

## **M.Sc. MOLECULAR MEDICINE 2022**

Molecular medicine is the study of molecular and cellular phenomena in biological systems, molecular aspects of human diseases, the human body's response to diseases, heterogeneity of response and personalized medicine, stem cells, immune response and genetic determinants. The course covers the use of molecular understanding in discovery research in disease prevention, drug development, diagnosis and therapy.

One of the unique strengths of this course is its emphasis on an interdisciplinary approach whereby medical sciences, molecular and biochemical aspects of biology is addressed. All students will be required to conduct a one-year thesis research that provides hands-on experience in molecular biology techniques, cell culture, biochemical techniques, bioinformatics and genetic analysis. The curriculum is designed according to the national education policy guidelines incorporating flexibility with respect to the opportunity to exit after one year with a post graduate diploma following obtaining the required credits

### **EDUCATIONAL OBJECTIVES.**

- Developing competent individuals with thorough scientific understanding of the subjects towards occupying places in both academia and industry
- Developing a thorough understanding of the basic concept of biology and medicine and its application in research and development.
- To establish careers in molecular medicine, medical biotechnology, in pharmaceutical industry or diagnostics labs including setting up startups in biotechnology field.
- Developing critical thinking and professionalism to function effectively in diverse environment holding to scientific ethics and responsibility.

## Curriculum

### First Semester

Course Code	Type	New Course	LTP	Credits												
22MMD501	FC	Advanced Cell Biology	300	3												
22MMD502	FC	Molecular Biology	300	3												
22MMD503	AC	Statistical Data Analysis	101	2												
22AVP103	AC	Mastery Over Mind	1 0 2	2												
22MMD581	SC	Molecular Biology Lab	101	2												
22MMD582	SC	Cell Culture and Animal Lab	101	2												
21HU601	HU	Amrita Values Program *	P/F	P/F												
21HU602	HU	Career Competency-I	P/F	P/F												
	E	<b>ELECTIVES (Any Two)</b>														
		<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="text-align: center;">22MMD531</td> <td>Organ Systems Physiology</td> <td style="text-align: center;">300</td> <td style="text-align: center;">3</td> </tr> <tr> <td style="text-align: center;">22MMD532</td> <td>Stem Cells and Applications in Medicine</td> <td style="text-align: center;">300</td> <td style="text-align: center;">3</td> </tr> <tr> <td style="text-align: center;">22MMD533</td> <td>Bioinformatics and Structure based Drug Design</td> <td style="text-align: center;">201</td> <td style="text-align: center;">3</td> </tr> </table>	22MMD531	Organ Systems Physiology	300	3	22MMD532	Stem Cells and Applications in Medicine	300	3	22MMD533	Bioinformatics and Structure based Drug Design	201	3		
22MMD531	Organ Systems Physiology	300	3													
22MMD532	Stem Cells and Applications in Medicine	300	3													
22MMD533	Bioinformatics and Structure based Drug Design	201	3													
<b>Total</b>			<b>20</b>													

### Second Semester

Course Code	Type	New Course	LTP	Credits																				
22MMD511	FC	Immunology	300	3																				
22MMD512	FC	Clinical Biochemistry and Proteomics	300	3																				
22MMD583	SC	Immunology Labs	101	2																				
22MMD584	SC	Biochemistry Lab	101	2																				
22MMD513	FC	Ethics in Research and Research Methodology	101	2																				
21HU603	HU	Career Competency-II	0 0 2	1																				
		<b>ELECTIVES (Any Two)</b>																						
		<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="text-align: center;">22MMD541</td> <td>Molecular Basis of Diseases.</td> <td style="text-align: center;">300</td> <td style="text-align: center;">3</td> </tr> <tr> <td style="text-align: center;">22MMD542</td> <td>Neurobiology: Chemical and Architectural Organization of Brain</td> <td style="text-align: center;">300</td> <td style="text-align: center;">3</td> </tr> <tr> <td style="text-align: center;">22MMD543</td> <td>Regenerative Medicine &amp; Tissue Engineering</td> <td style="text-align: center;">300</td> <td style="text-align: center;">3</td> </tr> <tr> <td style="text-align: center;">22MMD544</td> <td>Genetics: Principles and Analysis</td> <td style="text-align: center;">300</td> <td style="text-align: center;">3</td> </tr> <tr> <td style="text-align: center;">22MMD545</td> <td>Recombinant DNA Technology</td> <td style="text-align: center;">300</td> <td style="text-align: center;">3</td> </tr> </table>	22MMD541	Molecular Basis of Diseases.	300	3	22MMD542	Neurobiology: Chemical and Architectural Organization of Brain	300	3	22MMD543	Regenerative Medicine & Tissue Engineering	300	3	22MMD544	Genetics: Principles and Analysis	300	3	22MMD545	Recombinant DNA Technology	300	3		
22MMD541	Molecular Basis of Diseases.	300	3																					
22MMD542	Neurobiology: Chemical and Architectural Organization of Brain	300	3																					
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22MMD544	Genetics: Principles and Analysis	300	3																					
22MMD545	Recombinant DNA Technology	300	3																					
<b>Total</b>				<b>19</b>																				

<b>Third Semester</b>				
Course Code	Type	New Course	Credit	
22MMD698	P	Dissertation	18	

