values, ethics and integrity, Universal Human Values.

Communication: Process, Language Fluency, Non-verbal, Active listening. Assertiveness vs. aggressiveness. Barriers in communication. Digital communication

Aptitude

Numbers: Types, Power Cycles, Divisibility, Prime, Factors & Multiples, HCF & LCM, Surds, Indices, Square roots, Cube Roots and Simplification.

Percentage: Basics, Profit, Loss & Discount, and Simple & Compound Interest.

Ratio, Proportion & Variation: Basics, Alligations, Mixtures, and Partnership.

Averages: Basics, and Weighted Average.

Equations: Basics, Linear, Quadratic, Equations of Higher Degree and Problems on ages.

Logical Reasoning I: Blood Relations, Direction Test, Syllogisms, Series, Odd man out, Coding \& Decoding, Cryptarithmetic Problems and Input - Output Reasoning.

Verbal Skills

Vocabulary: Familiarize students with the etymology of words, help them realize the relevance of word analysis and enable them to answer synonym and antonym questions. Create an awareness about the frequently misused words, commonly confused words and wrong form of words in English.

Grammar (Basics): To learn the usage of grammar and facilitate students to identify errors and correct them.

Reasoning: Stress the importance of understanding the relationship between words through analogy questions. Emphasize the importance of avoiding the gap (assumption) in the argument/ statements/ communication.

Speaking Skills: Make students conscious of the relevance of effective communication in today's world through individual speaking activities.

Writing Skills: Introduce formal written communication and keep the students informed about the etiquette of email writing.

References:

1.Gulati. S., (1006) "Corporate Soft Skills", New Delhi, India: Rupa & Co.
2.The hard truth about Soft Skills, by Amazon Publication.
3.Verbal Skills Activity Book, CIR, AVVP
4. Nova's GRE Prep Course, Jeff Kolby, Scott Thornburg & Kathleen Pierce
5.The BBC and British Council online resources
6.Owl Purdue University online teaching resources
7.www.thegrammarbook.com online teaching resources
8.www.englishpage.com online teaching resources and other useful websites
9.Student Workbook: Quantitative Aptitude & Reasoning, Corporate & Industry Relations, Amrita Vishwa Vidyapeetham.
10. Quantitative Aptitude for All Competitive Examinations, Abhijit Guha.
11. How to Prepare for Quantitative Aptitude for the CAT, Arun Sharma.
12. How to Prepare for Data Interpretation for the CAT, Arun Sharma.
13. How to Prepare for Logical Reasoning for the CAT, Arun Sharma.
14. Quantitative Aptitude for Competitive Examinations, R S Aggarwal.
15. A Modern Approach to Logical Reasoning, R S Aggarwal.
16. A Modern Approach to Verbal & Non-Verbal Reasoning, R S Aggarwal.

Evaluation Pattern

Assessment	Internal	External
Continuous Assessment (CA)* – Soft Skills	30	-
Continuous Assessment (CA)* – Aptitude	10	25
Continuous Assessment (CA)* – Verbal	10	25
Total	50	50

*CA - Can be **presentations, speaking activities and tests.**

22AVP201 Message from Amma's Life for the Modern World

Amma's messages can be put to action in our life through pragmatism and attuning of our thought process in a positive and creative manner. Every single word Amma speaks and the guidance received in on matters which we consider as trivial are rich in content and touches the very inner being of our personality. Life gets enriched by Amma's guidance and She teaches us the art of exemplary life skills where we become witness to all the happenings around us still keeping the balance of the mind.

22ADM211 Leadership from the Ramayana

Introduction to Ramayana, the first Epic in the world – Influence of Ramayana on Indian values and culture – Storyline of Ramayana – Study of leading characters in Ramayana – Influence of Ramayana outside India – Relevance of Ramayana for modern times.

22ADM201 Strategic Lessons from the Mahabharata

Introduction to Mahabharata, the largest Epic in the world – Influence of Mahabharata on Indian values and culture – Storyline of Mahabharata – Study of leading characters in Mahabharata – Kurukshetra War and its significance - Relevance of Mahabharata for modern times.

22AVP204 Lessons from the Upanishads

Introduction to the Upanishads: Sruti versus Smrti - Overview of the four Vedas and the ten Principal Upanishads - The central problems of the Upanishads – The Upanishads and Indian Culture –

Relevance of Upanishads for modern times – A few Upanishad Personalities: Nachiketas, SatyakamaJabala, Aruni, Shvetaketu.

22AVP205 Message of the Bhagavad Gita

Introduction to Bhagavad Gita – Brief storyline of Mahabharata - Context of Kurukshetra War – The anguish of Arjuna – Counsel by Sri. Krishna – Key teachings of the Bhagavad Gita – Karma Yoga, Jnana Yoga and Bhakti Yoga - Theory of Karma and Reincarnation – Concept of Dharma – Concept of Avatar - Relevance of Mahabharata for modern times.

22AVP206 Life and Message of Swami Vivekananda

Brief Sketch of Swami Vivekananda's Life – Meeting with Guru – Disciplining of Narendra - Travel across India - Inspiring Life incidents – Address at the Parliament of Religions – Travel in United States and Europe – Return and reception India – Message from Swamiji's life.

22AVP207 Life and Teachings of Spiritual Masters India

Sri Rama, Sri Krishna, Sri Buddha, AdiShankaracharya, Sri Ramakrishna Paramahamsa, Swami Vivekananda, Sri RamanaMaharshi, Mata Amritanandamayi Devi.

22AVP208 Insights into Indian Arts and Literature

The aim of this course is to present the rich literature and culture of Ancient India and help students appreciate their deep influence on Indian Life - Vedic culture, primary source of Indian Culture – Brief introduction and appreciation of a few of the art forms of India - Arts, Music, Dance, Theatre.

22AVP209 Yoga and Meditation

The objective of the course is to provide practical training in YOGA ASANAS with a sound theoretical base and theory classes on selected verses of Patanjali's Yoga Sutra and Ashtanga Yoga. The coverage also includes the effect of yoga on integrated personality development.

22AVP210 Kerala Mural Art and Painting

Mural painting is an offshoot of the devotional tradition of Kerala. A mural is any piece of artwork painted or applied directly on a wall, ceiling or other large permanent surface. In the contemporary scenario Mural painting is not restricted to the permanent structures and are being done even on canvas. Kerala mural paintings are the frescos depicting mythology and legends, which are drawn on the walls of temples and churches in South India, principally in Kerala. Ancient temples, churches and places in Kerala, South India, display an abounding tradition of mural paintings mostly dating back between the 9th to 12th centuries when this form of art enjoyed Royal patronage. Learning Mural painting through the theory and practice workshop is the objective of this course.

22AVP213 Traditional Fine Arts of India

India is home to one of the most diverse Art forms world over. The underlying philosophy of Indian life is 'Únity in Diversity" and it has led to the most diverse expressions of culture in India. Most art forms of India are an expression of devotion by the devotee towards the Lord and its influence in Indian life is very pervasive. This course will introduce students to the deeper philosophical basis of Indian Art forms and attempt to provide a practical demonstration of the continuing relevance of the Art.

22AVP214 Principles of Worship in India

Indian mode of worship is unique among the world civilizations. Nowhere in the world has the philosophical idea of reverence and worshipfulness for everything in this universe found universal acceptance as it in India. Indian religious life even today is a practical demonstration of the potential for realization of this profound truth. To see the all-pervading consciousness in everything, including animate and inanimate, and constituting society to realise this truth can be seen as the epitome of civilizational excellence. This course will discuss the principles and rationale behind different modes of worship prevalent in India.

22AVP215 Temple Mural Arts in Kerala

The traditional percussion ensembles in the Temples of Kerala have enthralled millions over the years. The splendor of our temples makes art enthusiast spellbound, warmth and grandeur of color combination sumptuousness of the outline, crowding of space by divine or heroic figures often with in vigorous movement are the characteristics of murals.

The mural painting specially area visual counterpart of myth, legend, gods, dirties, and demons of the theatrical world, Identical myths are popular the birth of Rama, the story of Bhīma and Hanuman, Shiva, as Kirata, and the Jealousy of Uma and ganga the mural painting in Kerala appear to be closely related to, and influenced by this theatrical activity the art historians on temple planes, wood carving and painting the architectural plane of the Kerala temples are built largely on the pan-Indians almost universal model of the Vasthupurusha.

22AVP218 Insights into Indian Classical Music

The course introduces the students into the various terminologies used in Indian musicology and their explanations, like Nadam, Sruti, Svaram – svara nomenclature, Stayi, Graha, Nyasa, Amsa, Thala,- Saptatalas and their angas, Shadangas, Vadi, Samavadi, Anuvadi. The course takes the students through Carnatic as well as Hindustani classical styles.

22AVP219 Insights into Traditional Indian Painting

The course introduces traditional Indian paintings in the light of ancient Indian wisdom in the fields of aesthetics, the Shadanga (Sixs limbs of Indian paintings) and the contextual stories from ancient texts from where the paintings originated. The course introduces the painting styles such as Madhubani, Kerala Mural, Pahari, Cheriyal, Rajput, Tanjore etc.

22AVP220 Insights into Indian Classical Dance

The course takes the students through the ancient Indian text on aesthetics the Natyasastra and its commentary the AbhinavaBharati. The course introduces various styles of Indian classical dance such as Bharatanatyan, Mohiniyatton, Kuchipudi, Odissy, Katak etc. The course takes the students through both contextual theory as well as practice time.

22AVP221 Indian Martial Arts and Self Defense

The course introduces the students to the ancient Indian system of self-defense and the combat through various martial art forms and focuses more on traditional Kerala's traditional KalariPayattu. The course introduces the various exercise technique to make the body supple and flexible before going into the steps and techniques of the martial art. The advanced level of this course introduces the technique of weaponry.

SEMESTER 4

24MMD211 Proteomes in Diseases 2 0 0 2

Preamble

Despite having the same number of chromosomes in all cells, there are different types of cells and different functions they elicit. This is due to differential gene expression. As a result, the protein expression pattern and proteome of the tissue or cell type is going to be very different. Understanding the cellular proteins by proteome analysis is essential for deciphering the importance of cell/tissue specific proteins role in homeostasis and related functions

Unit 1 (5 lectures)

Maintenance of cellular protein complexity; what is proteome and proteomics, and its significance; proteomics versus genomics; significance of proteome research in health and disease; different types of proteomics.

Unit 2 (7 lectures)

How proteins of a cell can be identified; significance of different methods for studying proteomics; principles of mass spectrometry; ionization and its importance; MALDI and ESI; mass analyzers; Time of Flight; MS and MS/MS analyses; peptide fragmentation, deconvulation of mass spectra and peptide sequencing.

Unit 3 (5 lectures)

Mass spectrometry-based proteomics for protein identification; gel-free and gel-based proteomic approaches; significance of sample preparation in proteomics; protein extraction, protein fractionation; enzymatic digestion; peptide fractionation; database search for protein identification using software and search engines.

Unit 4 (4 lectures)

Peptide enrichment strategies for glycoproteomics and phosphoproteomics; quantitative proteomics; 2D and 2D-DIGE quantitative proteomics; labelled quantitative proteomics; metabolic (SILAC) and chemical labelling (iTRAQ, TMT) for quantitative proteomics; label-free quantitative proteomics.

Unit 5 (9 lectures)

Clinical proteomics and significance of mass spectrometry in clinics with respect to cancer and neurodegenerative diseases; application of mass spectrometry-based proteomics for biomarker discovery, drug target discovery, understanding disease pathogenesis, drug response.

Text Books:

1. Nawin C. Mishra, "Introduction to Proteomics: Principles and Applications" Wiley, 2010, ISBN: 0471754021

2. Proteomics for Biological Discovery: Timothy Veenstra and John Yates

Course outcome (CO)

CO1: Basic understanding of the proteome and its complexity

CO2: Understand the principles and instrumentation of mass spectrometry

CO3: Understand how proteins are identified and quantified using mass spectrometry-based proteomics

CO4: A deeper understanding of differential expression of cellular proteins using quantitative proteomics

CO5: Significance and application of proteomics in clinical setting

Program Outcome
PO1: Bioscience Knowledge
PO2: Problem Analysis
PO3: Design/Development of Solutions
PO4: Conduct Investigations of complex problems
PO5: Modern tools usage
PO6: Bioscientist and Society
PO7: Environment and Sustainability
PO8: Ethics
PO9: Individual & Team work
PO10: Communication
PO11: Project management & Finance
PO12: Lifelong learning

3 = High Affinity, 2 = Medium Affinity, 1 = Low Affinity, - = No Affinity

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	-	-	-	-	-	-	-	-	-	-	1
CO 2	3	-	-	-	3	-	-	-	-	-	-	1
CO 3	3	2	-	2	3	-	-	-	-	-	-	1
CO 4	3	2	-	2	2	-	-	-	-	-	-	1
CO 5	3	2	3	3	2	2	-	-	-	-	-	1

PSO 1 - Chemical and physical basis of biology
PSO 2 - Computational science in biology and medicine
PSO 3 - Biochemical and physiological complexity in biology and medicine
PSO 4 - Molecular technology in biology and medicine
PSO 5 - Cell based approaches in diagnosis and therapy
PSO 6 - Microorganisms in medicine
PSO 7 - Nanoscale entities and its significance in medicine

PSO 8 - Tissue architecture engineering in medicine
PSO 9 - Compounds as drugs and its efficacy
PSO 10 - Bioinformatics and artificial intelligence in medicine
PSO 11 –Technology in personalizing medicine
PSO 12 – Protein structural complexity in medicine
PSO 13 – Projecting science and medicine to public

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12	PSO13
CO 1	3	-	3	-	-	-	-	-	-	-	-	-	-
CO 2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	-	3	-	-	-	-	-	-	-	3	-	-	1
CO 4	-	3	2	-	-	-	-	-	-	3	2	1	2
CO 5	-	-	3	-	-	-	-	-	2	3	3	3	3

Evaluation Pattern: 50+50 = 100

Internal Assessment – 50%		
Periodical 1	Exam	20%
Periodical 2	Exam	20%
Continuous Assessment	Assignment/Test/Quiz	10%
		50%
End Semester Examination- 50%		
Theory Exam	50%	
		50%
	Total	**100%**

24MMD212 **Medical Physiology** **2 0 0 2**

This course integrates various functions of tissues and organs and presents the entire human physiology as one unit. Since function is dependent on tissue and organ structure, topics taught in this course will also stress on functional anatomy. This course can be viewed as a link between basic sciences and Medicine.

UNIT 1: **(3 lectures)**

Body organization and integumentary system: General anatomy of the body, introduction to various kinds of body planes, cavities their membranes, tissues level of organization (Types, origin, function & repair).

UNIT 2: **(3 lectures)**

Blood composition and function. Haemostasis, blood coagulation mechanism, blood groups and blood banking. Basic concepts about anaemia, abnormal haemoglobin, Polycythaemia, Thalassemia, Leukemia.

UNIT 3: **(5 lectures)**

Nerve physiology: Resting membrane potential structure and function of neuron. Action potential, electrophysiology of ion channels and conduction of nerve impulse

UNIT 4: **(5 lectures)**

The synapse, synaptic transmission, neurotransmitters; types and function. Concept of receptors in the body and their types, structure, functional anatomy, regulation and common disorders

UNIT 5: **(5 lectures)**

Muscular system: Muscular functional anatomy of muscular system, types of muscles, neuromuscular transmission, general and molecular mechanism of skeletal muscle excitation and contraction, energetics of muscle contraction and characteristics of whole muscle contraction. An overview of concepts of muscle fatigue, oxygen debt, shivering/tremor, muscle degeneration, tetany, muscular dystrophy.

UNIT 6: **(5 lectures)**

Skeletal system: Cartilage, structure, function and types. Bones: structure, function, location and types. Joints: structure, function and types.

