Amrita School of Nanosciences and Molecular Medicine

Program in the

Bachelor of Science (B.Sc.)

Molecular Medicine

(Honours)

2022

Amrita Vishwa Vidyapeetham

B.Sc-(Honours) Molecular Medicine

Curriculum

Total Credits 150

Course categorization:

Discipline core course: DCC
Discipline elective course: DEC
Skill enhancement course: SEC
Ability enhancement compulsory course: AECC
Generic compulsory course: GEC
Lab: L

SEMESTER 1			
Course Code	Course category	Course	Credit
22ENG102	AECC	English 1	3
22MMD103	GCC	Chemistry 1	3
22MMD101	DCC	Biochemistry	3
22MMD102	DCC	Cell biology	3
22CSA104	SEC	Computational Skills	2
22MMD182	L	Cell biology lab	2
22MMD181	L	Biochemistry lab	2
22MMD183	L	Chemistry lab 1	2
22ADM103	GEC	Cultural education	P/F
		TOTAL	**20**

SEMESTER 2			
Course Code	Course category	Course	Credit
22ENG112	AECC	English II	3
22MMD111	GCC	Chemistry 2	3
22MMD112	GCC	Bio Physics and Bio Energetics	3
22MMD113	DCC	Bioinformatics	3
22MMD114	DCC	Biochemistry of Energy Metabolism	3
22MMD184	L	Bio Physics and Bio Energetics lab	2
22MMD185	L	Chemistry lab 2	2
22SSK111	SEC	Life skills	3
22AVP103		Mastery Over Mind	2
		TOTAL	**24**
Students can exit with **Certificate in molecular medicine (44 credits)**			

SEMESTER 3			
Course Code	Course category	Course	Credit
22MMD201	DCC	Developmental biology	3
22MMD202	DCC	Microbiology	3
22MMD203	DCC	Molecular biology	3
22MMD204	SEC	Ethics and Research Methodology	3
22MMD205	GCC	Biostatistics	2
22MMD281	L	Molecular biology lab	2
22MMD282	L	Microbiology lab	2
		TOTAL	**18**

SEMESTER 4			
Course code	Course category	Course	Credit
22MMD211	DCC	Immunology	3
22MMD212	DCC	Genetics	3
22MMD213	DCC	Cancer Biology	3
22CSA211	SEC	Computer programming	3
22IPR211	SEC	Intellectual Property Rights (IPR)	2
22MMD283	L	Cell culture lab	2
22MMD284	L	Immunology lab	2
		TOTAL	**18**
Students can exit with **Diploma in Molecular Medicine (80 credits)**			

SEMESTER 5			
Course Code	Course category	Course	Credit
22MMD301	DCC	Molecular methods	3
22MMD302	DCC	Biotechniques	3
22MMD303	DCC	Introductory Medical Physiology	3
22MMD381	L	Molecular methods lab	2
22MMD382	L	Biotechniques lab	2
		Electives (Any Two. Each course carries 3 credits) 22MMD331 Regenerative Medicine 22MMD332 Fundamentals of Tissue Engineering 22MMD333 Principles of Pathology 22MMD334 Nano sciences in Biology	
		TOTAL	**19**

SEMSTER 6			
Course Code	Course category	Course	Credit
22MMD311	DCC	Protein structure and function	3
22MMD312	DCC	Fundamentals of Pharmacology	2
22MMD313	DCC	Proteome and Proteomics	3
22MMD391		Minor Project	5
	DEC	**Electives (Any Two. Each course carries 3 credits)** 22MMD341 Stem cell Biology 22MMD342 Microbial diseases and vaccine technology 22MMD343 Antimicrobial agents	
		TOTAL	19
Students can exit with **Bachelor's Degree in Molecular Medicine (118 credits)**			

SEMESTER 7			
Course Code	Course category	Course	Credit
22MMD401	DCC	Gene Editing Technology	3
22MMD402	SEC	Biosafety	1
22MMD498		Dissertation project 1	9
	DEC	**Electives (Any Two. Each course carries 3 credits)** 22MMD431 Immunotherapy 22MMD432 Cell Therapy 22MMD433 Biopolymers in Medicine	
		TOTAL	**19**

SEMESTER 8			
	Course category	Course	Credit
22MMD411	DCC	Machine Learning in Molecular Medicine	3
22MMD412	SEC	Art of scientific writing	1
22MMD499		Dissertation project 2	9
	DEC	**Electives (Any One. Each course carries 2 credits)** 22MMD441 Microbiome 22MMD442 Personalized Medicine	
		TOTAL	**15**
Students exit with **Degree in Molecular Medicine with Honors (152 credits)**			

SEMESTER 1

22ENG102 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%**

22MMD103 Chemistry-1 3 0 0 3

Preamble

This course deals with the basic introduction to organic chemistry, 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 (**3 lectures)**

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

Unit-2 (**4 lectures)**

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

Unit-3 (**6 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 (**3 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 (**8 lectures)**

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

Unit-6 (**12 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 (**9 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%**

22MMD101 Biochemistry 3 0 0 3

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 (15 lectures)

Foundations of biochemistry, Cellular foundations, cellular composition and dimensions; carbon compounds as functional groups in biomolecules; macromolecular constituents of cell; Conformation and configuration of macromolecules; Physical foundations, dynamic steady state in living organism, transformation of energy and matter in living organisms; Flow of electrons for energy productions

Unit-2 (15 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 (10 lectures)

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

Unit-4 (5 lectures)

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

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%**

22MMD102 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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12

C O												
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
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- C O	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%**

22CSA104 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 (8 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 (5 lectures)

Networks terminology: Types of networks, router, switch, server client architecture Multimedia

Unit-4 (7 lectures)

Introduction, Characteristics, Elements, Application, Problem Solving, Notion of algorithms, Stepwise methodology of developing an algorithm, developing macros in spreadsheet; General Awareness IT Act, System Security (virus/firewall etc.)