<b>Fourth Semester</b>				
Course Code	Type	New Course	Credit	
22MMD699	P	Dissertation	18	

**Total Credits 75**

## FIRST SEMESTER

22MMD501

ADVANCED CELL BIOLOGY

3-0-0-3

**Pre-requisites:** Basic understanding of biology

**Total number of classes:** 45

### **Syllabus**

#### **Unit-1**

**Lectures 8**

***Cellular basis of life:*** Universal features of cells and how these features separate the living world from non-living world, Cells and laws of thermodynamics; Cell membrane: Membrane structure and how it supported origin of life, Role of membrane asymmetry in cellular functions, Membrane proteins and how they support cellular diversity, Transport of small molecules across the membranes and electrical properties of membranes, Types of membrane transport and examples of molecular mechanisms involved in transport;

#### **Unit-2**

**Lectures 9**

***Internal organization of cells:*** Intracellular compartments and protein sorting: Compartmentalization of cells, Transport of proteins between intracellular compartments, Molecular mechanisms underlying protein sorting and transport across intracellular compartments, Glycosylation and its significance; Intracellular membrane traffic: Intracellular vesicular transport and underlying molecular mechanisms, Maintenance of compartmental diversity, Molecular mechanisms underlying specificity of molecular transport, Molecular mechanisms underlying transport into the cell from the plasma membrane and transport from trans-golgi network to cell exterior;

#### **Unit-3**

**Lectures 8**

***Communication between cells and the exterior.*** Cell signaling: General principles governing cell signaling, Types of cell communication, Negative feedback, Positive feedback, Signaling through GPCRs and enzyme-coupled surface receptors; Cytoskeleton: Types of cytoskeletal filaments, Molecular mechanisms involved in self-assembly and dynamic structure of cytoskeletal filaments, Polymerization and depolymerization of cytoskeletal filaments coupled to cellular functions, Molecular motors and their significance in intracellular transport, Cytoskeleton in cell division;

#### **Unit-4**

**Lectures 8**

***Cellular reproduction, the basis of sustenance of life on earth:*** Cell cycle: Role of templated polymerization of DNA in cellular reproduction and sustenance of life, Cell cycle control system in each phase of cell cycle, Regulation of cell cycle control system in different phases of cell cycle, Molecular mechanisms underlying cell cycle regulation, Control of cell growth; Apoptosis: Different types of cell death, Molecular pathways underlying cell death, Biological significance of cell death; Cancer from a cell's perspective: Cancer as a microevolutionary process resulting from failure of cellular surveillance system;

**Unit-5****Lectures 4**

**Cells in their social context.** Contacts between cell to cell and cells to extracellular matrix: Cell adhesions, Extracellular matrix, Types of junctions between cells and cells and matrix, Role of junctions in tissue formation and functions of organs;

**Unit-6****Lectures 4**

**How cells ensure continuity of life as well as genetic diversity on earth:** Germ cells and sexual reproduction: Germ cells as the cells equipped to transfer genetic information between generations, Sexual reproduction as a cellular process ensuring genetic diversity at the organismal levels;

**Unit-7****Lectures 4**

**Cells during development.** Developmental dynamics of cells: How cells undergo commitment, specification and lineage diversification during development, Contribution of cells in pattern formation, Developmental biology of cells from the perspective of diseases and tissue maintenance;

**TEXT BOOK:**

*Alberts B, Johnson A, Lewis J, Raff M, Roberts K and Walter P, "Molecular Biology of the Cell", Fifth and Sixth Editions, Garland Publishing Inc. 2008.*

**REFERENCE:**

*Gerald Karp, "Cell and Molecular Biology", Fifth Edition, John Wiley, 2008.*

**Course Outcome**

**CO1** To comprehend cell as the basic unit of life by studying the universal features of cells that distinguish the living and nonliving

**CO2** To understand the internal organization of cells, molecular bases of membrane transport, intracellular membrane traffic, cell communication and cytoskeleton

**CO3** To understand cell cycle and cell death as the bases for sustenance of life and cancer as a microevolutionary process originating from failure of cellular surveillance

**CO4** To perceive about a cell in its social context by studying cell – cell adhesions and cell – matrix associations

**CO5** To appreciate contribution of cells in reproduction and maintenance of genetic diversity, and the dynamic changes cells undergo during development

**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

0 – No affinity; 1 – low affinity; 2 – Medium affinity; 3 – High affinity

c	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO												
CO 1	3	1	1	2	1	2	3	0	0	0	0	3
CO 2	3	2	2	2	2	2	1	0	0	0	0	3
CO 3	3	2	2	2	2	2	1	0	0	0	0	3
CO 4	3	2	2	2	2	2	1	0	0	0	0	3
CO 5	3	2	2	2	2	2	3	0	0	0	0	3

### Program Specific Outcomes. (PSO)

PSO 1 - Biochemical organization and cellular complexity in function

PSO 2 - Biomolecules in Medicine

PSO 3 - Molecular dysregulation in diseases

PSO 4 - Molecular technology in diagnosis and therapy

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 biological data use

-	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO										
CO 1	3	1	1	1	1	0	0	2	0	0
CO 2	3	2	3	2	3	0	1	3	1	0
CO 3	3	3	3	3	3	0	1	2	0	0
CO 4	3	2	3	2	3	0	1	2	0	0
CO 5	3	3	2	2	2	0	0	3	0	0