UNIT 7: **(4 lectures)**

Fundamentals of the endocrine system. Glands, their secretions, function and regulation

Text book:

Guyton and Hall Textbook of Medical Physiology, 2nd edition (2016), J. E. Hall; Elsevier

Course outcomes:

CO1: Demonstrate knowledge of water compartmentalization in the human body and its relevance in physiological functions

CO2: Demonstrate knowledge of blood components and their functions in homeostasis

CO3: Demonstrate understanding of development of cell membrane potential and tissue excitability in nerve and muscle

CO4: Demonstrate understanding of bone metabolism and physiological functions

CO5: Demonstrate overall understanding of glandular systems and their specific functions

Program outcomes

PO1: Bioscience Knowledge
PO2: Problem Analysis
PO3: Design/Development of Solutions
PO4: Conduct Investigations of complex problems
PO5: Modern tools usage
PO6: Bioscientist and Society
PO7: Environment and Sustainability
PO8: Ethics
PO9: Individual & Team work
PO10: Communication
PO11: Project management & Finance
PO12: Lifelong learning

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	-	-	-	2	-	-	3	2	-	-
CO2	3	1	-	-	-	1	-	-	3	2	-	-
CO3	3	3	1	-	-	1	-	-	3	2	-	-

CO4	3	2	-	-	-	1	-	-	3	2	-	-
CO5	3	2	1	-	-	1	-	-	3	2	-	-

Program Specific Outcomes.

PSO 1 - Chemical and physical basis of biology
PSO 2 - Computational science in biology and medicine
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PSO 5 - Cell based approaches in diagnosis and therapy
PSO 6 - Microorganisms in medicine
PSO 7 - Nanoscale entities and its significance in medicine
PSO 8 - Tissue architecture engineering in medicine
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PSO 10 - Bioinformatics and artificial intelligence in medicine
PSO 11 –Technology in personalizing medicine
PSO 12 – Protein structural complexity in medicine
PSO 13 – Projecting science and medicine to public

	POS1	POS2	POS3	POS4	POS5	POS6	POS7	POS8	POS9	POS10	POS11	POS12	PO
CO1	3	1	3	1	2	-	-	-	-	-	-	2	2
CO2	3	1	3	2	2	-	-	-	-	-	-	2	2
CO3	3	2	3	2	2	-	-	-	-	-	-	2	2
CO4	3	1	3	1	2	-	-	1	-	-	-	2	2
CO5	3	1	3	1	2	-	-	1	-	-	-	2	2

Evaluation Pattern: 50+50 = 100

Internal Assessment – 50%		
Periodical 1	Exam	20%
Periodical 2	Exam	20%
Continuous Assessment	Assignment/Test/Quiz	10%
		50%
End Semester Examination- 50%		
Theory Exam	50%	
		50%
	Total	**100%**

24MMD213 Metabolism in Diseases 2 0 0 2

Preamble

Existence of cells require energy and nutrients towards maintenance and homeostasis. Thus, production of energy is vital for every function a cell execute. The question is, how effectively the cell achieves this task and what mechanisms at play and the role of various enzymes in this process. Enzymes are the key components responsible for the vital chemical rearrangements and modifications of various biological molecules carried out at 37ºC with utmost specificity. These changes are

responsible for various communications and modifications that happens as a result of environmental and internal cues a cell receives essential for the production of energy and various other metabolites critical for maintaining the cell structure function.

Unit-1 **(2 Lectures)**

Significance of six carbon sugar glucose in cellular homeostasis.

Unit 2 **(12 lectures)**

Breakdown of glucose in energy production. Glycolysis, Tricarboxylic acid cycle, pentose phosphate pathway and how they are connected together with energy production and growth. Mitochondrial structure and its significance in the oxidative phosphorylation leading to energy production. Significance of this metabolism in disease.

Unit 3 **(5 lectures)**

What are Lipids, Lipid composition and significance, Lipid metabolism: lipid synthesis and degradation

Unit 4 **(5 lectures)**

Oligosaccharides, different types of oligosaccharides, their synthesis and significance in biology.

Unit 5 **(6 lectures**)

Gluconeogenesis and its connection with the pentose phosphate pathway, metabolism of other important sugars (fructose metabolism and glycogen metabolism), glycogenesis, glycogenolysis, regulation of glycogen metabolism.

Text book:

(1) Lehninger Principles of Biochemistry by David L. Nelson; Michael M. Cox, Freeman publications; Seventh Edition 2017.

CO1 Understanding the fundamentals of biochemistry and its dependency to oxygen and carbohydrates from external environment.
CO2 Student will understand the assimilation and breakdown of glucose for energy and essential metabolic components required for cell survival and growth.
CO3 Significance of glycolysis and tricarboxylic acid cycle in maintaining homeostasis and in diseases such as cancer.
CO4 Significance of pentose phosphate pathway in the context of glycolysis and tricarboxylic acid cycle and its involvement in growth and survival.
CO5 How glucose is generated and stored in the presence of plenty of metabolites belonging to glycolysis and pentose phosphate pathway.

Program Outcomes (PO) (As given by NBA and ABET)

PO1: Bioscience Knowledge
PO2: Problem Analysis
PO3: Design/Development of Solutions
PO4: Conduct Investigations of complex problems
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PO12: Lifelong learning

3 = High Affinity, 2 = Medium Affinity, 1 = Low Affinity, - = No Affinity

c C O	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	1	-	-	-	1	2	1	-	-	-	3
CO 2	3	1	-	-	1	1	-	-	-	-	-	3
CO 3	3	2	1	1	2	1	-	-	-	-	-	2
CO 4	3	1	-	1	-	1	-	-	-	-	-	1
CO 5	3	1	-	1	-	-	-	-	-	-	-	1

Program Specific Outcomes. (PSO)

PSO 1 - Chemical and physical basis of biology
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- CO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12	PSO13
CO1	3	-	2	-	-	-	-	-	-	-	-	-	1
CO 2	3	-	2	-	-	-	-	-	-	-	-	-	1
CO 3	1	-	3	-	-	-	-	-	-	-	-	-	1
CO 4	2	-	3	-	-	-	-	-	-	-	-	-	1
CO 5	2	-	2	-	-	-	-	-	-	-	-	-	2

Evaluation Pattern: 50+50 = 100

Internal Assessment – 50%		
Periodical 1	Exam	20%
Periodical 2	Exam	20%

Continuous Assessment	Assignment/Test/Quiz	10%
		50%
End Semester Examination- 50%		
Theory Exam	50%	
		50%
	Total	**100%**

24MMD214 Bioinformatics 2 0 1 3

Preamble

Bioinformatics is a discipline that integrates different sub-disciplines of informatics, chemistry, physics, molecular biology, biochemistry and molecular medicine. This course aims at understanding the molecular basis of life by looking into genes, proteins and small molecules on the basis of different biological databases, sequence algorithms, computational biology and its related software. Latest trend in introduction of machine learning, artificial intelligence and its applications addressed.

Unit 1 **(5 Lectures)**

History of Bioinformatics. The notion of Homology. Sequence Information Sources, NCBI, EMBL, GENBANK, Entrez, Uniprot, Prosite, Understanding the structure of each source and using it on the web. Searching Databases: Integrated databases.

Unit 2 **(10 Lectures)**

Sequence Similarity Searches-BLAST, FASTA, Data Submission. Genome Annotation: Consensus sequence, Sequence Pattern and repeat finding, Gene identification tools; Protein Information Sources, SWISSPROT, TREMBL, Protein data bank, Understanding the structure of each source and using it on the web. Metabolomics and pathway databases.

Unit 3 **(11 Lectures)**

Protein sequence and Phylogeny analysis, Detecting Open Reading Frames, Outline of sequence assembly, Mutation/Substitution matrices, Pairwise sequence alignments, Introduction to BLAST, using it on the web, Interpreting results., Introduction to BLAST, using it on the web, Interpreting results. Multiple sequence alignments: ClustalOmega, XML and its applications in biochemoinformatics.

Unit 4 **(7 Lectures)**

Data mining, Introduction to machine learning and its applications. Introduction to Linux commands. Artificial intelligence concepts and its application in bioinformatics studies.

Unit 5 (Practical) (**12 Lectures)**

(1) Sequence information database resource;
(2) Understanding and use of various web resources: EMBL, Genbank, Unigene, Protein information resource (PIR);
(3) Understanding and using: PDB, Swissprot, TREMBL;
(4) Pair wise sequence alignment and interpretation of results;

(5) Data mining and small molecule structure optimization; Basic linux commands.
(6) Macromolecular structure visualization interaction and function interpretation.
(7) Multiple sequence alignment and visualization

Text Books:

(1) Bioinformatics: Genes, Proteins and Computers By Christine Orengo, David Jones, Janet Thornton, 2002 by Taylor & Francis, 320 Pages.
(2) Mount D W, "Bioinformatics Sequence and Genome Analysis", CBS Publishers & Distributors (2003), ISBN: 8123909985.
(3) Practical Bioinformatics, by Michael Agostino, 2013, ISBN 9780815344568.
(4) Artificial Intelligence in Drug Discovery, Editor: Nathan Brown, Copyright year 2021; Print ISBN 978-1-78801-547-9

Course Outcomes (CO):

CO1 : Basic concepts in biological sequence databases, using it on the web, and integrated database information.

CO2 : Fundamentals of biological sequence analysis, sequence pattern matching and recognition and pairwise sequence alignment, understanding the sequence structure-function relationships.

CO3 : Understanding the protein sequence, Protein evolution and Phylogenetic tree analysis, Functioning of BLAST software and its statistical parameters significance in pairwise sequence alignment.

CO4 : Basic concepts in Big data analysis and its web applications in drug discovery program. Introduction to machine learning techniques and its medical case studies. Knowledge in Linux environment and its commands.

CO5 : Practical application of different biologically important software, protocols and computational strategies taught and applied in different molecular medicine cases.

Program Outcomes (PO)
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c C O	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12

CO 1	3	2	2	1	2	2	-	-	1	1	-	2
CO 2	3	2	2	1	2	2	-	-	2	1	-	2
CO 3	3	2	2	2	3	2	-	-	2	1	-	2
CO 4	3	2	2	2	3	2	-	-	2	1	-	2
CO 5	3	2	2	2	3	2	-	-	2	1	-	2

3 = High Affinity, 2 = Medium Affinity, 1 = Low Affinity, - = No Affinity

Program Specific Outcomes (PSO)

PSO 1 - Chemical and physical basis of biology
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- / CO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12	PSO13
CO 1	2	3	2	2	-	1	-	-	1	2	1	2	-
CO 2	2	3	2	2	-	1	-	-	2	2	1	3	-
CO 3	2	3	2	2	-	1	-	-	2	3	2	2	-
CO 4	2	3	2	2	-	1	-	-	2	3	2	2	-
CO 5	2	3	2	2	-	1	-	-	2	2	2	3	-

Evaluation Pattern: 50+50 = 100

Internal Assessment – 50%		
Periodical 1	Exam	20%
Periodical 2	Exam	20%
Continuous Assessment	Assignment/Test/Quiz	10%
		50%
End Semester Examination- 50%		
Theory Exam	50%	
		50%
	Total	**100%**

24MMD215 Biotechniques 2 0 0 2

Preamble

Biotechniques are the key methods responsible for the advancement towards deciphering science and development of methods for diagnosis, prognosis and therapies in clinics.

Unit 1 (10 Lectures)

Purification methods and its requirements in science and medical applications, Affinity chromatography, Metal ion binding Immobilized metal ion affinity chromatography, Charge Ion exchange chromatography, Size Gel filtration, Hydrophobicity, Hydrophobic interaction chromatography, Reversed phase chromatography,

Unit 2 (10 lectures)

Isoelectric point, Chromato focusing, chromatography media, buffers for chromatography, Poly-acrylamide gel electrophoresis, Blotting techniques.

Unit 3 (10 Lectures)

Principles of fast performing liquid chromatography (FPLC) and high performing liquid chromatography (HPLC), use of FPLC and HPLC and its applications in science and industry. Mass spectrometry, principles of mass spectrometry, its applications and advantages. Use of mass spectrometry in clinics.

Text Book:

(1) Paul Cutler; Protein Purification Protocols, Humana Press.

(2) Protein Purification Principles and Practice, Springer New York, NY. 3rd Edition

Course Outcome

CO1 Develop an insight into the protein composition and how charges are distributed on it what how three-dimensional structures proteins plays a role in protein purification.

CO2 Student will learn protein characteristics such as charge, affinity, size and specific interactions and its use in purification.

CO3 Different techniques currently used in characterization of proteins and to identify its characteristics using different techniques.

CO4 Significance of different technologies used in protein identification, characterization and purification.

CO5 Instrumentation used in protein identification and purifications based on protein characteristics.

Programme Outcomes (PO) (As given by NBA and ABET)

PO1: Bioscience Knowledge
PO2: Problem Analysis
PO3: Design/Development of Solutions
PO4: Conduct Investigations of complex problems
PO5: Modern tools usage
PO6: Bioscientist and Society
PO7: Environment and Sustainability
PO8: Ethics
PO9: Individual & Team work
PO10: Communication
PO11: Project management & Finance

PO12: Lifelong learning

c C O	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	2	2	1	2	1	-	-	-	-	-	2
CO 2	3	1	2	1	2	-	-	-	-	-	-	2
CO 3	3	2	2	2	3	-	-	-	-	-	-	2
CO 4	3	3	3	3	3	-	-	-	-	-	-	3
CO 5	2	2	3	3	3	-	-	-	-	-	-	3

3 = High Affinity, 2 = Medium Affinity, 1 = Low Affinity, - = No Affinity

Program Specific Outcomes. (PSO)

PSO 1 - Chemical and physical basis of biology
PSO 2 - Computational science in biology and medicine
PSO 3 - Biochemical and physiological complexity in biology and medicine
PSO 4 - Molecular technology in biology and medicine
PSO 5 - Cell based approaches in diagnosis and therapy
PSO 6 - Microorganisms in medicine
PSO 7 - Nanoscale entities and its significance in medicine
PSO 8 - Tissue architecture engineering in medicine
PSO 9 - Compounds as drugs and its efficacy
PSO 10 - Bioinformatics and artificial intelligence in medicine
PSO 11 –Technology in personalizing medicine
PSO 12 – Protein structural complexity in medicine
PSO 13 – Projecting science and medicine to public

- C O	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12	PSO13
CO 1	3	-	2	-	-	-	-	-	-	-	-	2	2
CO 2	3	-	1	-	-	-	-	-	-	-	-	2	2
CO 3	1	-	1	3	-	-	-	-	-	-	-	2	2
CO 4	1	-	1	3	-	-	-	-	-	-	-	2	2
CO 5	-	-	-	3	-	-	-	-	-	-	-	2	2

Evaluation Pattern: 50+50 = 100

Internal Assessment – 50%		
Periodical 1	Exam	20%
Periodical 2	Exam	20%
Continuous Assessment	Assignment/Test/Quiz	10%

		50%
End Semester Examination- 50%		
Theory Exam	50%	
		50%
	Total	**100%**

24MMD283 Biotechniques Lab 0 0 6 2

1. Protein purification
2. Chromatography
3. SDS_PAGE
4. Measurement of Molecular weight
5. Protein estimation
6. Western blotting
7. Chemiluminescence reaction
8. Image capturing following chemiluminescence reaction

Text Books:

1. Introductory Practical biochemistry, S. K. Sawhney & Randhir Singh (eds) Narosa Publishing House, New Delhi, ISBN 81-7319-302-9, p 1- 15 2.
2. Hawk's Physiological Chemistry, Bernard L. Oser (ed) TATA McGRAW Hill Publishing Company LTD, New Delhi, p 10- 15.
3. Protein Purification Principles and Practice by Robert K. Scopes. Publisher, Springer New York, NY. 3rd Edition

Course Outcome

CO1 Understanding the principles applied to protein purification and its significance.
CO2 Student will understand different strategies applied towards proteins purification.
CO3 Different techniques currently used in characterization of proteins.
CO4 Significance of different technologies used in protein identification, characterization and purification.
CO5 Understand the different instruments used in protein identification and purifications.