Text Books

[1] V Rajaraman, Fundamentals of Computers, Fourth Edition, PHI.
[2] Anita Goel, Fundamentals of Computers; Forthcoming title in Pearson Education.

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**.**

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
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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

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PSO 1 - Chemical and physical basis of biology
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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	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%**

22MMD182 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
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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
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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

- / 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: 30+70 = 100

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

22MMD181 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

- / CO	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%**

22MMD183 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

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

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
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- / 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%**

22CUL102 Cultural Education P/F

Unit 1 **(15 lectures)**

Culture – definition and scope. Values and culture, cultural freedom, Culture and Education Culture of Research – creativity and responsibility in research. Spirituality and Culture – spirituality as a way of life, spirituality and religion. Culture and women – gender oppression, motherhood. Culture and the Media. Culture and Politics – national values and political harmony. Philosophy and Culture, epistemology.

SEMESTER 2

22ENG112 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

22MMD111 Chemistry-2 3 0 0 3

Preamble

This course deals with the microscopic properties of a gas, liquids and solids and their related intermolecular forces, effects of different kind of forces on phase transitions, understanding about phase diagrams, properties of acid and bases and their strength, concept of buffer solution, understanding of surface properties and colloidal suspension, emulsion etc, understudying of chemical kinetics and chemical thermodynamics.

Unit-1 (5 lectures)

Solid, liquids and phase transition: Bulk properties of gases, liquids, and solids.

Unit-2 (5 lectures)

Intermolecular forces, origin of molecular structure, Intermolecular forces in liquids, phase equilibrium, phase transitions, phase diagrams.

Unit-3 (5 lectures)

Acid-base Equilibrium: Classifications of acids and bases, properties of acid and bases, Acid and base strength, Buffer solutions, Polyprotic acids, organic acid and bases.

Unit-4 (10 lectures)

Surface Chemistry: Types of adsorption, factors affecting adsorption of gases on solids, properties of colloids; Tyndall effect, Brownian movement, electrophoresis, coagulation, emulsion – types of emulsions.

Unit-5 (10 lectures)

Chemical Kinetics: The concept of reaction rates. Effect of temperature, pressure, catalyst and other factors on reaction rates. Order and molecularity of a reaction. Derivation of integrated rate equations for zero, first and second order reactions. Half–life of a reaction.

Chemical Thermodynamics: Objectives and limitations of Chemical Thermodynamics, state functions, thermodynamic equilibrium, work, heat, internal energy, enthalpy. Laws of Thermodynamics.

Unit-6

(10 lectures)

Basic analytical techniques: Fourier transform infrared spectroscopy (FTIR), Ultraviolet–visible spectroscopy, Nuclear Magnetic Resonance spectroscopy, X-ray crystallography, thermogravimetric analysis, differential scanning calorimetry

Text books:

(1) Oxtoby, D.W, Gillis, H.P and Campion, A. Principles of Modern Chemistry, 7th Edition, Cengage

(2) Barrow, G.M. Physical Chemistry Tata McGraw-Hill (2007).

(3) Physical Chemistry by P.C. Rakshit

(4) Atkins, P.W. & Paula, J. Physical Chemistry, 10th Ed., Oxford University Press, 2014.

Course Outcome

CO1 To understand the basic physical chemistry concepts of solid, liquid and gaseous phase.

CO2 Learn about inter and intramolecular forces between the molecules and basic concept about chemical equilibrium.

CO3 To understand about different types of acid base concepts and buffers.
CO4 Learn about basic concepts of surface chemistry.
CO5 To understand basic concepts about thermodynamics and chemical kinetics

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

- / C O	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%**

22MMD112 Biophysics and Bioenergetics 3 0 0 3

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.

Unit 1 **(5 lectures)**

Physics: general overview, Does Physics treats disease? Why Physics for Biology and Molecular Medicine? Concepts in Physics to apply in Biology, Methods in Physics to elucidate Biology.

Unit 2 **(10 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 **(10 lectures)**

Biophysics in Medicine: Applications of physical principles in biology and its significance in the development of various biophysical methods for analysing the complexity of biological system. Principles of Medical-imaging, Image analysis, Instrumentation and Working principles, Medical applications of X-ray: Imaging, Introduction to Fluoroscopy.

Unit 4 **(10 lectures)**

Nuclear medicine and Radiotherapy: Pros and cons, Nano-bioelectronics: Monitoring and recording bioelectric signals, Transducers in physiology, 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.

Unit 5 **(10 lectures)**

Nanophotonics for Biology and Nanomedicine: Near-Field Bioimaging, Semiconductor Quantum Dots for Bioimaging, Up-Converting Nanophores for Bioimaging, Biosensing, Nanoclinics for Optical Diagnostics and Targeted Therapy, Nanoclinics for Photodynamic Therapy

Text books:

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

(2) Biological Physics: Energy, Information, Life by Philip Nelson, www.physics.upenn.edu/~pcn/.

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

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							

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 - 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
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PSO 10 - Bioinformatics and artificial intelligence in medicine
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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	2	1	-	-	-	-	1	1	-	-	-	-	3
CO 2	2	-	1	-	-	-	-	-	-	-	-	-	1
CO 3	1	1	1	-	1	-	-	-	-	-	-	-	1
CO 4	1	1	2	2	1	-	-	-	-	2	2	-	1
CO 5	-	1	1	2	1	-	3	1	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%**

22MMD113 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 and its applications addressed.

Unit 1 (5 Lectures)

History of Bioinformatics. The notion of Homology. Sequence Information Sources, EMBL, GENBANK, Entrez, Unigene, 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.