### Evaluation Pattern: 50+50 = 100

#### Internal Assessment – 50%

Periodical 1	Exam	20%
Periodical 2	Exam	20%
Continuous Assessment	Assignment/Test/Quiz	10%
		<b>50%</b>

<b>End Semester Examination- 50%</b>		
Theory Exam	50%	
		<b>50%</b>
	<b>Total</b>	<b>100%</b>

**22MMD502**

**MOLECULAR BIOLOGY**

**3-0-0-3**

**Pre-requisites:** Undergraduate level basic DNA biology

**Total number of classes:** 45

**Preamble**

This course will provide a thorough understanding about biology of DNA, its functional significance and how it is very much involved in the biochemistry and physiology of the cell.

**Syllabus**

**Unit 1**

**(Lectures 10)**

DNA: Structure and function, Chromosome and chromatin, Genetic code, wobble hypothesis, RNA and types of RNA (rasiRNA, tasiRNA, nat-siRNA, piRNA), Proteins and their structure

**Unit 2**

**(Lectures 10)**

DNA replication and its regulation, Homologous and site-specific recombination, DNA repair

**Unit 3**

**(Lectures 10)**

Transcription and its regulation, Translation and its regulation, Gene structure, Repeats and clusters, Gene expression regulations: operon, Epigenetics

**Unit 4**

**(Lectures 5)**

Types of mutations, Genetic system of mitochondria

**Unit 5**

**(Lectures 10)**

Gene identification, promoter identification, Molecular biology techniques: Isolation and

Quantification of DNA/RNA, PCR, Reverse transcriptase PCR, Real Time PCR, DNA Sequence analysis, hybridization (southern, northern and western) and Sanger sequencing.

**Course Outcome**

**CO1** Understand the structure and function of DNA, RNA and proteins

**CO2** Understand the basics of DNA and RNA replication, transcription, translation and DNA-repair systems

**CO3** Understand how genetic switches work, the basics of gene regulation in prokaryotes and eukaryotes

**CO4** Understand the consequences of different types of mutations and recombinations

**CO5** Understand basic and advanced molecular biology concepts and techniques

**TEXT BOOK:**

## REFERENCES

*Molecular Biology of the Gene, Seventh Edition, James D. Watson, Cold Spring Harbor Laboratory; Tania A. Baker, Massachusetts Institute of Technology; Alexander Gann, Cold Spring Harbor Laboratory; Michael Levine, University of California, Berkeley; Richard Losick, Harvard University, 2013*

## Course Outcome

**CO1** Understand the structure and function of DNA, RNA and proteins

**CO2** Understand the basics of DNA and RNA replication, transcription, translation and DNA-repair systems

**CO3** Understand how genetic switches work, the basics of gene regulation in prokaryotes and eukaryotes

**CO4** Understand the consequences of different types of mutations and recombinations

**CO5** Understand basic and advanced molecular biology concepts and techniques

**PO1:** Bioscience Knowledge

**PO2:** Problem Analysis

**PO3:** Design/Development of Solutions

**PO4:** Conduct Investigations of complex problems

**PO5:** Modern tools usage

**PO6:** Bioscientist and Society

**PO7:** Environment and Sustainability

**PO8:** Ethics

**PO9:** Individual & Team work

**PO10:** Communication

**PO11:** Project management & Finance

**PO12:** Lifelong learning

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



**Program Specific Outcomes. (PSO)**

PSO 1 - Biochemical organization and cellular complexity in function

PSO 2 - Biomolecules in Medicine

PSO 3 - Molecular basis of disease

PSO 4 - Molecular technology in diagnosis and therapy

PSO 5 - Cellular 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 biological data use

-	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
<b>CO</b>										
<b>CO 1</b>	3	2	1	-	1	-	-	-	-	1
<b>CO 2</b>	3	2	1	-	1	-	-	-	-	1
<b>CO 3</b>	3	2	3	-	1	1	-	-	-	-
<b>CO 4</b>	3	3	3	1	1	-	-	-	-	2
<b>CO 5</b>	-	2	-	3	2	2	-	-	-	3

**Evaluation Pattern: 50+50 = 100**

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

**22MMD503****STATISTICAL DATA ANALYSIS****1-0-1-2****Pre-requisites:** Undergraduate level statistics and biology**Total number of classes:** 30**Syllabus****Unit 1****Lectures 6**

Introduction to Biostatistics-Need for Biostatistical Methods –Their uses and Misuses, Types of Variables, Data collection Methods, Population and Sample.

Descriptive Data Analysis Methods- Statistical Tables, Diagrams examples; Graphs, Measures of Central Tendencies and Dispersion, Correlation Analysis Methods, Linear Regression Analysis.

**Unit 2**

**Lectures 6**

Theory of probability, Standard Probability Distributions – Discrete distributions Binomial and Poisson;; Univariate continuous distribution – Normal, and standard normal.

**Unit 3**

**Lectures 6**

Tests of Significance of Statistical Hypotheses- Concept of Hypotheses –Null and Alternative hypotheses, Type I and Type II errors, Significance level, Critical region, 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.

**Unit 4**

**Lectures 6**

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..