Program outcomes

PO1: Bioscience Knowledge
PO2: Problem Analysis
PO3: Design/Development of Solutions
PO4: Conduct Investigations of complex problems
PO5: Modern tools usage
PO6: Bioscientist and Society
PO7: Environment and Sustainability
PO8: Ethics
PO9: Individual & Team work
PO10: Communication
PO11: Project management & Finance

PO12: Lifelong learning

3 = High Affinity, 2 = Medium Affinity, 1 = Low Affinity, - = No Affinity

c C O	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	2	1	1	1	1	-	-	-	-	-	3
CO 2	3	2	3	2	1	1	-	-	-	-	-	3
CO 3	3	2	3	3	3	2	-	-	-	-	-	3
CO 4	3	2	3	3	3	1	-	-	1	-	-	3
CO 5	3	3	3	3	3	1	-	-	-	-	-	3

Program Specific Outcomes.
PSO 1 - Chemical and physical basis of biology
PSO 2 - Computational science in biology and medicine
PSO 3 - Biochemical and physiological complexity in biology and medicine
PSO 4 - Molecular technology in biology and medicine
PSO 5 - Cell based approaches in diagnosis and therapy
PSO 6 - Microorganisms in medicine
PSO 7 - Nanoscale entities and its significance in medicine
PSO 8 - Tissue architecture engineering in medicine
PSO 9 - Compounds as drugs and its efficacy
PSO 10 - Bioinformatics and artificial intelligence in medicine
PSO 11 –Technology in personalizing medicine
PSO 12 – Protein structural complexity in medicine
PSO 13 – Projecting science and medicine to public

- C O	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12	PSO13
CO 1	1	-	-	3	-	-	-	-	-	-	2	3	3
CO 2	-	-	-	3	-	-	-	-	-	-	1	3	3
CO 3	-	-	-	3	-	-	-	-	-	1	2	3	3
CO 4	-	-	-	3	-	-	-	-	-	-	1	3	3
CO 5	-	-	-	3	-	-	-	-	-	-	1	3	3

Evaluation Pattern: 30+70 = 100

Internal Assessment – 30%

Records	Evaluation	30%
		30%
End Semester Examination- 50%		
Practical	Exam	60%
Assessment	Viva	10%
		70%
	Total	**100%**

24IPR211 Intellectual Property Rights (IPR) 2 0 0 2

Unit-1 (15 lectures)

Introduction to IPR, Types of IP - Patents, Trademarks, Copyrights; Related Rights, Industrial Design, Geographical Indications. Importance of IPR – patentable and non. Patentables, patenting life, legal protection of Biotechnological inventions.

Agreements and Treaties - History of GATT & TRIPS Agreement; Madrid Agreement; Hague Agreement; WIPO Treaties; Budapest Treaty; PCT; Indian Patent Act 1970 & recent amendments.

Unit-2 (15 lectures)

Concept of Technology transfer, Technology transfer mechanism, Law framework for technology transfer, Benefits of technology transfer, technology transfer implementation. Lab to land challenges and regulations.

Course Outcomes

CO1 Comprehensive Knowledge of Intellectual Property Rights
CO2 Importance of Protecting Intellectual Property
CO3 Rights of the owner of Intellectual Property
CO4 Commercializing the Intellectual Property
CO5 Changing IP regimes, Technology and AI

Program Outcome

PO1: Bioscience Knowledge
PO2: Problem Analysis
PO3: Design/Development of Solutions
PO4: Conduct Investigations of complex problems
PO5: Modern tools usage
PO6: Bioscientist and Society
PO7: Environment and Sustainability
PO8: Ethics
PO9: Individual & Team work
PO10: Communication
PO11: Project management & Finance
PO12: Lifelong learning

c	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
C O												

CO 1	2	1	-	-	-	3	-	3	1	-	-	3
CO 2	1	2	2	-	-	3	-	3	-	-	1	2
CO 3	1	1	-	-	-	3	-	3	-	-	-	2
CO 4	-	2	1	-	2	1	2	1	2	2	3	3
CO 5	2	1	1	-	2	2	-	2	-	-	1	

3 = High Affinity, 2 = Medium Affinity, 1 = Low Affinity, - = No Affinity

Program Specific Outcomes. (PSO)

PSO 1 - Chemical and physical basis of biology
PSO 2 - Computational science in biology and medicine
PSO 3 - Biochemical and physiological complexity in biology and medicine
PSO 4 - Molecular technology in biology and medicine
PSO 5 - Cell based approaches in diagnosis and therapy
PSO 6 - Microorganisms in medicine
PSO 7 - Nanoscale entities and its significance in medicine
PSO 8 - Tissue architecture engineering in medicine
PSO 9 - Compounds as drugs and its efficacy
PSO 10 - Bioinformatics and artificial intelligence in medicine
PSO 11 –Technology in personalizing medicine
PSO 12 – Protein structural complexity in medicine
PSO 13 – Projecting science and medicine to public
PSO 14 – Translational Medicine and protecting inventions

- CO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12	PSO13	PSO14
CO 1	-	-	-	-	-	1	-	-	1	-	-	-	1	3
CO 2	-	-	-	-	-	1	-	-	1	-	-	-	1	3
CO 3	-	-	-	-	-	-	-	-	-	-	-	-	-	3
CO 4	-	-	-	-	-	1	-	-	1	-	-	-	1	3
CO 5	-	-	-	-	-	-	-	-	-	-	-	-	1	3

Evaluation Pattern: 50+50 = 100

Internal Assessment – 50%		
Periodical 1	Exam	20%
Periodical 2	Exam	20%
Continuous Assessment	Assignment/Test/Quiz	10%
		50%
End Semester Examination- 50%		
Theory Exam	50%	

	50%
Total	**100%**

24MMD284 Cell Culture Lab 0 0 6 2

(1) Fundamentals of cell culture.
(2) Facilities and Applications.
(3) Media preparation for Animal cells culture.
(4) Types of cell culture: Primary and secondary cell culture, cell lines, stem cell cultures,
(5) Tests: cell viability and cytotoxicity,
(6) Cryopreservation.

Text book:
(1) Basic Cell Culture Protocols (3rd edition) by Cheryl D. Helgason, Cindy L. Miller.
(2) Masters, J.R.W. *Animal Cell Culture: A Practical Approach*. 3rd Edition.Oxford University Press. 2000.

Course outcome (CO)
CO1: Understand the fundamentals of cell culture and its applications
CO2: Familiarize with cell culture facilities and equipments
CO3: Understand the composition of cell culture media and their significance
CO4: Basic understanding of different types of cell culture
CO5: Significance of cell viability and cell cytotoxicity assays in biological studies

Program outcome (PO)
PO1: Bioscience Knowledge
PO2: Problem Analysis
PO3: Design/Development of Solutions
PO4: Conduct Investigations of complex problems
PO5: Modern tools usage
PO6: Bioscientist and Society
PO7: Environment and Sustainability
PO8: Ethics
PO9: Individual & Team work
PO10: Communication
PO11: Project management & Finance
PO12: Lifelong learning
3 = High Affinity, 2 = Medium Affinity, 1 = Low Affinity, - = No Affinity

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	-	-	-	-	-	-	3	-	-	-	1
CO 2	3	-	-	-	1	-	-	-	-	-	-	1
CO 3	3	-	-	-	-	-	-	-	-	-	-	1
CO 4	3	-	-	-	-	-	-	-	-	-	-	1

CO 5	3	2	-	2	-	2	-	-	1	-	-	1

Program Specific Outcome (PSO)
PSO 1 - Chemical and physical basis of biology
PSO 2 - Computational science in biology and medicine
PSO 3 - Biochemical and physiological complexity in biology and medicine
PSO 4 - Molecular technology in biology and medicine
PSO 5 - Cell based approaches in diagnosis and therapy
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PSO 10 - Bioinformatics and artificial intelligence in medicine
PSO 11 – Technology in personalizing medicine
PSO 12 – Protein structural complexity in medicine
PSO 13 – Projecting science and medicine to public

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO10**	**PSO11**	**PSO12**	**PSO13**
CO 1	3	-	3	-	-	-	-	-	-	-	-	-	-
CO 2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 4	3	-	2	-	2	-	-	-	-	-	-	-	-
CO 5	3	-	2	-	3	-	-	-	3	-	-	-	2

Evaluation Pattern: 30+70 = 100

Internal Assessment – 30%		
Records	Evaluation	30%
		30%
End Semester Examination- 50%		
Practical	Exam	60%
Assessment	Viva	10%
		70%
	Total	**100%**

23LSK211 Life Skills II L-T-P-C: 1-0-2-2

Pre-requisite: Willingness to learn, communication skills, basic English language skills, knowledge of high school level mathematics.

Course Objective: To help students understand the corporate culture and assist them in improving their group discussion skills, communication skills, listening skills and problem-solving skills.

Course Outcomes

CO1: Soft Skills - To improve the inter-personal skills, professional etiquette and leadership skills, vital for arriving at win-win situations in Group Discussions and other team activities.
CO2: Soft Skills - To develop the ability to create better impact in a Group Discussions through examination, participation, perspective-sharing, ideation, listening, brainstorming and consensus.
CO3: Aptitude - To interpret, critically analyze and solve questions in arithmetic and algebra by employing the most suitable methods.
CO4: Aptitude - To analyze, understand and apply suitable methods to solve questions on logical reasoning.
CO5: Verbal - To be able to use vocabulary in the right context and to be competent in spotting grammatical errors and correcting them.
CO6: Verbal - To be able to logically connect words, phrases, sentences and thereby communicate their perspectives/ideas convincingly.
Skills: Communication, etiquette and grooming, inter-personal skills, listening skills, convincing skills, problem-solving skill.

CO-PO Mapping

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	-	-	-	-	2	3	3	2	3
CO2	-	-	-	-	-	-	-	2	3	3	2	3
CO3	-	3	-	-	-	-	-	-	-	-	-	3
CO4	-	3	-	-	-	-	-	-	-	-	-	3
CO5	-	-	-	-	-	-	-	-	-	3	-	3
CO6	-	-	-	-	-	-	-	-	3	3	-	3

Syllabus

Soft Skills

Professional Grooming and Practices: Basics of corporate culture, key pillars of business etiquette – online and offline: socially acceptable ways of behavior, body language, personal hygiene, professional attire and cultural adaptability and managing diversity. Handling pressure, multi-tasking. Being enterprising. Adapting to corporate life: Emotional Management (EQ), Adversity Management, Health consciousness. People skills, Critical Thinking and Problem solving.

Group Discussions: Advantages of group discussions, Types of group discussion and Roles played in a group discussion. Personality traits evaluated in a group discussion. Initiation techniques and maintaining the flow of the discussion, how to perform well in a group discussion. Summarization/conclusion.

Aptitude

Logarithms, Inequalities and Modulus: Basics

Sequence and Series: Basics, AP, GP, HP, and Special Series.

Time and Work: Basics, Pipes & Cistern, and Work Equivalence.

Time, Speed and Distance: Basics, Average Speed, Relative Speed, Boats & Streams, Races and Circular tracks.

Logical Reasoning II: Arrangements, Sequencing, Scheduling, Venn Diagram, Network Diagrams, Binary Logic, and Logical Connectives, Clocks, Calendars, Cubes, Non-Verbal reasoning and Symbol based reasoning.

Verbal Skills

Vocabulary: Help students understand the usage of words in different contexts.

Grammar (Medium Level): Train Students to comprehend the nuances of Grammar and empower them to spot errors in sentences and correct them.

Reading Comprehension (Basics): Introduce students to smart reading techniques and help them understand different tones in comprehension passages.

Reasoning: Enable students to connect words, phrases and sentences logically.

Oral Communication Skills: Aid students in using the gift of the gab to interpret images, do a video synthesis, try a song interpretation or elaborate on a literary quote.

References:

1. Adair. J., (1.986), "Effective Team Building: How to make a winning team", London, U.K: Pan Books.
2. Gulati. S., (2006) "Corporate Soft Skills", New Delhi, India: Rupa & Co.
3. The Hard Truth about Soft Skills, by Amazone Publication.
4. Verbal Skills Activity Book, CIR, AVVP
5. Nova's GRE Prep Course, Jeff Kolby, Scott Thornburg & Kathleen Pierce
6. The BBC and British Council online resources
7. Owl Purdue University online teaching resources
8. www.thegrammarbook.com online teaching resources
9. www.englishpage.com online teaching resources and other useful websites
10. Student Workbook: Quantitative Aptitude & Reasoning, Corporate & Industry Relations, Amrita Vishwa Vidyapeetham.
11. Quantitative Aptitude for All Competitive Examinations, Abhijit Guha.
12. How to Prepare for Quantitative Aptitude for the CAT, Arun Sharma.
13. How to Prepare for Data Interpretation for the CAT, Arun Sharma.
14. How to Prepare for Logical Reasoning for the CAT, Arun Sharma.
15. Quantitative Aptitude for Competitive Examinations, R S Aggarwal.
16. A Modern Approach to Logical Reasoning, R S Aggarwal.
17. A Modern Approach to Verbal & Non-Verbal Reasoning, R S Aggarwal.

Evaluation Pattern

Assessment	Internal	External
Continuous Assessment (CA)* – Soft Skills	30	-
Continuous Assessment (CA)* – Aptitude	10	25
Continuous Assessment (CA)* – Verbal	10	25
Total	50	50

*CA - Can be **presentations, speaking activities and tests.**

Amrita Value Program II* (need to select from the list) 1-0-0

SEMESTER 5

24MMD301 Molecular Genetics and Personalized Medicine 3 0 0 3

Preamble

The course on genetics is to provide clarity on the elements of heredity and variation existing in nature. Mendel's experiments, laws of heredity, extensions and deviations of Mendelism, structural and numerical alterations found in chromosomes, generation of transgenic animals for the study of genetics will be taught in detail. In the later part of the course, emphasis is given to human genetics to make the students understand genetic basis of heredity, disease and personalized medicine.

Unit 1: (4 Lectures)

Elements of heredity and variation: Mendel and his experiments; Principles of segregation and independent assortment and their chromosomal basis; Test cross; Application of laws of probability to Mendelian inheritance

Unit 2: (5 Lectures)

Extension of Mendelism: Dominance relationships (complete dominance, incomplete dominance and co-dominance); Multiple allelism; Lethal alleles; Pleiotropy; Epistasis; Penetrance and expressivity; Phenocopy; Polygenic inheritance.

Unit 3: (4 Lectures)

Cytoplasmic and infective inheritance; Linkage: Linkage and crossing over; Structural and numerical alterations of chromosomes; Transgenic animals: strategies and applications

Unit-4 (6 lectures)

Introduction: What Is in a Human Genome? Meiosis, Development and Aging.

Unit-5 (6 lectures)

Transmission Genetics: Single-Gene Inheritance; Beyond Mendel'sLaws; Matters of Sex; Multifactorial Traits; Genetics of Behavior.

Unit-6 (5 lecture)

Genes and Regulation: Gene Expression and Epigenetics; Gene Mutation; Chromosomes

Unit-7 (6 lecture)

Population Genetics: Constant Allele Frequencies and DNA Forensics; Changing Allele Frequencies; Human genome project and, human ancestry and Evolution.

Unit-8 (9 lectures)

Genetics of Personalized Medicine: Use of subtle genetic variations in personalized medicine, Next-generation-sequencing (NGS) and use of omics in personalized medicine, Pharmacogenomics in personalized medicine, Approaches to develop personalized medicine.

Text books:

(1) Gardner et al: Principles of Genetics (1991, John Wiley).
(2) Ricki Lewis: Human Genetics (12th edition, McGraw Hill).
(3) Genomic and Precision Medicine: Foundations, Translation, and Implementation (2016); by Geoffrey S. Ginsburg (Editor), Huntington F Willard.

(4) Personalizing Precision Medicine: A Global Voyage from Vision to Reality Author: Kristin ciriello Pothier (2017) by Wiley.