Unit 3 **(11 Lectures)**

Protein sequence and Phylogeny analysis, Detecting Open Reading Frames, Outline of sequence assembly, Mutation/Substitution matrices, Pairwise alignments, Introduction to BLAST, using it on the web, Interpreting results.

Unit 4 **(7 Lectures)**

Data mining, Introduction to machine learning and its applications. Introduction to Linux commands.

Unit 5 (**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.

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.

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)
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	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

Program Specific Outcomes (PSO)
PSO 1 - Chemical and physical basis of biology
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PSO 9 - Compounds as drugs and its efficacy
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-	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12	PSO13

C O													
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%**

22MMD114 Biochemistry of Energy Metabolism 3 0 0 3

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 (Lectures 2)

Significance of six carbon sugar glucose in cellular homeostasis.

Unit 2 (13 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.

Unit 3 5 lectures)

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

Unit 4 **(10 lectures)**

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

Unit 5 **(15 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
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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

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
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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%**

22MMD184 Biophysics and Bio Energetics lab 0 0 6 2

1. Study the principle of spectrophotometer. To verify the Lambert Beer's law.
2. Determine the beer's limit and measurement of molar and percent extinction coefficient.
3. Estimate the percent purities of dyes and inorganic compounds.
4. Establish the absorption spectrum and determine the absorption maxima of pNitro phenol.
5. Plot absorption spectrum of DNA and protein(BSA/Egg Albumin) and find λmax
6. Obtain relation between concentration & Refractive Index for solutions of proteins and sugars and estimation of specific refraction increment for proteins
7. Determine refractive index of a given liquid as a criterion for its purity (Benzene i.e. commercial benzene + A.R. acetone)
8. Study the principle of colorimeter and spectrophotometer and determine suitable filter for light absorption studies of inorganic salts. Verify Beer-Lambert law.Determine molar Extinction coefficient
9. Plot absorption spectrum of DNA and protein and find λmax.
10. study the effect of different solvents on UV absorption spectra of proteins
11. Study of spectral changes of proteins at different pH using Spectrophotometry
12. Study of structural changes of proteins at different temperature using UV spectrophotometry

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: 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	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

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 - 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	-	1	-	-	-	-	-	-	1	1	1	-	
CO 2	1	1	-	-	-	-	-	-	1	1	1	1	
CO 3	2	1	-	-	-	-	-	-	1	1	1	1	
CO 4	2	1	-	-	-	-	-	-	1	1	1	-	
CO 5	2	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%**

22MMD185 Chemistry Lab -2 0 0 6 2

(1) Determination of the melting point;
(2) Determination of the boiling point;
(3) Purification of solid organic compounds by re-crystallisation
(4) Crosslinking of chitosan
(5) Crosslinking of Alginate
(6) Permanganometric titration
(7) Acid base titrations
(8) Acid base titration using pH meter

Text books:
(1) A text-book of practical organic chemistry including qualitative organic analysis by A. I. Vogel.

Course Outcome
CO1 To understand lab experiments on quantitative analysis.
CO2 To learn microscale experiments which develops students observational and investigative skills using simple equipment and smaller quantities of chemicals.
CO3 To learn volumetric analysis especially permanganometric titration
CO4 To understand crosslinking of biopolymers
CO5 To understand purification technique of organic compounds.

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 O**	**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	-
CO 4	-	1	3	-	-	-	-	-	-	-	1	-
CO 5	-	1	3	-	-	-	-	-	-	-	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
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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	-	-	--	-	-	-	-	-	-	-	-	-	-
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%**

22SSK111 Life Skills 3 0 0 3

Module I

Soft Skills and its importance: Pleasure and pains of transition from an academic environment to work-environment. New-age challenges and distractions. Need for change and up-skilling oneself. Fears, stress and competition in the professional world and knowing how to manage them. Importance of positive attitude, self-motivation and continuous knowledge up- gradation. Goal setting and its importance in career planning.
Confidence: Importance of being confident, Building and displaying confidence. Understanding the situation, being sensitive to people, place and time. Importance of positive attitude, values, ethics and integrity. Assertiveness vs. aggressiveness, not being over-confident.
Presentations: Need, importance, preparations, research and content development, structuring and ensuring flow of the presentation. Ways and means of making an effective presentation: Understanding and connecting with the audience, managing time, appropriate language, gestures, posture, facial expressions, tones, intonations and grooming. Importance of practice to make an impactful presentation.
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 misspelt 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.
Speaking Skills: Make students conscious of the relevance of effective communication in today's world through role plays, debates and individual speaking activities.
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.
Data Interpretation: Tables, Bar Diagrams, Venn Diagrams, Line Graphs, Pie Charts, Caselets, Mixed Varieties, Network Diagrams and other forms of data representation.
Data Sufficiency: Introduction, 5 Options Data Sufficiency and 4 Options Data Sufficiency.

Module II

Professional Grooming and Practices: Basics of corporate culture, key pillars of business etiquette: socially acceptable ways of behavior, body language, personal hygiene, professional attire and cultural adaptability. 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.
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.
Equations: Basics, Linear, Quadratic, Equations of Higher Degree, and Problems on Ages.
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: Arrangements, Sequencing, Scheduling, Venn Diagram, Network Diagrams, Binary Logic, and Logical Connectives, Clocks, Calendars, Cubes, Non-verbal reasoning and Symbol based reasoning.

Module III

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.
Leadership, Internal problem solving, Growth and productivity, Evaluation and co-ordination.
Facing an interview: Importance of verbal & aptitude competencies, strong foundation in core competencies, industry orientation / knowledge about the organization, resume writing, being professional. Importance of good communication skills, etiquette to be maintained during an interview, appropriate grooming and mannerism.
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: Introduce formal written communication and keep the students informed about the etiquettes of email writing.
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, and Standard Deviation.
Logical Reasoning: Blood Relations, Direction Test, Syllogisms, Series, Odd man out, Coding & Decoding, Cryptarithmetic Problems and Input-Output Reasoning.
Campus recruitment papers: Discussion of previous year question papers of all major recruiters of Amrita Vishwa Vidyapeetham.
Competitive examination papers: Discussion of previous year question papers of CAT, GRE, GMAT, and other management entrance examinations.
Miscellaneous: Interview Puzzles, Calculation Techniques and Time Management strategies.