**TEXT BOOKS**

1. *Statistical Techniques for data Analysis: J.K. Taylor & Cheryl C, 2004 Chapman & Hall (CRC).*
2. *Performing Data Analysis Using IBM SPSS: Lawrence S Meyers, 2015, John Wiley..*

**REFERENCE**

*Biostatistics: A Foundation for Analysis in the Health Sciences: Daniel, Wayne W 8<sup>th</sup> Ed. 2005.*

**Evaluation Pattern: 50+50 = 100**

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

### 1. Course Overview

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

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

### 2. Course Syllabus

#### Unit 1 (4 hours)

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

#### Unit 2 ( 4 hours )

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

#### Unit 3 (4 hours)

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

### TEXT BOOKS:

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

**REFERENCES:**

- 1.Craig Groeschel, “Winning the War in Your Mind: Change Your Thinking, Change Your Life” Zondervan Publishers, February 2019
- 2.R Nagarathna et al, “New Perspectives in Stress Management “Swami Vivekananda Yoga Prakashana publications, Jan 1986
3. Swami Amritaswarupananda Puri “Awaken Children Vol 1, 5 and 7 - Dialogues with Amma on Meditation”, August 2019
4. Swami Amritaswarupananda Puri “From Amma’s Heart - Amma’s answer to questions raised during world tours” March 2018
5. Secret of Inner Peace- Swami Ramakrishnananda Puri, Amrita Books, Jan 2018.
6. Mata Amritanandamayi Devi “Compassion :The only way to Peace:Paris Speech”, MA Center, April 2016.
7. Mata Amritanandamayi Devi “Understanding and collaboration between Religions”, MA Center, April 2016.
8. Mata Amritanandamayi Devi “Awakening of Universal Motherhood: Geneva Speech” M A center, April 2016.

**3. Evaluation and Grading**

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

**4. Course Outcomes (CO)**

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

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

- PO1: Engineering Knowledge**
- PO2: Problem Analysis**
- PO3: Design/Development of Solutions**
- PO4: Conduct Investigations of complex problems**
- PO5: Modern tools usage**
- PO6: Engineer and Society**
- PO7: Environment and Sustainability**
- PO8: Ethics**

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

**CO – PO Affinity Map**

P O	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P
	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O
C O	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
<b>CO 1</b>	3	3	3	2		-	2	3	-	3	-	3	-	-	-
<b>CO 2</b>	3	3	3	2	2	-	2	3	3	3	-	3	-	-	-
<b>CO 3</b>	3	3	2	2	2	2	2	3	3	3	-	3	-	-	-
<b>CO 4</b>	3	3	3	2	-	2	3	3	3	3	-	3	-	-	-
<b>CO 5</b>	3	2	2	2	-	2	-	3	2	2	-	2	-	-	-
<b>CO 6</b>	3	2	2	2	3	2	-	3	2	2	-	2	-	-	-

**22MMD581**

**MOLECULAR BIOLOGY LAB**

**1-0-1-2**

**Pre-requisites:** Basic understanding of DNA chemistry and DNA biology

**Total number of classes:** 30

**Syllabus**

Isolation of chromosomal DNA from Escherichia coli; Agarose gel electrophoresis, Isolation of chromosomal DNA from human blood; Isolation of plasmid DNA from Escherichia coli; Nucleic acid quantification; Polymerase chain reaction (PCR), Restriction digestion, Restriction fragment length polymorphism (RFLP), RNA isolation from Escherichia coli; cDNA synthesis, Reverse Transcriptase PCR, DNA sequencing, Real time PCR.

**TEXT BOOK**

1. Joseph Sambrook, David William Russell, *Molecular Cloning: A Laboratory Manual, Volume 1-2-3* CSHL Press, 2001.
2. Terence A. Brown, *Essential Molecular Biology: A Practical Approach, Volume 1* Oxford University Press, 2000.
3. Udo Reischl; *Molecular Diagnostics of infectious diseases; Humana Press.*
4. Adrian J Harwood, *Methods in Molecular Biology; Protocols for gene analysis.*
5. Frederick M Ausubel, Roger Brent, Robert D Moore, J G Seidman, John A smith, Kevin Struhl; *Current protocols in Molecular Biology, John Wiley and Sons, Inc (Volume 1-4).*

## **REFERENCE**

*Gene Therapy Technologies, Applications and Regulations: From Laboratory to Clinical.*  
Anthony Meager 1999 John Wiley & Sons, Ltd.

### **Course Outcome**

**CO1** Explain the principles of the DNA & RNA isolation methods, PCR, agarose gel electrophoresis, sequencing methods.

**CO2** Can isolate DNA, RNA, plasmids.

**CO3** Can perform PCR, cDNA synthesis, RT-PCR, Real-time PCR, and sequencing.

**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 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

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

### **Program Specific Outcomes. (PSO)**

- PSO 1 - Biochemical organization and cellular complexity in function
- PSO 2 - Biomolecules in Medicine
- PSO 3 - Molecular basis of disease
- PSO 4 - Molecular technology in diagnosis and therapy
- PSO 5 - Cellular 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 biological data use

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

**Evaluation Pattern: 30+70 = 100**

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

**22MMD582**

**CELL CULTURE AND ANIMAL LAB**

**1-0-1-2**

**Pre-requisites:** Basic understanding of biology

**Total number of lab sessions:** 30

**Preamble:** Cell culture module introduces the students to the basics of cell culture. The course provides students with sufficient knowledge and laboratory skills needed in academia and industry for carrying out basic cell culture techniques properly and safely. The animal handling module introduces students to the regulations, ethics and importance of animal use in research, along with basic small animal handling techniques

**Syllabus**

**Unit 1****(Lab sessions = 3)**

General lay out of a cell culture lab, physical environment needed for the cell culture, growth media and its composition, BSC and its use in cell culture and how to work in a BSC, contamination during cell culture and how to control it, culturing and splitting of cell lines, cryopreservation of cells and cell viability assays.