CO1 To understand the elements of heredity and variation existing in nature and the laws of heredity

CO2 To learn about genes, alleles and types of associations between the alleles, and alleles and inheritance patterns

CO3 To know about cytoplasmic and infective inheritance, linkage, linkage mapping, and strategies employed in the production of transgenic animals and application potential of transgenics

CO4 To learn about human genome, meiosis, genetics of development and aging, transmission genetics and pharmacogenetics

CO5 To learn about genes and regulation, population genetics, personalized medicine, human ancestry and evolution

PO1: Bioscience Knowledge
PO2: Problem Analysis
PO3: Design/Development of Solutions
PO4: Conduct Investigations of complex problems
PO5: Modern tools usage
PO6: Bioscientist and Society
PO7: Environment and Sustainability
PO8: Ethics
PO9: Individual & Team work
PO10: Communication
PO11: Project management & Finance
PO12: Lifelong learning

3 = High Affinity, 2 = Medium Affinity, 1 = Low Affinity, - = No Affinity

c C O	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	3	2	2	3	3	3	-	-	-	-	3
CO 2	3	3	2	2	3	3	3	-	-	-	-	3
CO 3	3	3	2	2	3	3	3	-	-	-	-	3
CO 4	3	3	2	2	3	3	3	-	-	-	-	3
CO 5	3	3	2	2	3	3	3	-	-	-	-	3

Program Specific Outcomes (PSO)

PSO 1 - Chemical and physical basis of biology

PSO 2 - Computational science in biology and medicine
PSO 3 - Biochemical and physiological complexity in biology and medicine
PSO 4 - Molecular technology in biology and medicine
PSO 5 - Cell based approaches in diagnosis and therapy
PSO 6 - Microorganisms in medicine
PSO 7 - Nanoscale entities and its significance in medicine
PSO 8 - Tissue architecture engineering in medicine
PSO 9 - Compounds as drugs and its efficacy
PSO 10 - Bioinformatics and artificial intelligence in medicine
PSO 11 –Technology in personalizing medicine
PSO 12 – Protein structural complexity in medicine
PSO 13 – Projecting science and medicine to public

- CO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12	PSO13
CO 1	3	1	3	3	2	-	-	2	1	1	2	-	3
CO 2	3	1	3	3	2	-	-	2	1	1	2	-	3
CO 3	3	1	3	3	2	-	-	2	1	1	2	-	3
CO 4	3	1	3	3	2	-	-	2	1	1	2	-	3
CO 5	3	1	3	3	2	-	-	2	1	1	2	-	3

Evaluation Pattern: 50+50 = 100

Internal Assessment – 50%		
Periodical 1	Exam	20%
Periodical 2	Exam	20%
Continuous Assessment	Assignment/Test/Quiz	10%
		50%
End Semester Examination- 50%		
Theory Exam	50%	
		50%
	Total	**100%**

24MMD302 Principles of Pathology 3 0 0 3

Preamble
This course introduces fundamental concepts related to human pathology. Students will be exposed to concepts addressing how cells and tissue respond (both,

morphologically and functionally) to various external stimuli. Students will also learn about concepts in hemodynamic disorders and organ system-specific pathologies. Concepts discussed in this course will complement the topics learnt in the physiology course.

Unit 1: **(3 lectures)**

Introduction: Introduction to Pathology, Cellular adaptations to stress; Cell injury and Cell Death - Causes and mechanisms of cell injury, reversible and irreversible injury, Necrosis, Apoptosis, Types of apoptosis; Intracellular accumulations, Cellular ageing.

Unit 2: **(2 lectures**)

Hemodynamic Disorders: Edema, Hyperemia, Congestion, Hemorrhage, Hemostasis, Thrombosis, Embolism, Infarction, Shock.

Unit 3: **(3 lectures)**

Blood vessels: Hypertensive vascular wall disease, Vascular wall response to injury, Atherosclerosis, Vasculitis, Pathology of vascular intervention.

Unit 4: **(3 lectures)**

Heart: Heart failure, Congenital heart disease, Ischemic heart disease, Arrhythmias, Cardiomyopathies, Pericardial disease, Cardiac transplantation.

Unit 5: **(3 lectures)**

Hematopoietic and lymphoid systems: Red cell disorders, White cell disorders, Bleeding disorders, Disorders that affect the spleen and thymus.

Unit 6: **(3 lectures)**

Lung: Atelectasis, Acute lung injury, Obstructive lung diseases, Chronic interstitial lung disease.

Unit 7: **(4 lectures)**

Kidney: Clinical manifestation of renal diseases, glomerular diseases, diseases affecting tubules and interstitium, Cystic diseases of the kidney, Urinary outflow obstruction.

Unit 8: **(5 lectures)**

The Liver, Gallbladder and Biliary Tract: Liver - Hepatic failure, Jaundice and cholestasis, Cirrhosis, Portal hypertension, Acute and chronic hepatitis, Alcoholic and nonalcoholic fatty liver disease; Gallbladder and Biliary Tract – Disorders of the gallbladder and extrahepatic biliary tract.

Unit 9: **(2 lectures)**

Pancreas: Congenital anomalies, Pancreatitis.

Unit 10: **(3 lectures)**

Male and Female Urogenital Systems: Male – Cryptorchidism and testicular atrophy, Prostatitis; Female – Non-neoplastic epithelial disorders, Cervicitis, Endometriosis, Polycystic ovarian disease, Teratomas, Diseases of pregnancy, Fibrocystic changes in breast.

Unit 11: **(5 lectures)**

Endocrine system: Pituitary – Hyper and hypopituitarism; Thyroid – Hyper and hypothyroidism, Thyroiditis, Graves disease, Goiter; Parathyroid gland – Hyper and hypoparathyroidism; Endocrine pancreas – Diabetes mellitus, Insulin resistance; Adrenal gland – Hyperadrenalism, Adrenal insufficiency, Tumours of adrenal medulla, multiple endocrine neoplasia syndromes.

Unit 12: **(3 lectures)**

Bones, Joints and Soft Tissue: Bones - Congenital disorders of bones and cartilages, Acquired diseases of bone; Joints – Arthritis; Soft tissue – Tumours of adipose tissue.

Unit 13: **(3 lectures)**

Nervous System: Disease involving peripheral and central nervous system.

Unit 14: **(3 lectures)**

Skin: Acute and chronic inflammatory dermatoses, Blistering disorders.

Text Books

Robbins Basic Pathology, 9th edition, Kumar, Abbas, Fausto and Mitchell; Saunders, Publication, ISBN-13: 978-1437717815

Medical Laboratory Technology Methods and Interpretations, 6th edition, Ramnik. Sood; Jaypee Brothers Medical Publishers, ISBN-13: 978-8184484496.

Course Outcomes

CO1 To understand the significance of pathology in diagnosing disease and practicing medicine

CO2 To learn about cellular level pathological changes that lead to diseases and disorders

CO3 To understand hemodynamic disorders such as edema, hyperemia, congestion, hemorrhage, hemostasis, thrombosis, embolism etc. in diseases

CO4 To learn about organ system-specific pathologies and diseases

CO5 To learn about endocrine system and diseases caused by dysfunctional endocrine glands

Program Outcomes

PO1: Bioscience Knowledge

PO2: Problem Analysis

PO3: Design/Development of Solutions

PO4: Conduct Investigations of complex problems

PO5: Modern tools usage

PO6: Bioscientist and Society

PO7: Environment and Sustainability

PO8: Ethics

PO9: Individual & Team work

PO10: Communication

PO11: Project management & Finance

PO12: Lifelong learning

3 = High Affinity, 2 = Medium Affinity, 1 = Low Affinity, - = No Affinity

Program Specific Outcomes. (PSO)

PSO 1 - Chemical and physical basis of biology

PSO 2 - Computational science in biology and medicine

PSO 3 - Biochemical and physiological complexity in biology and medicine

PSO 4 - Molecular technology in biology and medicine

PSO 5 - Cell based approaches in diagnosis and therapy

PSO 6 - Microorganisms in medicine

PSO 7 - Nanoscale entities and its significance in medicine

PSO 8 - Tissue architecture engineering in medicine

PSO 9 - Compounds as drugs and its efficacy

PSO 10 - Bioinformatics and artificial intelligence in medicine

PSO 11 –Technology in personalizing medicine

PSO 12 – Protein structural complexity in medicine

PSO 13 – Projecting science and medicine to public

- CO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12	PSO13
CO 1	1	1	3	3	3	1	1	2	2	-	2	-	3
CO 2	1	1	3	3	3	1	1	2	2	-	2	-	3
CO 3	1	1	3	3	3	-	1	2	2	-	2	-	3
CO 4	1	1	3	3	3	-	1	2	2	-	2	-	3
CO 5	1	1	3	3	3	-	1	2	2	-	2	-	3

Evaluation Pattern: 50+50 = 100

Internal Assessment – 50%		
Periodical 1	Exam	20%
Periodical 2	Exam	20%
Continuous Assessment	Assignment/Test/Quiz	10%
		50%
End Semester Examination- 50%		
Theory Exam	50%	
		50%
	Total	**100%**

24MMD303 Regenerative medicine 3 0 0 3

Preamble: This course introduces the student to the fundamentals of regenerative medicine. The central focus of this course is to help the students to get familiarise with the inherent regenerative mechanisms in the human body and various approaches that are currently utilized for improving tissue repair and regeneration.

Unit 1 (12 Lectures)

Molecular organization of cells: Molecules that organize cells, Cell-cell adhesion, Changes in cell–cell adhesion, Cell interaction with the basal lamina, Cell polarity, Changes in cell polarity during cell transition, The epithelial–mesenchymal transition, Molecular control of the epithelial–mesenchymal transition. Signaling pathways is animal development and regeneration, Notch signaling, Wnt/β-catenin signaling

Unit 2 (9 Lectures)

Cell–extracellular matrix interactions in repair and regeneration: Extracellular matrix composition and diversity, Receptors for extracellular matrix molecules, Signal transduction events during cell–extracellular matrix interaction, Cell–extracellular matrix interactions during healing process,

Unit 3 (8 Lectures)

The Biology function and biomedical applications of exosomes: Biogenesis of exosomes, Heterogeneity in exosomes, Intracellular communication, Diagnostic potential of exosomes, Exosomes in regenerative applications.

Unit 4 **(9 Lectures)**

Wound repair and regeneration: Molecular pathology of chronic wounds, Molecular and cellular mechanisms in normal skin repair and wound healing, Scarring and tissue fibrosis, Diabetic wounds, Current treatments and their limitations in wound healing.

Unit 5 **(7 Lectures)**

Stem cells in regenerative medicine. Stem cell types, Stem isolation and expansion, characterisation, Cell therapy in regenerative medicine, Tissue engineering, Applications of engineered tissues in regenerative medicine.

Text book:

(1) Principles of Regenerative MedicineBook, 3rd Edition; 2019 edited by Anthony Atala, Robert Lanza, Antonios G. Mikos&Robert Nerem.
(2) Essentials of Stem Cell Biology, Second Edition, 2009, Edited by Robert Lanza, M.D.,ISBN: 978-0-12-374729-7, Elsevier Inc.

Course Outcomes

Upon successful completion, students will have the
CO1. Understanding on the cell-cell and cell-extracellular matrix interactions that regulate tissue development and regeneration
CO2. Understanding on the extracellular matrix and its role in regenerative medicine
CO3. Understanding on exosomes and their role in inter and intra cellular communications and applications in regenerative medicine
CO4. Knowledge on the inherent regenerative mechanisms in human body with specific emphasis on wound healing
CO5. Knowledge on the various types and sources of stem cells and their role in tissue growth, repair and regeneration

PO1: Bioscience Knowledge
PO2: Problem Analysis
PO3: Design/Development of Solutions
PO4: Conduct Investigations of complex problems
PO5: Modern tools usage
PO6: Bioscientist and Society
PO7: Environment and Sustainability
PO8: Ethics
PO9: Individual & Team work
PO10: Communication
PO11: Project management & Finance
PO12: Lifelong learning

3 = High Affinity, 2 = Medium Affinity, 1 = Low Affinity, - = No Affinity

c C O	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	-	-	2	2	-	-	-	1	-	-	3
CO 2	3	2	-	2	2	-	-	-	1	-	-	3
CO 3	3	1	2	3	1	-	-	1	1	-	-	3
CO 4	3	1	2	3	2	-	-	1	1	-	-	3
CO 5	3	1	2	3	2	1	-	2	1	-	-	3

Program Specific Outcomes. (PSO)

PSO 1 - Chemical and physical basis of biology
PSO 2 - Computational science in biology and medicine
PSO 3 - Biochemical and physiological complexity in biology and medicine
PSO 4 - Molecular technology in biology and medicine
PSO 5 - Cell based approaches in diagnosis and therapy
PSO 6 - Microorganisms in medicine
PSO 7 - Nanoscale entities and its significance in medicine
PSO 8 - Tissue architecture engineering in medicine
PSO 9 - Compounds as drugs and its efficacy
PSO 10 - Bioinformatics and artificial intelligence in medicine
PSO 11 –Technology in personalizing medicine
PSO 12 – Protein structural complexity in medicine
PSO 13 – Projecting science and medicine to public

c C O	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13
CO 1	2	-	1	-	3	-	1	3	-	-	2	-	-
CO 2	1	-	1	-	1	-	1	3	-	-	2	-	-
CO 3	1	-	-	-	1	-	3	-	2	-	2	-	-
CO 4	2	-	3	-	3	-	1	3	1	-	2	-	-
CO 5	-	-	1	-	3	-	-	3	-	-	2	-	-

Evaluation Pattern: 50+50 = 100

Internal Assessment – 50%		
Periodical 1	Exam	20%
Periodical 2	Exam	20%
Continuous Assessment	Assignment/Test/Quiz	10%
		50%
End Semester Examination- 50%		

Theory Exam	50%	
		50%
	Total	**100%**

24MMD304 Artificial Intelligence Applications in Medicine 3 0 0 3

Preamble
Machine learning is a discipline that integrates different sub-disciplines of informatics, chemistry, statistics, molecular biology, biochemistry and molecular medicine. Machine learning methods are essential and increasingly used in various fields of biomedicine from biomarker development to drug discovery. This course aims at to develop skills in using appropriate cutting-edge quantitative methods to fully exploit complex and high dimensional data in molecular medicine.

Unit 1 (10 Lectures)
Introduction to Machine learning; Supervised learning (parametric/non-parametric algorithms, support vector machines, kernels, neural networks) ; Unsupervised learning (clustering, dimensionality reduction, recommender systems, deep learning) ; Best practices in machine learning (bias/variance theory; innovation process in machine learning and AI. Basics of BioPython and its use in Structural bioinformatics discipline.

Unit 2 (10 Lectures)
Molecular docking with deep learning, convolution neural network and its potential in virtual screening and binding affinity prediction, machine learning algorithms as scoring functions and rank binding poses. Application of deep learning to predicting protein structure- A deep convolution neural network for bioactivity prediction in structure based drug discovery;

Unit 3 (8 Lectures)
Supervised and unsupervised representation to predict the future of patients from the electronic health records; deep dynamic memory model for predictive medicine, deep survival analysis; medical imaging data- deep learning for identifying metastatic breast cancer.

Unit 4 (9 Lectures)
Machine learning techniques in drug discovery and development, Machine learning applications in cancer prognosis and prediction, Emphasis on papers illustrating techniques for data-driven machine learning analysis of big data in Digital medicine.

Unit 5 (8 Lectures)
Practical aspects in Machine learning and project exercise in computer aided molecule design.

Text Books/References:

1) Introduction to Machine Learning, By Ethem Alpayd in, 4th Edition, MIT press, 2020
2) Artificial Intelligence in Drug Discovery, Editor: Nathan Brown, Copyright year 2021; Print ISBN 978-1-78801-547-9
3) Deep Learning for the Life Sciences, by Bharath Ramsundar, Peter Eastman, Patrick Walters, Vijay Pande, Released April 2019, Publisher(s): O'Reilly Media, Inc., ISBN: 9781492039839
4) https://www.mdpi.com/journal/biomolecules/special_issues/ML_drug_design

5) www.biopython.org

Course Outcomes: (CO)

CO1: Basic understanding of different machine learning concepts, deep learning and its application in structural bioinformatics.