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, May 2018
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.

SEMESTER 3

22MMD201 Developmental Biology 3-0-0-3

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 (9 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 Drosophila; Mammals).

Unit 4 (6 Lectures)

Building with Ectoderm: The Vertebrate Nervous System and Epidermis: Neural Tube Formation and Patterning; Brain Growth; Neural Crest Cells and Axonal Specificity; Ectodermal Placodes and the Epidermis.

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; Development of the Tetrapod Limb; The Endoderm: Tubes and Organs for Digestion and Respiration

Unit 6 (5 Lectures)

Postembryonic Development: Metamorphosis: The Hormonal Reactivation of Development; Regeneration; Aging and Senescence

Unit 7 (10 Lectures)

Development in Wider Contexts: Development in Health and Disease: Birth Defects, Endocrine Disruptors, and Cancer; 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, metamorphosis, 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: 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	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	-	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%**

22MMD202 Microbiology 3 0 0 3

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, synchronous batch and continuous culture, measurement of growth and factors affecting growth of bacteria.

Unit-3 **(10 lectures)**

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

Unit-4 **(10 lectures)**

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

Unit-5 **(5 lectures)**

Food and industrial microbiology; probiotics, biological waste management.

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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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	-	-	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%**

22MMD203 Molecular Biology 3 0 0 3

Preamble

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

Unit 1 (10 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 (10 Lectures)

The replication of DNA in Prokaryotes and Eukaryotes: 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 (Transitions, transversion and thymine dimer), DNA Damage (deamination, depurination and dimerization) and their

repair: mismatch repair, SOS response (recombination), Excision Repair, Photoreactivation. Types of mutations.

Unit 4 (10 Lectures)

Information Transfer –I: Mechanism of Transcription: Basic transcription apparatus, Initiation, elongation and termination of transcription, Eukaryotic 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 and Self splicing introns, alternative splicing and exon shuffling, mRNA transport. Principles of gene regulation, concept of operons, regulation of gene expression in bacteria : lac operon concept.

Unit 5 (10 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 (both in prokaryotes and eukaryotes), 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
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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
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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%**

22MMD204 Ethics and Research Methodology 3-0-0-3

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.

22MMD205 Biostatistics 2 0 0 2

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. Basics of Mathematics- (a) Differential & Integral Calculus Differentiation – Derivative of a function, Integration as the inverse of Differentiation, Common Methods of Integration. (b) Linear Algebra – Set Theory, Matrix Algebra (i) Set Theory- Sets and operations on sets. (ii) Matrix Algebra- Defenition, order of matrix, matrix operations, Special type of Matrices, Determinants.

Unit-2 **(10 lectures)**

Study Designs-Prevalence and incidence studies, Case control and Cohort studies, Experimental studies – randomization. Estimation of Minimum Sample size in Different Designs of Studies and Sampling Methods. 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- Probability: Random experiment, Sample space, Events, Mutually exclusive and exhaustive events, Frequency and classical definition of probability, Axiomatric definition of probability, Addition and multiplication theorems, Conditional probability and independence, Baye's theorem, 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. Sampling distributions – Chi- square distribution, F & 't' distributions. 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 & Non parametric methods.

Unit-4 **(10 lectures)**

Statistical methods in planning and analysis of clinical trials;
Statistical aspects of diagnostic tests.
Nonparametric methods-Non-parametric methods for estimation, Methods for tests of significance for the independent and correlated samples, Nonparametric Methods for more than two populations.

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

22MMD281 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

- / CO	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%**

22MMD282 Microbiology Lab 0 0 6 2

(1) Isolation of bacteria & their biochemical characterization;
(2) Staining methods: simple staining,
(3) Gram staining,
(4) Spore staining,
(5) Negative staining,
(6) Hanging drop;
(7) Preparation of media & sterilization methods,
(8) Methods of isolation of bacteria from different sources;
(9) Antimicrobial activity assays;
(10) Enumeration of microorganism - total & viable count.
(11) Bacterial mutagenesis – physical & chemical.
(12) Preparation of *Escherichia coli* competent cells, Transformation of bacteria.

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
PSO 5 - Cell based approaches in diagnosis and therapy
PSO 6 - Microorganisms in medicine
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PSO 8 - Tissue architecture engineering in medicine
PSO 9 - Compounds as drugs and its efficacy

PSO 10 - Bioinformatics and artificial intelligence in 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	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%**

SEMESTER 4

22MMD211 Immunology 3 0 0 3

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)

Unit 1 (10 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.

Unit 3 (10 Lectures)

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

Unit 4 (10 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'sImmunobiology, 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

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

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
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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	-	-	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%**

20MMD212 Genetics 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 and disease.

Unit 1: (5 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: (5 Lectures)

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

Unit-4 **(8 lectures**)

Introduction: What Is in a HumanGenome? Meiosis, Development and Aging

Unit-5 (**8 lectures)**

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

Unit-6 **(8 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 ancestry and Evolution.