**Unit 2****(Lab sessions = 7)**

Hands-on cell culture work, media changes, seeding, splitting adherent cells, cell counting, reseeding, and safe disposal

**Unit 3****(Lab sessions = 5)**

Animal handling techniques, animal feed, gavage, different routes of injection, ethical treatment of animals and Institutional Animal Ethics Committee policies

**REFERENCE:**

1. R. Ian Freshney. *Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications*, 6th ed. 2010. Wiley-Blackwell.
2. *CPCSEA Guidelines for Laboratory Animal Facility, 2004. Guide for the Care and use of Laboratory Animals – 8th Edition, 2011, The National Academic Press.*

**Course Outcome**

**CO1:** To demonstrate a general level of understanding towards the function, maintenance and working of Bio-safety Cabinets (BSC) and be able to work in BSCs with a good sterilization technique

**CO2:** To identify culture contamination and methods involved to maintain sterility

**CO3:** Able to prepare media and maintain adherent cells in culture for atleast a week

**CO4:** To become aware of standard practices in cell culture and related ethical dilemmas

**CO5:** Be able to handle small animals and become familiar with ethics involved in animal use for research.

**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

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2
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CO 1	3	1	-	-	3	-	3	-	1	1	-	2
CO 2	2	3	-	-	-	-	3	-	1	1	-	2
CO 3	2	3	-	3	3	-	3	-	3	1	-	2
CO 4	2	1	-	-	-	3	3	3	3	2	-	2
CO 5	2	1	-	-	2	3	3	3	3	2	-	2

### Program Specific Outcomes. (PSO)

PSO 1 - Biochemical organization and cellular complexity in function

PSO 2 - Biomolecules in Medicine

PSO 3 - Molecular dysregulation in diseases

PSO 4 - Molecular technology in diagnosis and therapy

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 biological data use

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

### Evaluation Pattern: 30+70 = 100

#### Internal Assessment – 30%

Records	Evaluation	30%
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**30%**

#### End Semester Examination- 50%

Practical	Exam	60%
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Assessment	Viva	10%
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**70%**

**Total 100%**

**21HU601**

**AMRITA VALUES PROGRAM**

**p/f**

**Pre-requisites:** Basic understanding of Indian culture and values

**Total number of classes:** 15

**Unit 1**

**Lectures 3**

Culture – definition and scope. Values and culture, cultural freedom  
Culture and Education

**Unit 2**

**Lectures 4**

Culture of Research – creativity and responsibility in research  
Spirituality and Culture – spirituality as a way of life, spirituality and religion

**Unit 3**

**Lectures 4**

Culture and women – gender oppression, motherhood  
Culture and the Media

**Unit 4**

**Lectures 4**

Culture and Politics – national values and political harmony  
Philosophy and Culture, epistemology

**Course Outcome**

**CO1** The basic concept of culture and values

**CO2** The relationship of culture with education, research, spirituality

**CO3** How culture is linked with gender, especially women

**CO4** The influence of media and politics in culture

**21HU602**

**CAREER COMPETENCY-I**

**P/F**

**Pre-requisites:** Basic understanding of the importance of career in life

**Total number of classes:** 15

**Unit-1**

**Lectures 5**

Soft Skills

Introduction to 'campus to corporate transition': Communication and listening skills: communication process, barriers to communication, verbal and non-verbal communications, elements of effective communication, listening skills, empathetic listening, role of perception in communication. Assertiveness skills: the concept, assertiveness and self-esteem, advantages of being assertive, assertiveness and organizational effectiveness. Self-perception and self-confidence: locus of control (internal v/s external), person perception, social perception, attribution theories-self presentation and impression management, the concept of self and self-confidence, how to develop self-confidence. Goal setting: the concept, personal values and personal goals, goal setting theory, six areas of goal setting, process of goal setting: SMART goals, how to set personal goals Time management: the value of time, setting goals/ planning and prioritizing, check the time killing habits, procrastination, tools for time management, rules for time management, strategies for effective time

management Presentation skills: the process of presentation, adult learning principles, preparation and planning, practice, delivery, effective use of voice and body language, effective use of audio visual aids, dos and don'ts of effective presentation Public speaking-an art, language fluency, the domain expertise (Business GK, Current affairs), self-confidence, the audience, learning principles, body language, energy level and conviction, student presentations in teams of five with debriefing

## **Unit 2**

## **Lectures 5**

### **Verbal**

Vocabulary building: introduction to the methods and practices of learning

vocabulary, learning through practice sets to face questions on antonyms, synonyms, spelling error, analogy, wrong form of words, frequently confused words, understanding the nuances of spelling changes and wrong use of words.