CO2: Machine learning techniques and its application in Chemoinformatics and drug discovery program. Its use in different case studies in molecular medicine field.

CO3: Introduction to clinical applications of machine learning and its use in different diagnosis of disease process.

CO4: Understanding the machine learning process in cancer and other medical cases by review of latest literature and bringing in latest knowledge in the field.

CO5: Different machine learning project applications in molecular medicine implemented and executed.

Program Outcomes (PO)

PO1: Bioscience Knowledge
PO2: Problem Analysis
PO3: Design/Development of Solutions
PO4: Conduct Investigations of complex problems
PO5: Modern tools usage
PO6: Bioscientist and Society
PO7: Environment and Sustainability
PO8: Ethics
PO9: Individual & Team work
PO10: Communication
PO11: Project management & Finance
PO12: Lifelong learning

3 = High Affinity, 2 = Medium Affinity, 1 = Low Affinity, - = No Affinity

c C O	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	2	2	2	2	2	1	-	-	-	-	-	2
CO 2	3	2	2	2	2	1	-	-	-	-	-	2
CO 3	3	3	2	2	2	1	-	-	-	-	-	2
CO 4	3	3	2	2	2	1	-	-	-	-	-	2
CO 5	3	3	2	2	2	1	-	-	-	-	-	2

Program Specific Outcomes (PSO)
PSO 1 - Chemical and physical basis of biology
PSO 2 - Computational science in biology and medicine

PSO 3 - Biochemical and physiological complexity in biology and medicine
PSO 4 - Molecular technology in biology and medicine
PSO 5 - Cell based approaches in diagnosis and therapy
PSO 6 - Microorganisms in medicine
PSO 7 - Nanoscale entities and its significance in medicine
PSO 8 - Tissue architecture engineering in medicine
PSO 9 - Compounds as drugs and its efficacy
PSO 10 - Bioinformatics and artificial intelligence in medicine
PSO 11 –Technology in personalizing medicine
PSO 12 – Protein structural complexity in medicine
PSO 13 – Projecting science and medicine to public

- / C O	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12	PSO13
CO 1	3	3	2	1	-	1	-	-	1	3	1	2	1
CO 2	3	3	2	1	-	1	-	-	1	3	1	2	1
CO 3	3	3	2	1	-	1	-	-	3	3	2	2	1
CO 4	3	3	2	1	-	1	-	-	3	3	2	2	1
CO 5	3	3	2	1	-	1	-	-	3	3	1	2	1

Evaluation Pattern: 50+50 = 100

Internal Assessment – 50%		
Periodical 1	Exam	20%
Periodical 2	Exam	20%
Continuous Assessment	Assignment/Test/Quiz	10%
		50%
End Semester Examination- 50%		
Theory Exam	50%	
		50%
	Total	**100%**

23LSK301 Life Skills III 1-0-2-2

Pre-requisite: Team Spirit, self-confidence and required knowledge, basic English language skills, knowledge of high school level mathematics.

Course Objective: To help students understand the nuances of leadership, know the importance of working in teams, face challenging situations, crack interviews, improve communication skills and problem-solving skills.

Course Outcomes

CO1: Soft Skills - To acquire the ability to work in teams, present themselves confidently and showcase their knowledge, skills, abilities, interests, practical exposure, strengths and achievements to potential recruiters through a resume, video resume, and personal interview.

CO2: Soft Skills - To have better ability to prepare for facing interviews, analyse interview questions, articulate correct responses and respond appropriately to convince the interviewer of one's right candidature through displaying etiquette, positive attitude and courteous communication.
CO3: Aptitude - To manage time while arriving at appropriate strategies to solve questions in geometry, statistics, probability and combinatorics.
CO4: Aptitude - To analyze, understand and apply suitable methods to solve questions on data analysis and data sufficiency.
CO5: Verbal - To use diction that is less verbose and more refined and to use prior knowledge of grammar to correct/improve sentences.
CO6: Verbal - To understand arguments, analyze arguments and use inductive/deductive reasoning to arrive at conclusions. To be able to generate ideas, structure them logically and express them in a style that is comprehensible to the audience/recipient.
Skills: Communication, teamwork, leadership, facing interviews and problem-solving.

CO-PO Mapping

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	-	-	-	-	2	3	3	-	3
CO2	-	-	-	-	-	-	-	2	3	3	-	3
CO3	-	3	-	-	-	-	-	-	-	-	-	3
CO4	-	3	-	-	-	-	-	-	-	-	-	3
CO5	-	-	-	-	-	-	-	-	-	3	-	3
CO6	-	-	-	-	-	-	-	-	3	3	-	3

Syllabus

Soft Skills
Team Work: Value of teamwork in organizations, Definition of a team. Why team? Effective team building. Parameters for a good team, roles, empowerment and need for transparent communication, Factors affecting team effectiveness, Personal characteristics of members and its influence on team. Project Management Skills, Collaboration skills.
Leadership: Initiating and managing change, Internal problem solving, Evaluation and co-ordination, Growth and productivity, Importance of Professional Networking.
Facing an interview: Importance of verbal & aptitude competencies, strong foundation in core competencies, industry orientation / knowledge about the organization, resume writing (including cover letter, digital profile and video resume), being professional. Importance of good communication skills, etiquette to be maintained during an interview, appropriate grooming and mannerism.

Aptitude
Geometry: 2D, 3D, Coordinate Geometry, and Heights & Distance.

Permutations & Combinations: Basics, Fundamental Counting Principle, Circular Arrangements, and Derangements.

Probability: Basics, Addition & Multiplication Theorems, Conditional Probability and Bayes' Theorem.

Statistics: Mean, Median, Mode, Range, Variance, Quartile Deviation and Standard Deviation.

Data Interpretation: Tables, Bar Diagrams, Line Graphs, Pie Charts, Caselets, Mixed Varieties, and other forms of data representation.

Data Sufficiency: Introduction, 5 Options Data Sufficiency and 4 Options Data Sufficiency.

Campus recruitment papers: Discussion of previous year question papers of all major recruiters of Amrita Vishwa Vidyapeetham.

Miscellaneous: Interview Puzzles, Calculation Techniques and Time Management Strategies.

Verbal Skills

Vocabulary: Create an awareness of using refined language through idioms and phrasal verbs.

Grammar (Advanced Level): Enable students to improve sentences through a clear understanding of the rules of grammar.

Reasoning Skills: Facilitate the student to tap his reasoning skills through Syllogisms, and critical reasoning arguments.

Reading Comprehension (Advanced): Enlighten students on the different strategies involved in tackling reading comprehension questions.

Public Speaking Skills: Empower students to overcome glossophobia and speak effectively and confidently before an audience.

Writing Skills: Practice closet tests that assess basic knowledge and skills in usage and mechanics of writing such as punctuation, basic grammar and usage, sentence structure and rhetorical skills such as writing strategy, organization, and style. Practice formal written communication through writing emails especially composing job application emails.

References:

1. Adair. J., (1.986), "Effective Team Building: How to make a winning team", London, U.K: Pan Books.
2. Gulati. S., (2006) "Corporate Soft Skills", New Delhi, India: Rupa & Co.
3. The Hard Truth about Soft Skills, by Amazone Publication.
4. Verbal Skills Activity Book, CIR, AVVP
5. Nova's GRE Prep Course, Jeff Kolby, Scott Thornburg & Kathleen Pierce
6. The BBC and British Council online resources
7. Owl Purdue University online teaching resources
8. www.thegrammarbook.com online teaching resources
9. www.englishpage.com online teaching resources and other useful websites
10. Student Workbook: Quantitative Aptitude & Reasoning, Corporate & Industry Relations, Amrita Vishwa Vidyapeetham.
11. Quantitative Aptitude for All Competitive Examinations, Abhijit Guha.
12. How to Prepare for Quantitative Aptitude for the CAT, Arun Sharma.
13. How to Prepare for Data Interpretation for the CAT, Arun Sharma.
14. How to Prepare for Logical Reasoning for the CAT, Arun Sharma.
15. Quantitative Aptitude for Competitive Examinations, R S Aggarwal.
16. A Modern Approach to Logical Reasoning, R S Aggarwal.
17. A Modern Approach to Verbal & Non-Verbal Reasoning, R S Aggarwal.

Evaluation Pattern

Assessment	Internal	External
Continuous Assessment (CA)* – Soft Skills	30	-
Continuous Assessment (CA)* – Aptitude	10	25

Continuous Assessment (CA)* – Verbal	10	25
Total	50	50

*CA - Can be **presentations, speaking activities and tests.**

Electives

24MMD331 Cell Therapy 3-0-0-3

Preamble
The course gives an overview of basic understanding of cellular function and gene manipulation being harnessed to develop efficient therapy for the cure of different disease such as cancer and other disorders.

Syllabus
Unit 1 5 lectures
What is cell therapy and its significance? When does a cell therapy is required? What type of cells are used for cell therapy and why? Disease requiring cell therapy.

Unit 2 12 lectures
Cell function enhancement by genetic engineering of these cells. Emerging approaches that are used for genetic modification. Examples of cell therapy in the context of cancer and other disorders.

Unit 3 12 lectures
Engineered T cells, history of CAR T development and CAR-T cell therapy in haematological malignancies, Different strategies adopted to culture cells for therapy, Link between cell therapy development in the laboratory and commercial therapy.

Unit 4 16 lectures
Advantages and limitations of cell therapy. Toxicities associated with cell therapy; Regulations applicable to cell therapies. Analytical methods for safe and effective quality control for the effectiveness of therapy. Preparation of patients for cell therapy. Continuous monitoring of patients following cell therapy.

Text Books

1. Cell Therapy, Current Status and Future Directions, Edited by Dwaine F. and Emerich Gorka Orive (2017). Published by Humana press.
2. Alberts B, Johnson A, Lewis J, Morgan D, Raff M, Roberts K, Walter P. (2014) Molecular Biology of the Cell 6th Ed. Garland Science, London.
3. Second Generation Cell and Gene-Based Therapies, Biological Advances, Clinical Outcomes and Strategies for Capitalisation, Editors: Alain Vertes, Nathan Dowden, Devyn Smith, Nasib Qureshi (2020). Published by Elsevier.

Course Outcomes
CO1 To understand the significance of cell therapy in treating debilitating diseases
CO2 To learn about types of cells used in cell therapy
CO3 To learn how cells are modified genetically and the application of such cells in treating cancer and other disorders
CO4 To learn about CAR T cells, its development and application of CAR T therapy in hematological malignancies
CO5 To learn about the pros and cons of cell therapy, regulatory and ethical aspects, and preparation and monitoring of patients

Program Outcome

PO1: Bioscience Knowledge
PO2: Problem Analysis
PO3: Design/Development of Solutions
PO4: Conduct Investigations of complex problems
PO5: Modern tools usage
PO6: Bioscientist and Society
PO7: Environment and Sustainability
PO8: Ethics
PO9: Individual & Team work
PO10: Communication
PO11: Project management & Finance
PO12: Lifelong learning

3 = High Affinity, 2 = Medium Affinity, 1 = Low Affinity, - = No Affinity

c C O	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	3	3	2	3	3	1	-	-	-	-	3
CO 2	3	3	3	2	3	3	1	-	-	-	-	3
CO 3	3	3	3	2	3	3	1	-	-	-	-	3
CO 4	3	3	3	2	3	3	1	-	-	-	-	3
CO 5	3	3	3	2	3	3	1	3	-	-	-	3

Program Specific Outcomes. (PSO)

PSO 1 - Chemical and physical basis of biology
PSO 2 - Computational science in biology and medicine
PSO 3 - Biochemical and physiological complexity in biology and medicine
PSO 4 - Molecular technology in biology and medicine
PSO 5 - Cell based approaches in diagnosis and therapy
PSO 6 - Microorganisms in medicine
PSO 7 - Nanoscale entities and its significance in medicine
PSO 8 - Tissue architecture engineering in medicine
PSO 9 - Compounds as drugs and its efficacy
PSO 10 - Bioinformatics and artificial intelligence in medicine
PSO 11 –Technology in personalizing medicine
PSO 12 – Protein structural complexity in medicine

- C O	PSO1	PSO2	PSO3	PSO 4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12	PSO13
CO 1	-	1	3	3	3	-	-	-	-	-	3	-	3
CO 2	-	1	3	3	3	-	-	-	-	-	3	-	3

CO 3	-	1	3	3	3	-	-	-	-	-	3	-	3
CO 4	-	1	3	3	3	-	1	-	-	-	3	-	3
CO 5	-	1	3	3	3	1	-	-	-	-	3	-	3

PSO 13 – Projecting science and medicine to public

Evaluation Pattern: 50+50 = 100

Internal Assessment – 50%		
Periodical 1	Exam	20%
Periodical 2	Exam	20%
Continuous Assessment	Assignment/Test/Quiz	10%
		50%
End Semester Examination- 50%		
Theory Exam	50%	
		50%
	Total	**100%**

24MMD332 Post-translational modifications in Biology and Medicine 3 0 0 3

Preamble
Post translational modification is a key event that impart different functions to proteins. These modifications play a major role in many diseases and are target for therapy. Thus, identification, understanding and targeting it for therapy has huge applications in medicine.

Unit 1 **7 Lectures**
What are post translational modifications and how many different types of these modifications exists and its significance in biology and medicine. What is the purpose of post translational modifications. What are phosphorylation, glycosylation, neddylation, ubiquitinylation, sumoylation, acetylation, deamidation, sulfation including oxidation.

Unit 2 **10 Lectures**
What is phosphorylation and its biological and medical significance. Role of phosphorylation in the function of those biological macromolecules such as proteins or lipids. How the addition/removal of functional groups in drastic alterations in protein function.

Unit 3 **10 Lectures**
What is glycosylation. What are glycoproteins and glycolipids and their significance in biology and medicine. Why they are part of many receptors and its role in function of those proteins. Use of it as biomarkers in many diseases.

Unit 4 **10 Lectures**
Significance of ubiquitinylation, sumoylation, acetylation, deamidation, sulfation including oxidation. Their significance in biology and its applications in medicine. PTM

Characterization and its modification patterns in biopharmaceutical development and production.

Unit 5 **8 Lectures**

Post-Translational Modification in Drug Design, enzyme function and drug binding affinity. Conformational changes and its role in protein function and diseases. Impact of post-Translational modification on biotherapeutic formulation.

CO1 To understand the basic concept of post-translational modifications, protein properties and its significance in biology

CO2 To understand the different types of post-translational modifications and its significance

CO3 Protein structure function understanding and its importance

CO4 Significance of post-translational modifications drug development and therapy

CO5 Role of post-translational modifications in diseases

PO1: Bioscience Knowledge
PO2: Problem Analysis
PO3: Design/Development of Solutions
PO4: Conduct Investigations of complex problems
PO5: Modern tools usage
PO6: Bioscientist and Society
PO7: Environment and Sustainability
PO8: Ethics
PO9: Individual & Team work
PO10: Communication
PO11: Project management & Finance
PO12: Lifelong learning

c / C O	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	3	3	3	2	2	-	-	1	-	-	2
CO 2	3	3	3	3	2	-	-	-	1	-	-	2
CO 3	3	3	3	3	2	-	-	-	-	-	-	1
CO 4	3	3	3	3	2	1	-		-			2
CO 5	3	3	3	3	2	2	1	-	-	-	-	1

Program Specific Outcomes.