Text books:

(1) Gardner et al: Principles of Genetics (1991, John Wiley).
(2) Ricki Lewis: Human Genetics (12th edition, McGraw Hill).
(3) Griffith et al: An Introduction to Genetic Analysis (2005, Freeman).
(4) Gardner et al: Principles of Genetics (1991, John Wiley)
(5) Ricki Lewis: Human Genetics (12th edition, McGraw Hill)
(6) Griffith et al: An Introduction to Genetic Analysis (2005, Freeman)

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, and transmission genetics**

CO5 **To learn about genes and regulation, population genetics and 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

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

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
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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	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%**

22MMD213 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 (10 Lectures)
Introduction to cancer, cardinal manifestations of cancer, history of cancer research, overview of the hallmarks of cancer, cell proliferation and differentiation; tumor growth and proliferation in vivo, cell cycle control, check points, DNA damage induced check points, check point defects in tumor cells, differentiation, extracellular and intracellular factors of differentiation, differentiation and cancer therapy.

Unit 2 (10 lectures)
Cancer etiology; genetic predisposition to cancer, chemical carcinogenesis, multistage carcinogenesis (tumor initiation, tumor promotion, malignant conversion and tumor progression), caretaker and gate keeper genes, carcinogen metabolism, DNA damage and repair, hormones and the etiology of cancer, radiation and cancer,

UV-radiation and cancer, physical carcinogens and cancer, virus and cancer, parasites and cancer, cancer epidemiology; incidence of cancers in India and other parts of the world.

Unit 3 **(8 lectures)**

Apoptosis, caspase activation pathways, apoptosis dysregulation in cancer, growth factors and signal transduction in cancer, classification of growth factors and its receptors, abnormalities associated with growth factors in cancer cells, signaling pathways in cancer, signaling pathways and its implications for cancer therapy.

Unit 4 **(7 lectures)**

Oncogenes, mutagens, carcinogens and mutations, Tumor viruses and the discovery of oncogenes, Tumor cells and genetic abnormalities, mechanism of oncogene activation, oncogenes in the initiation and progression of neoplasia, tumor suppressor genes and their role in cancer.

Unit 5 **(10 lectures)**

Invasion and metastasis, tumor-host and tumor-stroma interactions, adhesion, tumor cell migration, angiogenesis, genetic regulation of invasion and metastases, cancer stem cells, therapeutic intervention, introduction to tumor antigens, categories of tumor antigens, application of tumor antigens for clinical immunotherapy.

Text book:

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

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

Course outcome (CO)

CO1: Understand the basic aspects of cancer and the alterations at the cellular levels, and introduction to cancer therapy

CO2: Understand how genetics contributes to predisposition and progression of cancer as well as cancer incidence

CO3: Significance of apoptotic cell death pathways and growth factor signaling pathways in cancer

CO4: Be familiar with the concept of oncogene and tumor suppressor gene and their roles in cancer initiation and progression

CO5: In-depth understanding of the concerted events driving invasion and metastasis of cancer

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
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PSO 13 – Projecting science and medicine to public

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

22CSA211 COMPUTER PROGRAMMING 2 0 1 3

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 Cookbook‖, 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

P O / C O	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	PS
CO 1	-	2	-	-	-	-	-	-	-	3	-	-	
CO 2	-	2	-	-	-	-	-	-	-	3	-	-	
CO 3	-	2	-	-	-	-	-	-	-	3	-	-	
CO 4	-	2	-	-	-	-	-	-	-	3	-	-	
CO 5	-	2	-	-	-	-	-	-	-	3	-	-	

22IPR211 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 C O	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
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%**

22MMD283 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
PSO 6 - Microorganisms in medicine
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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	-	-	-	-	-	-	-	-	-	-	-	-	-
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%**

22MMD284 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 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	-	-	-	-	-	-	-	-
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%**

SEMESTER 5

22MMD301 Molecular Methods 3 0 0 3

Unit 1 **(10 Lectures)**

PCR Principle, procedure, types and applications. Designing primers, real-time and quantitative PCR, reverse transcription PCR, DNA fingerprinting

Unit 2 **(10 Lectures)**

Cloning, linkers, adapters, cDNA library construction and screening, DNA finger printing, chromosome walking and chromosome jumping.

Unit 3 **(5 Lectures)**

RFLP, RAPD, SCAR (Sequence characterized amplified region) markers characteristics, advantages and disadvantages.

Unit 4 **(10 Lectures)**

DNA Sequencing: Maxam-Gilbert method and Sanger method of DNA sequencing, Next Generation Sequencing (NGS)

Unit 5 **(10 Lectures)**

Hybridisation techniques: Principle of hybridization. Southern, Northern, in-situ Hybridization, DNA microarray andluminex assays.

Text book:

(1) 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

Program Specific Outcomes. (PSO)

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	-	-	-	-	-	2

PSO 1 - Chemical and physical basis of biology
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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	-	-	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%**

22MMD381 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
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PSO 4 - Molecular technology in biology and medicine
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PSO 8 - Tissue architecture engineering in medicine
PSO 9 - Compounds as drugs and its efficacy
PSO 10 - Bioinformatics and artificial intelligence in medicine
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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	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%**

22MMD302 Biotechniques 3 0 0 3

Preamble

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

Unit 1 (20 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 (15 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
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PSO 10 - Bioinformatics and artificial intelligence in medicine
PSO 11 –Technology in personalizing 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	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%**

22MMD303 Introductory Medical Physiology 3 0 0 3

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: **(7 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: **(6 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: **(7 lectures)**

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

UNIT 4: **(7 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: **(7 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: **(6 lectures)**

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

UNIT 7: **(5 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
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	POS12	POS13
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%**

22MMD382 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

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

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

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	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%**

Electives

22MMD331 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
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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

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%**

22MMD332 Fundamentals of Tissue Engineering 3-0-0-3

Preamble

In the emerging context of cell therapy and the significance of biopolymers as supportive scaffolds for tissue formation, development of tissues from cells or engineer cells to tissue format for carrying out a specific function is extremely important. In this course, student will be exposed to these aspects.