Grammar: Analyzing subject verb agreement, pronoun agreement, tense consistency, and misplaced or dangling modifiers, parallel construction, active and passive voices, faulty comparison

Students take a few online practice tests to understand the test taking strategy and work on their specific areas of improvement.

## **Unit 3**

## **Lectures 5**

### **Aptitude**

Introduction to numbers – number line, classification of numbers, prime and composite numbers, co-prime numbers, number of zeros in an expression, LCM, HCF, remainder theorem, rules of divisibility, base system. Basics of equations- introduction to simple and quadratic equations, roots of an equation, word problems, problems on ages, consistency of equations Percentages, profit and loss: introduction to percentages, percentage change, value appreciation and depreciation, comparison observations, fundamentals concepts of business/commercial terminologies like cost price, selling price, profit, loss, marked price and discount

Ratio proportion and variation/partnership – fundamentals of ratios, duplicate ratio, triplicate ratio, sub duplicate ratio and sub triplicate ratio, direct and inverse proportion, joint variation, partnership and profit sharing

Averages and mixtures – mean, median and mode, measure of central tendency, concept of assumed average and weighted average, AM, GM and HM – relationship between AM, GM and HM, cheaper quantity and dearer quantity, rule of allegation, profit v/s quality of items getting mixed.

Simple interest and compound interest – time value of money, capital/principle, period of investment, rate of return, period of compounding, SAGR and CAGR Data interpretation – representation of data using tables, bar charts, pie charts, case study, line graph, scatter diagram – analyzing the data for decision making Venn diagrams-

set theory – concept of sets, types of set, forms of set representation, power set, sub set and super set, 2 and 3 variable venn-diagrams, familiarity with words like AND, OR, atleast, atmost, exactly 'n' elements Cubes – importance of aligning cuts to minimize/maximize the number of pieces of small cubes, painting a cube and cutting the cube, disintegration and integration of cubes, diagonal cutting, volume/LSA/TSA of cubes

## TEXT BOOKS/REFERENCES

1. Andrew J DuRbin , “Applied Psychology: Individual and organizational effectiveness”, Pearson- Merril Prentice Hall, 2004
2. Michael G Aamodt, “An Applied Approach, 6 th edition”, Wadsworth Cengage Learning, 2010
3. Robert Bolton, Dorothy Grover Bolton, “People Style at Work..and Beyond: Making Bad Relationships Good and Good”, Ridge Associates Inc., 2009
4. John Hayes “Interpersonal skills at work”, Routledge, 2003
5. Mark J Martinko, “Attribution theory: an organizational perspective”, St. Lucie, 1995
6. Stephen Covey, “The habits of highly effective people”, Free press Revised edition,2004
7. Kenneth H Blanchard ,”The 25 Best Time Management Tools & Techniques: How to Get More Done Without Driving Yourself Crazy” , Peak Performance Press, 1 st edition 2005
8. S. Upendran, “Know Your English”, Universities Press (India) Limited, 2015
9. Kaplan, “New GMAT Premier”, Kaplan Publishing, U.K., 2013
10. Arun Sharma, “How to Prepare for Data Interpretation for the CAT Common Admission Test”, Tata Mc GrawHills, 3rd Edition, 2015
11. R.S. Aggarwal, “A Modern Approach To Verbal & Non-Verbal Reasoning”, S. Chand Publishing, Revised -2015
13. Sarvesh Verma, “Quantitative Aptitude-Quantum CAT”, Arihant Publications, 2016

## ELECTIVES

**22MMD531**

**Organ Systems Physiology**

**3-0-0-3**

**Pre-requisites:** Undergraduate level basic biology

**Total number of classes:** 45

**Preamble:** This course builds on basic physiology and delves into individual organ systems, their design, structure, and function. Each organ system will be discussed from a perspective of its function and how tissue and cellular hierarchies, in terms of their architecture and processes, contribute to organ system homeostasis. Current progress in terms of biomedical advancement in each organ system will also be explored.

## Syllabus

**Unit 1****(Lectures 5)**

Introduction, body water and distribution, regulation of water within extracellular, transcellular, and intracellular compartments, determination of compartmental fluid volumes, electrolyte distribution and their role in cell membrane potential

**Unit 2****(Lectures 4)**

Blood and its components, serum, plasma, the coagulation process and dyscrasias, advancement in blood substitutes and their principle, and the lymphatic system

**Unit 3****(Lectures 6)**

Cardiovascular system and the vascular tree, cardiac electrophysiology, arrhythmias, pressure and volume changes in the ventricular chambers, cardiac cycle, valve kinetics, cardiac muscle physiology and calcium regulation, and cardiac biomedical technology

**Unit 4****(Lectures 4)**

Pulmonary system, mechanics of ventilation, bronchial and alveolar cell functions, pulmonary function tests and assisted respiration technology

**Unit 5****(Lectures 6)**

Hepatobiliary system, pancreas and the gut, hepatocyte architecture and function, blood-bile dynamics, pancreatic acini function, advancement in artificial liver and pancreas development, and gut physiology

**Unit 6****(Lectures 5)**

Renal physiology, function of nephron, process of urine formation, pressures across the Bowmans membrane, and developments in body fluid dialysis

**Unit 7****(Lectures 10)**

Nerve function, introductory neurophysiology, synapse physiology, neural circuits, signal processing in the special sense organs, cognition, and brain machine interface