PSO 1 - Chemical and physical basis of biology
PSO 2 - Computational science in biology and medicine
PSO 3 - Biochemical and physiological complexity in biology and medicine
PSO 4 - Molecular technology in biology and medicine
PSO 5 - Cell based approaches in diagnosis and therapy
PSO 6 - Microorganisms in medicine
PSO 7 - Nanoscale entities and its significance in medicine
PSO 8 - Tissue architecture engineering in medicine
PSO 9 - Compounds as drugs and its efficacy
PSO 10 - Bioinformatics and artificial intelligence in medicine
PSO 11 –Technology in personalizing medicine
PSO 12 – Protein structural complexity in medicine
PSO 13 – Projecting science and medicine to public

- / CO	PSO1	PSO2	PSO3	PSO 4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12	PSO13
CO 1	3	1	3	3	3	-	-	-	3	2	2	3	2
CO 2	3	2	3	2	3	-	-	-	3	2	1	3	1
CO 3	3	3	3	2	3	-	-	-	3	2	2	3	2
CO 4	3	3	3	3	3	-	-	-	3	3	3	3	2
CO 5	3	1	3	3	3	-	-	-	3	2	2	3	3

Evaluation Pattern: 50+50 = 100

Internal Assessment – 50%		
Periodical 1	Exam	20%
Periodical 2	Exam	20%
Continuous Assessment	Assignment/Test/Quiz	10%
		50%
End Semester Examination- 50%		
Theory Exam	50%	
		50%
	Total	**100%**

24MMD333 Stem cell Biology 3 0 0 3

Preamble:

Advancements in stem cell biology are occurring at a rapid pace. Breakthroughs in this field may lead to regenerative therapies for diabetes, heart disease, age-related organ failure, genetic diseases, Parkinson's, and severe tissue traumas such as spinal

cord injuries. Stem cells are revolutionizing the regenerative medicine sector and it provides immense hope for the medical world to treat the diseases that are once considered as non-treatable. Stem cells are also being used to gain a better understanding of mammalian development, cell differentiation and gene regulation.This course aims to provide a comprehensive overview of the basic biology and some applications of stem cells. This course will cover the basics of stem cells, classification of stem cells, embryonic stem cells, adult stem cells, self renewal and quiescence of stem cells, applications of stem cells, induced pluripotent stem cells and its applications, current controversies associated with stem cell research.
-

Unit 1 **(10 Lectures)**

Introduction to stem cells; basic concepts and definitions; self-renewal, clonality, and potency of stem cells; types of stem cells; differentiation potential of stem cells; stem cell niche; introduction, concept of stem cell niche and its importance

Unit 2 **(10 Lectures)**

Introduction to cell cycle kinetics of stem cells in vivo; mammalian cell cycle regulation and cyclin-dependent kinase inhibitors; role of cyclin-dependent kinase inhibitors in stem cell regulation; molecular, epigenetic, and genetic control of stem cell differentiation and specializations.

Unit 3 **(10 Lectures)**

Embryonic stem cells, defining properties of embryonic stem cells, Human embryonic stem cells, human embryonic germ cells; adult stem cells, types of adult stem cells, significance of adult stem cells in therapy, markers of adult stem cells

Unit 4 **(10 Lectures)**

Hematopoietic stem cell (HSC); introduction, definition, sources of HSCs, identification of HSCs, uses of HSCs; Mesenchymal stem cell (MSC); introduction, sources of MSCs, identification of MSCs, properties of MSCs, uses of MSCs; Pluripotency and Induced pluripotency; introduction, definition, induced pluripotent stem cell (iPSC), potential application of iPSCs

Unit 5 **(5 Lectures)**

Stem cell application; existing and potential clinical use of stem cells; application of stem cells to regenerative medicine; controversies in stem cell research; ethical issues associated with stem cell research; current controversies surrounding stem cell research.

Text book:

(1) Essentials of Stem Cell Biology, Second Edition, 2009, Edited by Robert Lanza, M.D.,ISBN: 978-0-12-374729-7, Elsevier Inc.

(2) Stem Cell Biology, Daniel Marshak, Richard L. Gardener and David Gottlieb, Cold Spring Harbour Laboratory Press.

Course outcome (CO)

CO1: Understanding of basic concepts and definitions in stem cell biology

CO2: Understand the cell cycle regulation in stem cells

CO3: Understand the properties of embryonic and adult stem cells along with their potential application in stem cell therapy

CO4: A deeper understanding of hematopoietic, mesenchymal and induced pluripotent stem cells and their clinical applications

CO5: Significance of existing and potential clinical use of stem cells and the controversies in stem cell research

Program Outcome
PO1: Bioscience Knowledge
PO2: Problem Analysis
PO3: Design/Development of Solutions
PO4: Conduct Investigations of complex problems
PO5: Modern tools usage
PO6: Bioscientist and Society
PO7: Environment and Sustainability
PO8: Ethics
PO9: Individual & Team work
PO10: Communication
PO11: Project management & Finance
PO12: Lifelong learning

3 = High Affinity, 2 = Medium Affinity, 1 = Low Affinity, - = No Affinity

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	-	-	-	-	-	-	-	-	-	-	1
CO 2	3	-	-	-	-	-	-	-	-	-	-	1
CO 3	3	2	-	2	2	1	-	-	-	-	-	1
CO 4	3	2	-	2	2	1	-	-	-	-	-	1
CO 5	3	2	3	3	3	2	-	2	-	-	-	1

Program Specific Outcome

PSO 1 - Chemical and physical basis of biology
PSO 2 - Computational science in biology and medicine
PSO 3 - Biochemical and physiological complexity in biology and medicine
PSO 4 - Molecular technology in biology and medicine
PSO 5 - Cell based approaches in diagnosis and therapy
PSO 6 - Microorganisms in medicine
PSO 7 - Nanoscale entities and its significance in medicine
PSO 8 - Tissue architecture engineering in medicine
PSO 9 - Compounds as drugs and its efficacy
PSO 10 - Bioinformatics and artificial intelligence in medicine
PSO 11 –Technology in personalizing medicine
PSO 12 – Protein structural complexity in medicine
PSO 13 – Projecting science and medicine to public

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12	PSO13
CO 1	2	-	1	-	-	-	-	-	-	-	-	-	-
CO 2	2	-	2	-	-	-	-	-	-	-	-	-	-
CO 3	1	-	2	2	3	-	-	-	-	-	2	-	1
CO 4	1	-	2	2	3	-	-	-	-	-	2	-	1
CO 5	-	-	3	3	3	-	-	2	-	-	3	-	3

Evaluation Pattern: 50+50 = 100

Internal Assessment – 50%		
Periodical 1	Exam	20%
Periodical 2	Exam	20%
Continuous Assessment	Assignment/Test/Quiz	10%
		50%
End Semester Examination- 50%		
Theory Exam	50%	
		50%
	Total	**100%**

SEMESTER 6

24MMD311 Fundamentals of Pharmacology 2-0-0-2

Preamble

Introduction to Pharmacology, Definition, historical landmarks and scope of pharmacology, nature and source of drugs, essential drugs concept and routes of drug administration, Pharmacokinetics- Membrane transport, absorption, distribution, metabolism and excretion of drugs. Pharmacodynamics- Principles and mechanisms of drug action. Drug discovery and clinical evaluation of new drugs -Drug discovery phase, preclinical evaluation phase, clinical trial phase, phases of clinical trials and pharmacovigilance.

Unit 1: (4 lectures)
Introduction to pharmacology, history and current developments in pharmacology
Unit 2: (8 lectures)
Drug receptors and Pharmacodynamics
Unit 3: (8 lectures)
Pharmacokinetics and Pharmacodynamics
Unit 4: (6 lectures)
Drug Biotransformation
Unit 5 (4 lectures)
Development and Regulation of Drugs

Text book:
Essentials of Medical Pharmacology by KD Tripathi 8th Edition 2018
Class reference book: Basic & Clinical Pharmacology by Bertram G. Katzung, 14th Edition 2018

Program Outcome
PO1: Bioscience Knowledge
PO2: Problem Analysis
PO3: Design/Development of Solutions
PO4: Conduct Investigations of complex problems
PO5: Modern tools usage
PO6: Bioscientist and Society
PO7: Environment and Sustainability
PO8: Ethics
PO9: Individual & Team work
PO10: Communication
PO11: Project management & Finance
PO12: Lifelong learning

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	-	-	-	1	-	-	3	2	-	-
CO2	3	1	-	-	-	1	-	-	3	2	-	-
CO3	3	1	-	-	-	1	-	-	3	2	-	-
CO4	3	1	-	-	-	1	2	3	3	2	-	-
CO5	3	2	1	-	-	1	-	-	3	2	-	-

Program Specific Outcomes. (PSO)

PSO 1 - Chemical and physical basis of biology
PSO 2 - Computational science in biology and medicine
PSO 3 - Biochemical and physiological complexity in biology and medicine
PSO 4 - Molecular technology in biology and medicine
PSO 5 - Cell based approaches in diagnosis and therapy
PSO 6 - Microorganisms in medicine
PSO 7 - Nanoscale entities and its significance in medicine
PSO 8 - Tissue architecture engineering in medicine
PSO 9 - Compounds as drugs and its efficacy
PSO 10 - Bioinformatics and artificial intelligence in medicine
PSO 11 –Technology in personalizing medicine
PSO 12 – Protein structural complexity in medicine
PSO 13 – Projecting science and medicine to public

	POS1	POS2	POS3	POS4	POS5	POS6	POS7	POS8	POS9	POS10	POS11
CO1	2	-	3	1	-	-	-	-	3	-	-
CO2	3	-	3	3	-	-	-	-	3	-	-

CO3	3	-	3	3	2	-	-	-	3	-	-
CO4	3	-	3	3	-	-	-	-	3	-	-
CO5	1	-	3	1	-	-	-	-	3	-	-

Evaluation Pattern: 50+50 = 100

Internal Assessment – 50%		
Periodical 1	Exam	20%
Periodical 2	Exam	20%
Continuous Assessment	Assignment/Test/Quiz	10%
		50%
End Semester Examination- 50%		
Theory Exam	50%	
		50%
	Total	**100%**

24MMD312 Therapeutics in Medicine 2 0 0 2

Preamble:

These are chemical entities that prevent the growth of microorganisms specifically. They are nontoxic to other organisms and are largely safe for the environment. There are different types of anti-microbial agents. In recent years, the field of therapeutics has expanded to include medications targeting specific diseases and processes, including cancer. A prominent role is played by monoclonal antibodies, engineered proteins that precisely target cancer cells.

Syllabus:

Unit 1 (10 Lectures)
Antibiotics (Bacterial cell wall synthesis, DNA replication, transcription, folate synthesis, protein synthesis inhibitors etc), Antifungal, antiviral and anti-parasitic agents and their resistance mechanisms.

Unit 2 (10 Lectures)
Monoclonal Antibodies in Targeted Therapy. Introduction to monoclonal antibodies and their production methods. Mechanisms of action of different types of monoclonal antibodies used in cancer treatment (e.g., immune checkpoint inhibitors, antibody-drug conjugates).

Unit 3 (5 Lectures)
Small-Molecule Inhibitors and Cellular Therapies. Targeting specific signaling pathways in cancer cells with small-molecule inhibitors.

Unit 4 (5 Lectures)
CAR T-cell therapy and other emerging cellular therapies for cancer treatment, including their mechanisms of action and potential applications.

Text Books:

(1) Antimicrobial Agents: Antibacterials and Antifungals by André Bryskier (Editor); ASM Press.
(2) Antimicrobial Chemotherapy by David Greenwood (Editor); Oxford University Press; 4 edition.
(3) Kröger N, Gribben J, Chabannon C, et al., editors. The EBMT/EHA CAR-T Cell Handbook [Internet]. Cham (CH): Springer; 2022. Available from: https://www.ncbi.nlm.nih.gov/books/NBK584154/ doi: 10.1007/978-3-030-94353-0
(4) Human Monoclonal Antibodies: Methods and Protocols. Springer;2014

CO1: The students will learn about different antimicrobial agents that can be effectively used against various infectious agents.
CO2: Understand the mechanism of action of different antimicrobial drugs and targeted therapies.
CO3: Comprehend traditional and targeted therapeutic approaches.
CO4: The students will learn about various methods involved in infection control.
CO5: The students will learn to evaluate the benefits and limitations of targeted therapy.

PO1: Bioscience Knowledge
PO2: Problem Analysis
PO3: Design/Development of Solutions
PO4: Conduct Investigations of complex problems
PO5: Modern tools usage
PO6: Bioscientist and Society
PO7: Environment and Sustainability
PO8: Ethics
PO9: Individual & Team work
PO10: Communication
PO11: Project management & Finance
PO12: Lifelong learning

c / C O	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	1	2	1	-	-	-	-	-	-	-	3
CO 2	3	1	1	1	-	-	-	-	-	-	-	3
CO 3	3	1	1	1	-	-	-	-	-	-	-	3
CO 4	3	1	3	1	-	-	-	-	-	-	-	3
CO 5	3	1	1	1	-	-	-	-	-	-	-	3

Program Specific Outcomes. (PSO)

PSO 1 - Chemical and physical basis of biology
PSO 2 - Computational science in biology and medicine
PSO 3 - Biochemical and physiological complexity in biology and medicine
PSO 4 - Molecular technology in biology and medicine

PSO 5 - Cell based approaches in diagnosis and therapy
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PSO 9 - Compounds as drugs and its efficacy
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PSO 11 –Technology in personalizing medicine
PSO 12 – Protein structural complexity in medicine
PSO 13 – Projecting science and medicine to public

- CO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12	PSO13
CO 1	-	-	-	-	-	3	-	-	2	-	-	-	1
CO 2	-	-	-	-	-	3	-	-	2	-	-	3	1
CO 3	-	-	-	-	-	3	-	-	2	-	3	3	1
CO 4	-	-	-	-	-	3	-	-	2	-	3	3	1
CO 5	-	-	-	-	-	3	-	-	2	-	-	-	1

Evaluation Pattern: 50+50 = 100

Internal Assessment – 50%		
Periodical 1	Exam	20%
Periodical 2	Exam	20%
Continuous Assessment	Assignment/Test/Quiz	10%
		50%
End Semester Examination- 50%		
Theory Exam	50%	
		50%
	Total	**100%**

24MMD313 Art of Scientific Writing 1-0-0-1
Preamble

Art of scientific writing is an essential component for an aspiring student pursuing scientific endeavors. Projecting one's idea and design of experiments towards proving or disproving a hypothesis and interpretation of the findings scientifically forms the pillar of scientific research. In order to communicate efficiently and effectively to mass at large, requires introducing one's idea and concept by articulating effectively and succinctly the research question, hypothesis and the experiments used to test one's hypothesis. This include introducing the topic, how the hypothesis originated and the methods used to test the hypothesis. The results obtained following testing hypothesis needs to be explained and communicated effectively to be accepted by the scientific community. Based on the results, the student is prompted to think critically on the

results in the context of literature leading to a productive scientific discussion. This session will expose the student to translate the scientific work they carried out into a manuscript of publication quality.

Unit 1 **(1 Lectures)**
Developing a hypothesis and the research question and its validity in the context of the literature.

U**nit 2** **(2 Lectures)**
Based on the above conceptual understanding summarize the study in a paragraph for anyone to understand what this study is without reading the entire body text. This would lead to creation of an abstract.

Unit 3 **(2 Lectures)**
Introduce the topic: The goal here is to introduce the subject under study with respect to the literature and state why this study is conducted and what for. Bring in the questions to be evaluated with supporting literature by referencing carefully.

Unit 4 **(3 Lectures)**
In order to accomplish the task of experiments, materials and methods needs to be specified clearly to address the question. In this section one will provide a detailed explanation of the experiment including the samples used, chemicals used and experimental protocols etc that has been carried out such that someone might be able to reproduce the study. If statistical analysis is involved, provide details of it.

Unit 5 **(6 Lectures)**
Describe the results in details with the help of tables, graphs and/or figures. The goal of this section is to state the results as it is and do not engage in discussing your findings. The discussion section is to discuss about one's findings in the context of experiments one performed and explain the outcomes and assess the findings related to investigation. Discuss how the results are compared to other published findings and how it adds value to the advancement of science and well-being. Appropriate references should be cited to support the statements and avoid making unsubstantiated claims or interpretations.