Unit-1: (15 Lectures)

Introduction to Tissue engineering; Current scope of tissue engineering; Use in Therapeutics; Traid of Tissue Engineering – Biomaterials; Cells and Growth Factors; Wound healing and sequence of events Cell migration, proliferation, differentiation, angiogenesis and tissue remodeling; Extracellular matrix and its significance in context of Tissue engineering

Unit-2: (15 Lectures)

Biomaterials in tissue engineering; Overview of type of biomaterials; Cell-Biomaterial interactions, Biomaterials properties in protein adsorption, cellular interactions and Tissue regeneration; Growth factors and its impact in tissue regeneration

Unit-3: (7 Lectures)

Scaffold fabrication techniques, Techniques to evaluate Tissue-engineered construct in vitro and in vivo; Animal models in Tissue engineering

Unit-4: (8 Lectures)

Case Studies; Tissue Engineering of Bone, cartilage, Vascular graft, Ligament.

Text Books

1. Principles of Tissue Engineering, Edited by Robert Lanza, Robert Langer, Joseph Vacanti, Anthony Atala, Academic Press, ISBN 978-0-12-818422-6
2. Methods of Tissue engineering, Edited by Anthony Atala and Robert P. Lanza, Academic Press, Academic Press, ISBN-13: 978-0124366367

Course Outcome

CO1: Understand the fundamental principles of tissue engineering
CO2: Understand wound healing process and apply this knowledge to Tissue engineering
CO3: Understand the biomaterial features and tissue biology toward the development of biomedical devices
CO4: Understand scaffold fabrication techniques
CO5: Understand different biological systems to engineer biomedical devices

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

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8	PSO 9	PSO 10	PSO11	PSO12	PSO13
CO 1	3	3	-	-	1	-	-	3	-	-	-	-	3
CO	3	3	3	-	-	-	-	3	-	-	-	-	-

2													
CO 3	3	3	3	2	3	-	3	3	-	-	3	-	-
CO 4	3	3	-	3	-	-	3	3	-	-	3	-	1
CO 5	3	3	3	3	3	-	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%**

22MMD333 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. Tissue inflammation and ensuing cellular events including healing, tissue regeneration, and cell death will be discussed. Students will also learn about concepts in hemodynamic disorders, nutritional diseases and malignant disorders. Concepts discussed in this course will complement the topics learnt in the physiology course

Unit 1: (6 lectures)

Introduction: History of pathology, Basic definitions and common terms used in pathology, Survival Introduction mechanism and disease, microscopic and cellular pathology, scope and techniques used.

Unit 2: (6 lectures)

Cell injury and responses of cells: Cellular Adaptations, and Cell Death, An overview of cellular adaptation: Hyperplasia, Hypertrophy, Atrophy, Metaplasia; Causes and mechanisms of cell injury, reversible and irreversible injury, Necrosis, Apoptosis, Types of apoptosis, Intracellular accumulations, Cellular ageing

Unit 3: (8 lectures)

Role of Inflammation in disease Basic concepts with suitable examples of general features of acute and chronic inflammation: Vascular Changes, cellular events, important chemical mediators of inflammation, Morphological effects inflammation response, Granulomatus Inflammation.

Unit 4: (5 lectures)

Role of Tissue repair, Healing and Fibrosis: Basic mechanism of tissue regeneration, and repair by healing, scar formation and fibrosis

Unit 5: (6 lectures)

Hemodynamic Disorders in diseases: An overview of Edema, hyperemia, congestion, hemorrhage, hemostasis and thrombosis, Embolism, Infarction and shock with suitable examples

Unit 6: (6 lectures)

Nutritional Diseases, Protein energy malnutrition, deficiency diseases of vitamins, minerals, nutritional excess and imbalances. Role and effect of metals.

Unit 7: (8 lectures)

Cancer: Definitions, Nomenclature, characteristics of benign and malignant neoplasms, grading and staging of cancer, biology of tumor growth, invasion and metastasis, carcinogens and cancer, concept of oncogenes, tumor suppressor genes, DNA repair genes and cancer stem cells.

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 cell injuries, cellular responses, cellular adaptations, cell death, inflammation and tissue repair

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

CO4 To learn about involvement of nutritional, vitamin and mineral deficiencies, imbalances and excesses as well as role and effect of metals in disease pathology

CO5 To learn about cancer, the genesis of cancer and genetic causes of cancer

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
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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

- / 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%**

22MMD334 Nanosciences in Biology 3 0 0 3

Unit-1 **(10 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 **(25 lecture)**

Applications of nanomaterials to biology: Fluorescent biological labels - Bioimaging, Nanoparticles for biological assays, Nanoparticles for drug/gene delivery, Active and passive delivery of nanoparticles to cells, Bio detection of pathogens, Nanobiotechnological applications in health and disease - infectious and chronic, Nanoparticles in disease diagnosis - MRI, CT and optical contrast agents, Nanoparticles for therapy of diseases – cancer, diabetes, Nanomaterials in tissue engineering and regenerative medicine

Unit-3 **(10 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

Course Outcome

CO1 Provides a fundamental understanding of nanotechnology and nanobiotechnology

CO2 A deeper understanding of the diverse nanostructures in biological systems and the concept of DNA nanotechnology

CO3 Details the various applications of nanomaterials to biology such as biolabeling, bioassays, drug/gene delivery

CO4 Importance of nanotechnology in disease diagnosis and regenerative medicine using nanomaterials

CO5 Significance of nanotechnology in biosensing applications and device development

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
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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	3	2	-	-	-	-	2
CO 2	3	1	1	1	2	2	1	-	-	-	-	2
CO 3	3	1	2	1	2	2	1	-	-	-	-	2
CO 4	3	1	2	1	2	2	1	-	-	-	-	2
CO 5	3	1	2	1	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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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	-	-	3	-	-	-	2	2	2
CO 2	2	-	3	2	-	-	3	-	-	-	2	2	2
CO 3	2	-	2	3	3	2	3	1	2	-	3	1	2
CO 4	2	-	2	3	-	-	3	2	-	-	3	1	2
CO 5	1	-	2	3	3	-	3	1	-	-	3	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%**

SEMESTER 6

22MMD311 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.