**Unit 8****(Lectures 5)**

Reproductive and endocrine system, hormonal axis, and regulation in various endocrine glands

**TEXT BOOK:**

*John E. Hall, "Guyton and Hall Textbook of Medical Physiology", 13e Elsevier, 2015*

**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

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2
CO 1	3	1	1	-	1	-	-	-	3	2	-	1
CO 2	3	3	1	-	1	-	-	-	3	2	-	1
CO 3	3	3	3	-	1	-	-	-	3	2	-	1
CO 4	3	2	1	-	1	-	-	-	3	2	-	1
CO 5	2	1	3	2	1	3	-	2	3	2	-	1

**Program Specific Outcomes. (PSO)**

PSO 1 - Biochemical organization and cellular complexity in function

PSO 2 - Biomolecules in Medicine

PSO 3 - Molecular dysregulation in diseases

PSO 4 - Molecular technology in diagnosis and therapy

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 biological data use

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8	PSO 9	PSO1 0
CO 1	3	2	-	-	-	-	-	-	-	-
CO 2	3	3	-	-	2	-	-	-	-	-
CO 3	3	3	3	3	2	-	-	-	-	-
CO 4	3	2	-	2	-	-	-	-	-	-
CO 5	3	1	2	2	2	-	1	2	-	-

**Evaluation Pattern: 50+50 = 100**

**Internal Assessment – 50%**

<b>Periodical 1</b>	Exam	20%
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<b>Periodical 2</b>	Exam	20%
<b>Continuous Assessment</b>	Assignment/Test/Quiz	10%
		<b>50%</b>
<b>End Semester Examination- 50%</b>		
Theory Exam	50%	
		<b>50%</b>
<b>Total</b>		<b>100%</b>

**22MMD532 STEM CELLS AND ITS APPLICATIONS IN MEDICINE 3-0-0-3**

**Course code:**

**Course name: STEM CELLS AND ITS APPLICATION IN MEDICINE**

**Credits: 3**

**Pre-requisites:** Basic understanding of biology biotechnology

**Total number of classes: 45**

### **Preamble**

Stem cells are essential in the understanding of development of a fully functional organism from a single cell and the complexities associated with it. These cells have huge application in medicine with respect to developing cellular therapies patient oriented viz personal medicine level. The potential therefore in medicine and medical research is enormous.

### **Syllabus**

#### **Unit 1**

**(Lectures 3)**

Introduction to stem cells, Origin of thoughts on the potential of nucleus, history of the origin of stem cells.

#### **Unit 2**

**(Lectures 8)**

Journey from embryo to fetus and the role of cytoplasm in stemness. Nuclear transfer and its significance in stem cell evolution. Identification and characterization of pluripotent stem cells in animal and humans; sources of pluripotent cells – blastocysts, parthenogenesis. Evolution of induced pluripotent stem cells. Significance of cytoplasm in stemness revisited and application of molecular biology, Generation of iPSC's.

#### **Unit 3**

**(Lectures 8)**

Stem cell markers. Types of stem cells its advantages and disadvantages. Classification of stem cells. Normal stem cells: hematopoietic stem cells, mesenchymal stem cells, cardiac stem cells. Embryonic stem cells (ESC): difference between mouse and human ESCs, derivation of ESCs, scientific and ethical hindrance to ESC therapy. Tissue Stem Cells, Stem cell microenvironment: Cancer stem cells, Stem cell niche and its significance in signaling and cancer cell stem cell survival. Role of engineered materials in stem cell maintenance.

#### **Unit 4**

**(Lectures 9)**

Identifying and isolating stem cells. Cancer stem cells: Historical perspective, isolation and characterization of cancer stem cells. Solid cancer stem cells (Breast,

Lung, prostate, liver, stomach, Glioma). Targeting cancer stem cells. Hematological malignancies and stem cells. Side population cells in flow cytometry, Induced pluripotent stem cells, its derivation and applications.

#### **Unit 5**

**(Lectures 7)**

Proliferation and differentiation control stem cells by signalling mechanisms. The role of various stimuli and cytokines. Endothelial mesenchymal transition (EMT). EMT in fibrotic diseases and cancer.

#### **Unit 6**

**(Lectures 7)**

Translational Stem Cell Medicine, Stem cells and Gene Therapy: Signaling pathway involved in self-renewal and differentiation of stem cells. clinical use of stem cells. Molecular mechanisms controlling the stem cell survival and viability and its significance in stem cell therapy. Basic principles and methodologies in generating stem cells.

#### **Unit 6**

**(Lectures 3)**

Regulatory and ethical issues of stem cell research in India. Stem cell therapy for various diseases (neurodegenerative, retinal, leukemia, heart).

#### **TEXT BOOK:**

*Robert Lanza, "Essentials of Stem cell Biology", Elsevier, 2006*

#### **REFERENCE:**

*Daniel R. Marshak, Richard L. Gardner and David Gottlieb, "Stem cell Biology", Cold spring Harbour Laboratory Press, 2001*

#### **Course Outcome**

**CO1** The student will be exposed to the history of stem cells, how the basic concept of stem cells has evolved over a period of 100 years.

**CO2** Student will be exposed to the classification and also the major developments in stem cell biology area as well as principles and methodologies practiced.