Unit 6 **(1 Lectures)**
Conclusion and future perspectives based on the findings.

Text Books
The Art of Scientific Writing: From Student Reports to Professional Publications in Chemistry and Related Fields, 2nd, Completely Revised Edition by Wiley
Authors: Hans F. Ebel, Claus Bliefert, William E. Russey.

Course Outcome
CO1 Students will be exposed to the significance scientific articulation and its important in conveying scientific concept.
CO2 Students will be exposed to how a scientific summary is structured to form an abstract.
CO3 Importance of developing appropriate research question and hypothesis to address the scientific challenge and articulating it in a scientific language.
CO4 Students will be exposed to how critically and scientifically interpret and write data.
CO5 Students will be exposed to scientifically discuss their results in the context of literature and develop the skills to conclude the outcome of the findings.

Program Outcome

PO1: Bioscience Knowledge
PO2: Problem Analysis
PO3: Design/Development of Solutions
PO4: Conduct Investigations of complex problems
PO5: Modern tools usage
PO6: Bioscientist and Society
PO7: Environment and Sustainability
PO8: Ethics
PO9: Individual & Team work
PO10: Communication
PO11: Project management & Finance
PO12: Lifelong learning

3 = High Affinity, 2 = Medium Affinity, 1 = Low Affinity, - = No Affinity

c C O	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	2	2	1	-	-	2	-	1	2	3	-	3
CO 2	2	2	1	-	2	2	-	1	-	3	-	3
CO 3	1	2	1	1	2	2	-	-	1	3	-	2
CO 4	3	3	1	1	2	2	-	2	-	3	-	2
CO 5	3	2	-	2	2	1	-	2	2	3	-	2

Program Specific Outcomes. (PSO)

PSO 1 - Chemical and physical basis of biology
PSO 2 - Computational science in biology and medicine
PSO 3 - Biochemical and physiological complexity in biology and medicine
PSO 4 - Molecular technology in biology and medicine
PSO 5 - Cell based approaches in diagnosis and therapy
PSO 6 - Microorganisms in medicine

- / C O	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12	PSO13
CO 1	1	-	-	-	-	-	-	-	-	-	-	-	3
CO 2	1	-	-	-	-	-	-	-	-	-	-	-	3
CO 3	1	-	-	-	-	-	-	-	-	-	-	-	3
CO 4	1	-	-	-	-	-	-	-	-	-	-	-	3
CO 5	1	-	-	-	-	-	-	-	-	-	-	-	3

PSO 7 - Nanoscale entities and its significance in medicine
PSO 8 - Tissue architecture engineering in medicine
PSO 9 - Compounds as drugs and its efficacy
PSO 10 - Bioinformatics and artificial intelligence in medicine
PSO 11 –Technology in personalizing medicine
PSO 12 – Protein structural complexity in medicine
PSO 13 – Projecting science and medicine to public

Evaluation Pattern: 50+50 = 100

Internal Assessment – 50%		
Periodical 1	Exam	20%
Periodical 2	Exam	20%
Continuous Assessment	Assignment/Test/Quiz	10%
		50%
End Semester Examination- 50%		
Theory Exam	50%	
		50%
	Total	**100%**

24MMD391 Project (6 credits)

Research project for providing hands on training to those who want to graduate with a three year degree.

24MMD314 Nanosciences in Biology 3 0 0 3

Unit-1 (15 lecture)
Introduction to nanotechnology; Different types of nanomaterials; Nanostructures in Biological Systems - Nucleic Acid, Amino acids, proteins, Carbohydrates and lipids; Nanobiotechnology – learning from nature - DNA nanotechnology - self-assembled DNA nanotubes and their applications, Biological nanoparticles production - plants and microbial

Unit-2 (15 lecture)
Applications of nanomaterials to biology: Fluorescent biological labels - Bioimaging, Nanoparticles for biological assays; Nanoparticles in disease diagnosis - MRI, CT and optical contrast agents, Nanomaterials in tissue engineering and regenerative medicine

Unit-3 (15 lecture)

Biosensors – different types, Applications of molecular recognition elements in nanosensing of different analytes, Miniaturized devices in nanobiotechnology - types and applications, lab on a chip concept.

Text books:

(1) Nanotechnology in Biology and Medicine: Methods, Devices and Application by Tuan Vo-Dinh .CRC press, 2007.
(2) Nanosystem characterization tools in the life sciences by Challa Kumar. WileyVCH, 2006.
(3) Challa Kumar(Ed) - Nanomaterials for Medical Diagnosis and Therapy, Wiley-VCH, 2006

Electives

24MMD341 Protein structure and function 3 0 0 3

Preamble:
Protein structure and function is a sub-discipline that integrates structural bioinformatics and molecular medicine. This course aims at understanding the biomolecular sequence, structure and function which form the fundamental concepts in structural bioinformatics. This course is divided into different units: Molecular structure of biomolecules; physico-chemical properties of amino acids; Biomolecular structure and function, Pattern identification and recognition.

Unit 1 (10 Lectures)

The amino acid building blocks - classification, structure and physical properties of the standard amino acids; essential and non-essential amino acids; proteinaceous and non-proteinaceous amino acids; optical properties of amino acids; zwitterionic property, isoelectric points and titration curves of amino acids; chemistry of peptide bond; non-ribosomal peptide bond formation; amino acids as precursors of other bioactive compounds; Lambert-Beer Law.

Unit 2 (10 Lectures)

Classification of proteins on the basis of structure, function and composition; conformation of proteins; weak and strong interactions in protein conformation; software involved in judging protein conformation and optimization; basics of protein structure prediction using homology modelling, threading and ab initio modelling.

Unit 3 (10 Lectures)

Primary, secondary (alpha helix, beta sheet, beta turn, collagen helix), tertiary and quaternary structure of biomolecules; Ramachandran Plot; Errat plot; different normal databases and integrated databases in molecular biology; biomolecular structure and function of myoglobin and hemoglobin; molecular physiology of myoglobin and hemoglobin; Bohr effect; Hill's coefficient.

Unit 4 (10 Lectures)

Concept of lock and key, and induced fit theory; concept of activation energy and binding energy; enzyme kinetics and its physiological significances; enzyme inhibition; types of inhibitors of enzyme with examples.

Unit 5 (5 Lectures)

Symmetry; identification of three dimensional structural pattern; pattern recognition and function of biomolecules.

Unit 5: Post translational modifications in structure function,

Reference Books:

1. Introduction to protein structure, by Carl Branden and John Tooze. 2nd Edition, New York: Garland Publishing Company, 410, (1999). ISBN 9780815323051.

2. Lehninger Principles of biochemistry 7th Edition (2017), Publisher: WH Freeman, Authors Michael Cox, David L. Nelson.

Course outcome (CO)

CO1: A deeper understanding of amino acid structure, peptide bond chemistry and physic-chemical properties of amino acids

CO2: Understand the conformation of proteins and the basics of protein structure prediction

CO3: Understand the different levels of biomolecular organization

CO4: A deeper understanding of enzyme kinetics and enzyme inhibition

CO5: Significance of bioinformatics in understanding three dimensional structure of proteins

Program outcome (PO)

PO1: Bioscience Knowledge
PO2: Problem Analysis
PO3: Design/Development of Solutions
PO4: Conduct Investigations of complex problems
PO5: Modern tools usage
PO6: Bioscientist and Society
PO7: Environment and Sustainability
PO8: Ethics
PO9: Individual & Team work
PO10: Communication
PO11: Project management & Finance
PO12: Lifelong learning

3 = High Affinity, 2 = Medium Affinity, 1 = Low Affinity, - = No Affinity

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	-	-	-	-	-	-	-	-	-	-	1
CO 2	3	2	2	2	2	-	-	-	-	-	-	1
CO 3	3	-	-	-	-	-	-	-	-	-	-	1
CO 4	3	2	-	2	-	2	2	-	-	-	-	1
CO 5	3	2	3	3	3	-	-	-	-	-	-	1

Program Specific Outcomes.

PSO 1 - Chemical and physical basis of biology
PSO 2 - Computational science in biology and medicine
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PSO 9 - Compounds as drugs and its efficacy
PSO 10 - Bioinformatics and artificial intelligence in medicine
PSO 11 –Technology in personalizing medicine
PSO 12 – Protein structural complexity in medicine
PSO 13 – Projecting science and medicine to public

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12	PSO13
CO 1	3	-	1	-	-	-	-	-	-	-	-	-	-
CO 2	3	3	1	-	-	-	-	-	-	2	-	3	-
CO 3	3	-	2	-	-	-	-	-	-	-	-	3	-
CO 4	3	-	3	-	-	-	-	-	2	-	-	-	2
CO 5	3	3	-	-	-	-	-	-	-	3	-	3	-

Evaluation Pattern: 50+50 = 100

Internal Assessment – 50%		
Periodical 1	Exam	20%
Periodical 2	Exam	20%
Continuous Assessment	Assignment/Test/Quiz	10%
		50%
End Semester Examination- 50%		
Theory Exam	50%	
		50%
	Total	**100%**

24MMD342 Biopolymers in Medicine 3 0 0 3

Preamble
Biopolymers in nature are produced by a range of microorganisms and plants. Biopolymers produced by microorganisms require specific nutrients and controlled environmental conditions. This course deals with the recent developments and trends of biopolymers especially in the field of nanotechnology, a basic introduction, a detailed discussion on various characterization techniques used for characterizing biopolymers, applications of biopolymers in various fields, especially in the field related to nanoscience and nanotechnology for medical application.

Unit-1 (**3 lectures)**

Introduction and Basic Concepts: Definition of Terminology and Basic Concepts, Nomenclature of Polymers, Polymer Architectures

Unit-2 **(6 lectures)**

Polymers in Solution, Molecular Weight, Physical State of Polymers and related Materials: Fracture Behavior, Tailor-Made Plastics, Cross-Linked Materials, Polymer Additives.

Unit-3 **(10 lectures)**

Biopolymers introduction and classification, Biopolymers: Bioplastics, biofibers, biopolymeric composites, Bio-inorganic polymeric composites, Biopolymers for Specific Applications, Biomedical, Drug delivery, Environmental, Pharmaceutical Technology. Polymeric nanoparticles: Bio-polymeric nanomaterials and its applications:

Unit-4 (**11 lectures)**

Polysaccharides Basic sources, characteristics, polymer isolation process, derivatives and their various bio medical applications.Polysaccharide Graft Copolymers – Synthesis, Properties and Applications.

Unit-5 (**15 lectures)**

Biopolymer Blends and Biocomposites, Scaffolds, Hydrogels-Classifications, preparation and their various applications. Applications of Biopolymers in Drug Delivery, Hemostasis, Tissue Engineering, Regenerative Medicine and Wound Healing.

Text Books:

(1) Text book of Polymer Science….by Fred W. Billmeyer;

(2) Biopolymers: Biomedical and Environmental Applications by Susheel Kalia and Luc Avérous, Wiley 2011.

CO1 To understand the basic concept of polymer science, nomenclature properties and architectures

CO2 Learn about polymer solution, molecular weight calculation and physical state of polymers

CO3 To understand about biopolymer and their composites, bioplastics and biomedical applications of biopolymers and their nanoparticles

CO4 To learn about different types of polysaccharides and their biomedical applications in different field

CO5 To know about the future trends of biopolymers and biopolymers in wound healing and other applications

PO1: Bioscience Knowledge
PO2: Problem Analysis
PO3: Design/Development of Solutions
PO4: Conduct Investigations of complex problems
PO5: Modern tools usage
PO6: Bioscientist and Society
PO7: Environment and Sustainability

PO8: Ethics
PO9: Individual & Team work
PO10: Communication
PO11: Project management & Finance
PO12: Lifelong learning

c C O	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	-	2	-	-	1	2	-	-	-	-	2
CO 2	2	2	1	-	-	-	2	-	-	-	-	1
CO 3	3	1	1	1	1	1	2	-	-	-	-	1
CO 4	3	1	-	2	-	2	3		-			2
CO 5	3	-	1	1	-	2	2	-	-	-	-	1

Program Specific Outcomes.
PSO 1 - Chemical and physical basis of biology
PSO 2 - Computational science in biology and medicine
PSO 3 - Biochemical and physiological complexity in biology and medicine
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PSO 5 - Cell based approaches in diagnosis and therapy
PSO 6 - Microorganisms in medicine
PSO 7 - Nanoscale entities and its significance in medicine
PSO 8 - Tissue architecture engineering in medicine
PSO 9 - Compounds as drugs and its efficacy
PSO 10 - Bioinformatics and artificial intelligence in medicine
PSO 11 –Technology in personalizing medicine
PSO 12 – Protein structural complexity in medicine
PSO 13 – Projecting science and medicine to public

- C O	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO 1	-	1	-	-	-	-	1	-	-	-
CO 2	-	-	-	-	-	_	-	-	-	-
CO 3	2	3	-	2	1	2	3	1	1	-
CO 4	2	3	1	1	1	2	2	2	2	-
CO 5	-	3	1	1	1	1	1	2	2	-

Evaluation Pattern: 50+50 = 100

Internal Assessment – 50%		
Periodical 1	Exam	20%
Periodical 2	Exam	20%
Continuous Assessment	Assignment/Test/Quiz	10%
		50%
End Semester Examination- 50%		
Theory Exam	50%	
		50%
	Total	**100%**

24MMD343 Molecular Diagnostics 3 0 0 3

Preamble

Molecular diagnostics has revolutionized healthcare by providing highly sensitive and specific methods for diagnosing diseases. Building upon the foundational knowledge of molecular biology and methods, this course delves into the practical applications of these techniques in a clinical setting. Students will explore diverse molecular diagnostic assays used to detect pathogens, diagnose genetic disorders, and guide personalized medicine approaches.

Syllabus

Unit 1 (10 Lectures)

Introduction to Advanced Molecular Diagnostics: Overview of Advanced Molecular Diagnostics**.** Historical Perspective and Recent Advances. **Nucleic Acid Extraction:** Methods for isolating high-quality DNA or RNA from blood, saliva, cerebrospinal fluid (CSF), tissues, and other clinical samples.

Unit 2 (10 Lectures)

Advanced Applications and Future Trends: Introduction to next-generation sequencing (NGS) in molecular diagnostics. Microarrays for large-scale gene expression profiling and disease diagnosis.

Unit 3 (5 Lectures)

Molecular diagnostics in oncology: Identification of cancer-causing mutations, targeted therapies). Future directions in molecular diagnostics (e.g., liquid biopsies, digital PCR).

Unit 4 (10 Lectures)

Applications in Infectious Diseases: Molecular diagnosis of bacterial, viral, parasitic, and fungal infections. Antibiotic resistance testing using molecular assays (PCR, Sanger sequencing for specific resistance genes and NGS based resistance detection). Emerging infectious diseases and their molecular diagnostic strategies (e.g., COVID-19 diagnostics).

Unit 5 (10 Lectures)

Applications in Genetic Disorders: Prenatal diagnosis of genetic diseases using chorionic villus sampling (CVS) or amniocentesis coupled with molecular techniques. Carrier testing for inherited diseases using mutation analysis. Pharmacogenomics and personalized medicine based on individual genetic variations.
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TEXT BOOKS

Molecular Diagnostics: For the Clinical Laboratorian. William B. Coleman (Editor), Gregory J. Tsongalis (Editor) Publisher: Springer-Verlag New York, LLC.

REFERENCES:

Buckingham and Flaw's, "Molecular Diagnostics: Fundamentals, Methods and Clinical Applications", F.A. Davis Company; First edition, 2007.