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
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	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%**

22MMD312 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
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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

	PO S1	PO S2	PO S3	PO S4	PO S5	PO S6	PO S7	PO S8	PO S9	POS 10	POS 11	POS 12	POS 13
CO1	2	-	3	1	-	-	-	-	3	-	-	2	-
CO2	3	-	3	3	-	-	-	-	3	-	-	2	-
CO3	3	-	3	3	2	-	-	-	3	-	-	2	2
CO4	3	-	3	3	-	-	-	-	3	-	-	2	3
CO5	1	-	3	1	-	-	-	-	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%**

22MMD313 Proteome and Proteomics 3 0 0 3

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 **(10 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 **(10 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 **(10 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 **(10 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 **(5 lectures)**

Clinical proteomics and significance of mass spectrometry in clinics; application of mass spectrometry-based proteomics for biomarker discovery, drug target discovery, understanding disease pathogenesis, drug response, and personalized medicine.

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
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	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%**

22MMD391 Minor Project (5 credits)

Electives

22MMD341 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
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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
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	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%**

22MMD342 Microbial diseases and vaccine technology 3 0 0 3

Unit 1 **(5 Lectures)**

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

Unit 2 **(10 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 **(10 Lectures)**

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

Unit 4 **(10 Lectures)**

Vaccines & Vaccination – adjuvants, DNA vaccines, recombinant vaccines, bacterial vaccines, viral vaccines.

Unit 5 **(10 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

PO1: Bioscience Knowledge
PO2: Problem Analysis
PO3: Design/Development of Solutions
PO4: Conduct Investigations of complex problems
PO5: Modern tools usage
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PO8: Ethics
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PO10: Communication
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PO12: Lifelong learning

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)

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	-	-	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%**

22MMD343 Antimicrobial agents 3 0 0 3

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,

Syllabus

Unit 1 (10 Lectures)

Antiseptics: Commonly used antiseptics. Antibiotics: Bacterial cell wall synthesis, DNA replication, transcription, folate synthesis, protein synthesis inhibitors etc.

Unit 2 (10 Lectures)

Antibiotic resistance mechanisms: modification/destruction of antibiotics, efflux pumps, target modification, biofilm, quorum sensing; MDR bacteria, ESKAPE pathogens, MRSA, VRSA etc; modes of transmission of antimicrobial resistance genes.

Antifungal, antiviral and anti-parasitic agents and their resistance mechanisms.

Unit 3 (10 Lectures)

Problems associated with antimicrobial resistance across healthcare. Other antimicrobial agents (Fatty acids, antimicrobial peptides etc).

Unit 4 (5 Lectures)

Significance of these antimicrobial agents in treatment and the associated challenges.

Unit 5 (10 Lectures)

Plants and plant derived phytochemical components as alternative source of developing anti-microbial therapeutics.

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.

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.
CO3: Test of minimum growth inhibitory concentration of different drugs, isolation of resistant mutants.
CO4: The students will learn about various methods involved in infection control.
CO5: The students will learn about different plant-derived antimicrobial compounds and their use as possible alternatives to antibiotics.

PO1: Bioscience Knowledge
PO2: Problem Analysis
PO3: Design/Development of Solutions
PO4: Conduct Investigations of complex problems
PO5: Modern tools usage
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c C O	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	1	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 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	-	-	-	-	-	3	-	-	2	-	-	-	1
CO 2	-	-	-	-	-	3	-	-	2	-	-	-	1
CO 3	-	-	-	-	-	3	-	-	2	-	-	-	1
CO 4	-	-	-	-	-	3	-	-	2	-	-	-	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%**

SEMESTER 7

22MMD401 Gene Editing Technology 3-0-0-3

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 **4 lectures**
Introduction to Genome Editing
Unit 2 **6 lectures**
DNA Repair Mechanisms in Genome Editing
Unit 3 **5 lectures**
Genome Editing tools: Restriction enzymes, Zinc finger nucleases (ZFNs), TALENs, CRISPR-Cas9
Unit 4 **7 lectures**
ZFNs and TALENs: Design and assembly, Functional testing of assembled designer tools, Applications in genome editing, Limitations
Unit 5 **18 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 **5 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
PO2: Problem Analysis
PO3: Design/Development of Solutions

PO4: Conduct Investigations of complex problems
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Program Specific Outcomes. (PSO)

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 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	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%**

22MMD402 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

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	2	-	-	-	-	-	-	-
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%**

22MMD498 Dissertation Project 1 9 credits

Electives

22MMD431 Immunotherapy 3-0-0-3

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 **(8 Lectures)**
What is immunotherapy? Its historical perspectives, basis of a healthy immune system.

Unit 2
(16 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 (**15 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%**

22MMD432 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

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

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	PS
CO 1	-	1	3	3	3	-	-	-	-	-	3	-	
CO 2	-	1	3	3	3	-	-	-	-	-	3	-	
CO 3	-	1	3	3	3	-	-	-	-	-	3	-	
CO 4	-	1	3	3	3	-	1	-	-	-	3	-	
CO 5	-	1	3	3	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%**

22MMD433 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 (**5 lectures)**
Introduction and Basic Concepts: Definition of Terminology and Basic Concepts, Nomenclature of Polymers, Polymer Architectures

Unit-2 **(8 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 (**10 lectures)**
Polysaccharides, Polysaccharide Graft Copolymers – Synthesis, Properties and Applications, Chitosan bio-polymers- Basic sources, characteristics, polymer isolation process, derivatives and their various bio medical applications.

Unit-5 (**12 lectures)**
Future research trends of biopolymers. Biopolymer Blends and Biocomposites, Biopolymers as wound healing materials, Biopolymers as biofilters and biobarriers. Stimuli responsive polymers: Classifications, preparation and their various applications.

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
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

C O										
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%**

SEMESTER 8

22MMD411 Machine Learning in Molecular Medicine 3 0 03

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

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

22MMD412 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.

Unit 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

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

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

- / 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 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%**

22MMD499 Dissertation Project 2 9 credits

Electives

22MMD441 Microbiome 2-0-0-2

Preamble:

Microbiome science is a fast-emerging new discipline in biology. Microbiota of the oral cavity, nasopharyngeal, respiratory tracts, gut, skin and genitourinary tract are different. Diet and medications influences the composition of our microbiome. Healthy microbiome can provide protection against many pathogens; it may influence our behavior, from social recognition to emotional states. Altered microbiome is reported in several neurological & inflammatory bowel diseases,

irritable bowel syndrome and colitis. It is possible to manipulate our microbiome using antibiotics, probiotics, prebiotics and faecal transplantation.

Unit 1 **5 lectures**

Description of the bacteria, fungi and viruses that comprise the human microbiome. Microbiota of the oral cavity, nasopharyngeal, respiratory tracts, gut, skin, genitourinary system, placenta and fetal tissues.

Unit 2 **5 lectures**

Effects of diet and medications on the gut microbiome and its physiological effects. Infant microbiome development and route of birth influencing the microbiome development.

Unit 3 **10 lectures**

Microbiome composition during diseased conditions; the role of gut microbiome on behavior, mood, cognition, nervous system diseases, inflammatory bowel diseases, irritable bowel syndrome and colitis.

Unit 4 **5 lectures**

Modification of the microbiome by antibiotics, probiotics and prebiotics. Fecal transplantion and its significance in disease modification. Implications in disease therapy. Interaction of the components of the microbiome including bacterial-phage interactions and bacterial-fungal interactions.

Unit 5 **5 lectures**

The potential of the microbiome manipulations in the treatment to prevent or modify diseases. Microbiome in diagnosis. Animal models to study microbiota.

Text book:

1. Fundamentals of Microbiome Science, How Microbes Shape Animal Biology by Douglas A.E. (2018). Published by Princeton Unversity Press.
2. The Gut Microbiome in Health and Disease Edited by Dr. Dirk Halle (2018). Published by Springer.
3. Human Microbiome by Sabu Thomas, ISBN: 978-981-16-7672-7; Publisher: Springer Singapore.

Course Outcome

CO1: Understanding the composition of human microbial communities.
CO2: Understanding the impact of microbial communities on human health and disease.
CO3: They will gain knowledge about probiotics and prebiotics.
CO4: The student will gain knowledge regarding manipulating microbiome to prevent and treat gastroenteritis, antibiotic-associated diarrhea, colitis and inflammatory bowel disease.

CO5: The student will understand the importance of microbiota transplantation for the treatment of metabolic syndrome, diabetes, cancer and Parkinson's disease.

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

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

22MMD442 Personalized Medicine 2-0-0-2

Preamble

Personalized Medicine is an evolving very essential aspect of healthcare. Due to the wealth of information on the molecular basis of disease, mechanisms by which how drugs work led to development of this area in recent years. As a result, tailored disease specific strategies have been developed that takes into account variability in genes, environment, and lifestyle for each person. However, translating this knowledge is essential by understanding biological and scientific insights into advanced therapies and diagnostic tools.

Syllabus (2 credits)

Unit 1 **(3 lectures)**

What is personalized medicine? Why is it important in medicine? Subtle differences in genome are advantageous or disadvantageous.

Unit 2 **(6 lectures)**

Measuring genetic variations and why they are important? How genetic and non-genetic factors influence disease development?

Unit 3 **(8 lectures)**

Use of different omics strategies to develop new treatments for different diseases based on individual variations. Human genome project and its significance.

Unit 4 **(6 lectures)**

Next-generation-sequencing (NGS) in detection of somatic driver mutations, resistance mechanisms, quantification of mutational burden, germline mutations. Genetic variants in gene function and regulation. How these genetic variants interact with the environment to increase risk of disease development.

Unit 5 **(7 lectures)**

Pharmacogenomics in personalized medicine. Approaches to develop personalized medicine.

Text Book

1. Genomic and Precision Medicine: Foundations, Translation, and Implementation (2016); by Geoffrey S. Ginsburg (Editor), Huntington F Willard.
2. Personalizing Precision Medicine: A Global Voyage from Vision to Reality Author: Kristin ciriello Pothier (2017) by Wiley.

Course Outcome

CO1 Why individual biochemical makeups are important and critical in treating diseases and its significance.
CO2 Understanding genetic and transcriptomic map of individuals and its relevance in the context of human genome project.
CO3 Understanding the role of epigenetic modifications in controlling gene expression and its significance in diseases.
CO4 Significance of drugs in gene expression and controlling pathways.
CO5 Students will be exposed to cutting edge genomic technology and its applications in personalized medicine.

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	1	2	2	2	1	-	-	-	-	-	-	1
CO 2	2	2	1	2	2	-	-	-	-	-	-	2
CO 3	2	1	1	1	1	-	-	-	-	-	-	2
CO 4	2	1	1	1	1	-	-	-	-	-	-	2
CO 5	2	2	2	2	3	-	-	-	-	-	-	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	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8	PSO 9	PSO10	PSO11	PSO12	PSO13
CO 1	1	-	2	-	1	2	-	-	2	2	3	1	1
CO 2	1	-	1	1	-	-	-	-	2	1	3	1	1
CO 3	-	-	2	2	-	-	-	-	3	1	3	1	1
CO 4	1	-	1	1	-	-	-	-	3	1	3	1	1
CO 5	-	-	1	3	-	-	-	-	1	1	3	-	1

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%**