Pre-requisites:

- Molecular Biology (assumed knowledge of macromolecules, gene structure, replication, transcription, translation)
- Molecular Methods (assumed knowledge of PCR principles, types, applications, primer design)

Course Outcome

CO1 Demonstrate a comprehensive understanding of advanced molecular diagnostic techniques.
CO2 Understand advanced molecular diagnostic methods to diagnose various diseases, including oncological and infectious diseases.
CO3 Evaluate future trends and emerging technologies in molecular diagnostics.
CO4 Design molecular diagnostic strategies for personalized medicine and genetic disorder management.
CO5 Communicate scientific findings and concepts related to advanced molecular diagnostics effectively.

Program Outcome

PO1: Bioscience Knowledge
PO2: Problem Analysis
PO3: Design/Development of Solutions
PO4: Conduct Investigations of complex problems
PO5: Modern tools usage
PO6: Bioscientist and Society
PO7: Environment and Sustainability
PO8: Ethics
PO9: Individual & Team work
PO10: Communication
PO11: Project management & Finance

PO12: Lifelong learning

c C O	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	2	2	2	3	1	-	2	-	-	-	3
CO 2	3	2	2	2	3	1	1	2	-	-	-	3
CO 3	3	2	2	2	3	1	-	2	-	-	-	3
CO 4	3	2	2	2	3	1	-	2	-	-	-	3
CO 5	3	2	2	2	3	1	-	3	-	-	-	3

Program Specific Outcomes. (PSO)

PSO 1 - Chemical and physical basis of biology
PSO 2 - Computational science in biology and medicine
PSO 3 - Biochemical and physiological complexity in biology and medicine
PSO 4 - Molecular technology in biology and medicine
PSO 5 - Cell based approaches in diagnosis and therapy
PSO 6 - Microorganisms in medicine
PSO 7 - Nanoscale entities and its significance in medicine
PSO 8 - Tissue architecture engineering in medicine
PSO 9 - Compounds as drugs and its efficacy
PSO 10 - Bioinformatics and artificial intelligence in medicine
PSO 11 –Technology in personalizing medicine
PSO 12 – Protein structural complexity in medicine
PSO 13 – Projecting science and medicine to public

- C O	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12	PSO13
CO 1	1	-	-	3	-	-	-	-	-	3	-	-	1
CO 2	1	3	3	3	1	2	-	-	-	3	3	-	1
CO 3	1	2	-	3	-	-	-	-	-	1	3	-	1
CO 4	1	-	-	3	-	-	-	-	-	3	3	-	1
CO 5	1	-	-	3	-	-	-	-	-	2	3	-	1

Evaluation Pattern: 50+50 = 100

Internal Assessment – 50%		
Periodical 1	Exam	20%
Periodical 2	Exam	20%
Continuous Assessment	Assignment/Test/Quiz	10%

		50%
End Semester Examination- 50%		
Theory Exam	50%	
		50%
	Total	**100%**

SEMESTER 7

24MMD401 Microbial diseases and vaccine technology 2 0 0 2

Unit 1 (3 Lectures)
Entry of pathogens into the host, types of pathogens, Microbial toxins (exotoxins, enterotoxins, endotoxins, neurotoxins) and virulence factors.

Unit 2 (7 Lectures)
Microbial diseases caused by major human pathogens (E. coli, Salmonella, Helicobacter, Staphylococcus, Mycobacterium, Candida etc). HIV, HPV, Dengue, Corona virus, HBV etc).

Unit 3 (7 Lectures)
Microbial diseases caused by major human pathogens (HIV, HPV, Dengue, Corona virus, HBV etc).

Unit 4 (6 Lectures)
Vaccines & Vaccination – adjuvants, DNA vaccines, recombinant vaccines, bacterial vaccines, viral vaccines.

Unit 5 (7 Lectures)
Principles of vaccination, passive & active immunization, immunization programs & role of WHO in immunization programs.

CO1: Understanding the molecular structure and function of known viral, bacterial, fungal and parasitic pathogens.
CO2: Understanding insights into mechanisms of infection, pathogenicity, virulence, host-pathogen interactions.
CO3: The students will learn about different mechanisms of anti-microbial resistance development.
CO4: The students will learn about different vaccines and their working principles.
CO5: They will gain knowledge about different vaccine developed methods.

Text book:
(1) Essentials of Medical Microbiology by ApurbaSankar Sastry, Sandhya Bhat K, 2nd edition

Program Outcome
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c C O	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	1	1	3	2	2	1	-	-	-	-	3
CO 2	3	1	1	3	2	2	1	-	-	-	-	3
CO 3	3	1	1	3	2	2	1	-	-	-	-	3
CO 4	3	1	1	3	3	2	1	-	-	-	-	3
CO 5	3	1	1	3	3	2	1	-	-	-	-	3

Program Specific Outcomes. (PSO)

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CO 1	-	-	1	-	-	3	-	-	-	-	-	-	2
CO 2	-	-	1	-	-	3	-	-	-	-	-	-	2
CO 3	-	-	1	-	-	3	-	-	2	-	-	-	2
CO 4	-	-	1	-	-	3	-	-	2	-	-	-	2
CO 5	-	-	1	-	-	3	-	-	2	-	-	-	2

Evaluation Pattern: 50+50 = 100

Internal Assessment – 50%		
Periodical 1	Exam	20%
Periodical 2	Exam	20%
Continuous Assessment	Assignment/Test/Quiz	10%
		50%

End Semester Examination- 50%		
Theory Exam	50%	
		50%
	Total	**100%**

24MMD402 Immunotherapy 2-0-0-2

Preamble

The immune system main function is to ward off foreign bodies that may enter into our system as well as destroying cancer cells or can go aberrant leading development of autoimmunity. Development of drugs or cells that can alter the immune system functioning can help in restoring the immune balance leading to disease prevention/treatment. The course will help in developing an understanding the fundamental concept and associated cellular or antibody or small molecule technologies involved in, harnessing the immune response to treat infections, cancers and autoimmunity.

Syllabus

Unit 1 (4 Lectures)

What is immunotherapy? Its historical perspectives, basis of a healthy immune system.

Unit 2 (10 Lectures)

What are human immunodeficiences, Autoimmunity, Cancer immunology, Immunopathology. Significance of niche in disease pathology. Understanding the microenvironment and how this knowledge can be harnessed to treat the disease by cell therapy.

Unit 3 (10 Lectures)

Issues important towards design of cellular therapeutics, Application of different strategies in the treatment of cancer and other immunological diseases, nanotechnology in cell therapy.

Unit 4 (6 Lectures)

T cell and dendritic cell technologies and associated cellular therapies normally practiced in clinic.

Text Books

1. The Immunotherapy Revolution (Publisher: Gatekeeper Press Author: Williams Jason R,)
2. Cancer Immunology and Immunotherapy; (Publisher: Springer-Verlag Berlin and Heidelberg GmbH & Co. KG; Edited by Glenn Dranoff)

Evaluation Pattern: 50+50 = 100

Internal Assessment – 50%		
Periodical 1	Exam	20%
Periodical 2	Exam	20%
Continuous Assessment	Assignment/Test/Quiz	10%
		50%

End Semester Examination- 50%		
Theory Exam	50%	
		50%
	Total	**100%**

24MMD403 Drug Delivery 2-0-0-2

Unit-1 (10lecture)

Fundamental concepts of drug delivery: Physicochemical Properties of Drugs, Effects of fundamental physicochemical properties on the biopharmaceutical behavior of drugs, Introduction to pharmacokinetics and pharmacodynamics – concept of ADME, Concentration-time curve of pharmacokinetics; Fundamentals of controlled drug delivery, Pharmacokinetic and pharmacodynamic basis of controlled drug delivery, Physicochemical and biological factors influencing design and performance of controlled release products.

Unit-2 (10 lecture)

Routes of Drug Delivery: Enteral – Oral, Sublingual, Buccal, Rectal; Parenteral – Intravenous, Intramuscular, Intra-arterial, Intra-thecal, Intradermal; Topical – Transdermal, Intranasal, Conjuctival; Conventional drug delivery systems; Concept of active and passive targeting of drugs - Drug Delivery to Tumors as an Example; Protein and Peptide Delivery; Vaccine delivery

Unit-3 (10 lecture)

Nanotechnology in Drug Delivery: Nanoscale Drug Delivery Systems - Advantages of nanodrug delivery – Improvements in pharmacokinetics, bioavailability, biodistribution; Scaffolds and hydrogels in drug delivery: Applications of drug delivery systems in tissue engineering and regenerative medicine area.

TEXT BOOKS/ REFERENCES:

1. Drug Delivery: Fundamentals and Applications, Second Edition, CRC Press 2017. n
2. Drug Delivery Systems, Pieter Stroeve and MortezaMahmoudi, World Scientific Series: From Biomaterials towards Medical Devices, Vol I, 2018.
3. N.K. Jain, Controlled and Novel Drug Delivery, CBS Publishers & Distributors, New Delhi, First edition 1997 (reprint in 2001).
4. Nanoparticulates as Drug Carriers, Vladimir Torchillin, Imperial College Press, 2006

24MMD404 Biosafety 1-0-0-1

Preamble

The recent advances in the field of biotechnology/biomedical technologies have brought into focus several safety and ethical issues. The inventions in the field of

genetic engineering, molecular medicine and related fields of molecular biology not only affect us but also the plants, microorganisms, animals and the entire environment and the way we practice agriculture, medicine and food processing. The present course focuses on the biosafety issues the modern society confronts. Topics such as biosafety levels, biosafety guidelines, biomedical technologies, its health and human rights perspectives, emerging trends in biomedical and genetic technologies and regulatory frameworks will be discussed in the curriculum.

Unit I **(5 Lectures)**

General laboratory practice; Biosafety and biohazards: Introduction to biological safety cabinets, primary containment for biohazards, biosafety levels of non-pathogenic and infectious agents; Biowaste disposal; Biohazard spills

Definition of genetic modified organism (GMOs) and living modified organisms (LMOs): Roles of institutional biosafety committee; GM-food debate and biosafety assessment procedures for biotech foods and related products, including transgenic food crops, case studies of relevance; Biosafety assessment of pharmaceutical products such as drugs/vaccines etc.

Unit 2 **(3 lectures)**

Chemical hazards and safety: Identify hazards and assess the risk; MSDS; Chemical Storage; Chemical Spills; Handling and Transportation of Chemicals; Waste segregation and disposal; handling chemicals in Fume hoods

Unit 3 **(3 Lectures)**

Fire Safety; Relevance; Reporting of accidents, first aids, fire instructions and other emergencies

Unit 4 **(4 Lectures)**

Demonstration of Fire safety; Chemical safety and Life Support Skills

Text books:

(1) Bioethics and Biosafety, 1st edition (2008), M. K Sateesh, I K International Pvt Ltd, ISBN-13: 978-8190675703.

(2) BIOSAFETY MANUAL FOR PUBLIC HEALTH LABORATORIES, Ministry of Health, Government of India.

(3) Biological Safety, Principles and Practices, 4th edition, Editors:
Diane O. Fleming and Debra L. Hunt

Course outcome (CO)

CO1: Understanding the importance of biohazards and the safety related to their handling and disposal

CO2: Understand the safety related to handling of genetic modified organism and living modified organisms

CO3: Understand the safety related to their handling and disposal of chemical hazards

CO4: Significance of fire safety and other emergencies

Program outcome (PO)

PO1: Bioscience Knowledge
PO2: Problem Analysis
PO3: Design/Development of Solutions
PO4: Conduct Investigations of complex problems
PO5: Modern tools usage
PO6: Bioscientist and Society
PO7: Environment and Sustainability
PO8: Ethics
PO9: Individual & Team work

PO10: Communication
PO11: Project management & Finance
PO12: Lifelong learning
3 = High Affinity, 2 = Medium Affinity, 1 = Low Affinity, - = No Affinity

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	1	-	-	-	-	3	-	-	-	-	1
CO 2	3	1	-	-	2	-	3	-	-	-	-	1
CO 3	3	1	-	-	-	-	3	-	-	-	-	1
CO 4	-	1	-	-	-	-	-	-	1	-	-	1

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PSO 1 - Chemical and physical basis of biology
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CO 2	-	-	-	2	-	-	-	-	-	-	-	-	-
CO 3	-	-	-	-	-	-	-	-	2	-	-	-	-
CO 4	-	-	-	-	-	-	-	-	-	-	-	-	-

Evaluation Pattern: 50+50 = 100

Internal Assessment – 50%		
Periodical 1	Exam	20%
Periodical 2	Exam	20%
Continuous Assessment	Assignment/Test/Quiz	10%
		50%
End Semester Examination- 50%		
Theory Exam	50%	
		50%

Total	**100%**

23MMD498 Dissertation Project 1 13 credits

SEMESTER 8

24MMD411 Gene Editing Technology 2-0-0-2

Preamble:
Genome editing provides the ability to manipulate gene expression in a variety of cell types and animal models. This course will provide an overview of the current major genome engineering platforms and cover CRISPR genome editing technology in depth.

Syllabus

Unit 1 **2 lectures**
Introduction to Genome Editing
Unit 2 **3 lectures**
DNA Repair Mechanisms in Genome Editing
Unit 3 **3 lectures**
Genome Editing tools: Restriction enzymes, Zinc finger nucleases (ZFNs), TALENs, CRISPR-Cas9
Unit 4 **4 lectures**
ZFNs and TALENs: Design and assembly, Functional testing of assembled designer tools, Applications in genome editing, Limitations
Unit 5 **15 lectures**
Origins of CRISPR, Introduction to CRISPR Technology, sgRNA Design Considerations, sgRNA and Cas9 Delivery into Target Cells, Validation of CRISPR Gene Editing, CRISPR Knockout Case Study, Clinical Applications, The Future of CRISPR and Ethical Considerations (CRIPSR in the Clinic, CRISPR Babies, Case-Studies)
Unit 6 **3 lectures**
Ethics: Moral considerations for applications of genomic editing, policies and guidelines for gene modifications. Biosafety Considerations. Regulatory Issues and Future of Genome -Editing Technology

Text books:
1. Targeted Genome Editing Using Site-Specific Nucleases, ZFNs, TALENs, and the CRISPR/Cas9 system by Takashi Yamamoto; ISBN: ISBN 978-4-431-55226-0; Publisher: Springer Singapore.
2. Precision Medicine, CRISPR, and Genome Engineering by Stephen H. Tsang; ISBN 978-3-319-63903-1; Publisher: Springer Singapore.

Course Outcome
CO1 Understand the role of DNA repair mechanisms in genome editing. Understand the principles and mechanisms of different genome editing tools (ZFNs, TALENs & CRISPR-Cas9).
CO2 Learn how to design optimal target-specific ZFNs, TALENS and gRNA molecules to edit genes of interests.
CO3 Learn how to deliver the genome editing components using various transfection methods.

CO4 Understand how to measure the editing efficiency with a mismatch detection assay
CO5 Understand the ethics and biosafety of gene editing technologies

PO1: Bioscience Knowledge
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Program Specific Outcomes. (PSO)

PSO 1 - Chemical and physical basis of biology

c / C O	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	2	2	2	3	1	-	-	-	-	-	2
CO 2	3	2	2	2	3	1	1	-	-	-	-	2
CO 3	3	2	2	2	3	1	-	-	-	-	-	2
CO 4	3	2	2	2	3	1	-	-	-	-	-	2
CO 5	3	2	2	2	3	1	-	3	-	-	-	2

PSO 2 - Computational science in biology and medicine
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CO 1	3	1	2	3	1	-	-	-	-	3	3	-	1
CO 2	1	1	3	3	1	-	-	-	-	3	1	-	1
CO 3	1	1	3	3	2	-	-	-	-	-	1	-	1
CO 4	1	-	-	3	-	-	-	-	-	1	1	-	1

CO 5	-	-	1	-	-	-	-	-	-	-	1	-	1

Evaluation Pattern: 50+50 = 100

Internal Assessment – 50%		
Periodical 1	Exam	20%
Periodical 2	Exam	20%
Continuous Assessment	Assignment/Test/Quiz	10%
		50%
End Semester Examination- 50%		
Theory Exam	50%	
		50%
	Total	**100%**

24MMD499 Dissertation Project 2 18 credits