**CO3** Student will understand the concept of induced pluripotent stem cells, its derivation and differentiation to various lineages.

**CO4** Student will understand the adult and embryonic stem cells and its derivations, isolation etc. Student will get clarity on the concept of stem cell niche and the concepts about cancer stem cells

**CO5** At the end of this module the students will get an idea about stem cell therapy for various diseases and the ethical issues of stem cell research.

**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



0 – No affinity; 1 – low affinity; 2 – Medium affinity; 3 – High affinity

c	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO												
CO 1	3	0	0	1	0	1	0	0	0	0	0	2
CO 2	3	2	2	2	2	2	0	0	0	0	0	2
CO 3	3	3	2	2	3	2	1	1	0	0	0	3
CO 4	3	2	3	3	3	2	0	0	0	0	0	3
CO 5	3	3	3	3	3	2	1	3	0	0	0	3

### Program Specific Outcomes. (PSO)

PSO 1 - Biochemical organization and cellular complexity in function

PSO 2 - Biomolecules in Medicine

PSO 3 - Molecular dysregulation in diseases

PSO 4 - Molecular technology in diagnosis and therapy

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 biological data use

-	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO										
CO 1	1	1	0	0	2	0	0	2	0	0
CO 2	2	2	1	2	2	0	0	1	0	0
CO 3	1	3	0	1	3	0	0	0	0	0
CO 4	2	1	1	1	3	0	0	0	0	0
CO 5	1	2	2	1	3	0	0	0	0	0

### Evaluation Pattern: 50+50 = 100

#### Internal Assessment – 50%

Periodical 1	Exam	20%
Periodical 2	Exam	20%
Continuous Assessment	Assignment/Test/Quiz	10%
		<b>50%</b>

<b>End Semester Examination- 50%</b>		
Theory Exam	50%	
		<b>50%</b>
	<b>Total</b>	<b>100%</b>

## 22MMD533 BIOINFORMATICS AND STRUCTURE BASED DRUG DESIGN 2-0-1-3

**Pre-requisites:** Basic understanding of computer and biology

**Total number of classes:** 45

### Syllabus

#### Unit 1

#### Lectures 12

Introduction to Concept of Genomics, Proteomics and Bioinformatics; Databases on web: Genome, Proteome and Molecular biology; Sequence alignment: Near-optimal sequence alignment; Global pair wise sequence alignment; Multiple sequence alignment; Genome rearrangement; Evolutionary Bioinformatics: Phylogenetic tree construction and analysis. Different methods used for protein evolution; Protein Modeling: Protein structure prediction and analysis, Protein visualization software, Protein dynamics and Protein structure validation tools.

#### Unit 2

#### Lectures 12

Chemoinformatics: Basic idea of molecule design, Visualization and generation of 2D and 3D molecular structures, Chemical databases and its implications, Pharmacophore model, Virtual screening, Ligand based and structure-based molecular design; Commands and Languages: Basic Unix and Linux commands, Extensible markup language and its use in Bioinformatics; Sequence similarity and database search: Pattern recognition and matching; Quantitative and probabilistic pattern matching; Sequence pattern databases, Spectral pattern matching, String matching algorithm.

#### Unit 3

#### Lectures 6

Machine learning, Deep learning and Artificial Intelligence in Drug discovery; Few case studies of integrating this methodology towards in vitro/in vivo model systems in understanding the molecular basis of the disease.

#### Unit 4

#### Lectures 15

Lab course work: Basic linux commands and linux editors, X-windows and linux environment used for learning different linux commands and text editors like vi, xedit etc. Exposure to different useful databases, virtual screening and Data mining, Different biologically important databases were explored. Structural similarity search of drug like molecules were mined from different small molecular databases. Sequence alignment studies of protein family using BLAST software.

### TEXT BOOKS:

1. Mount D W, "Bioinformatics Sequence and Genome Analysis", Cbs Publishers & Distributors (2003), ISBN: 8123909985

2. Jenny G and Philip E B, "Structural Bioinformatics", Second Edition, Wiley-Blackwell publisher (2011). ISBN: 978-1-118-21056-7
3. Practical Bioinformatics; Editors: Bujnicki, Janusz M. (Ed.), Series: Nucleic Acids and Molecular Biology, Springer publisher, 10.1007/978-3-540-74268-5, 2008.

#### REFERENCES:

Mohan CG, "Structural Bioinformatics- Applications in Preclinical Drug Discovery Process", Springer Nature Publisher, 2019. ISBN 978-3-030-05282-9.

#### Course Outcome

**CO1** Basic concepts on amino acids, peptide bond, Genomics basics, database analysis and structure-property relationships.

**CO2** Pairwise and Multiple sequence alignment methods, algorithms and applications and understanding the sequence conservation for protein sequence-function relationships

**CO3** Molecular docking, pharmacophore modeling, protein ligand complex interactions and its mechanism of action, QSAR, QSPR, QSTR techniques used in Chemoinformatics field.

**CO4** Different techniques in Machine learning and deep learning, concepts taught to make awareness in molecular modeling studies. Its integration with wet lab studies will be discussed.

**CO5** Skills working in Linux environment; Different linux commands and linux editor will be taught; Sequence alignment studies; Macromolecule sequence-structure and function studies and visualization using different software.

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

#### Program Specific Outcomes. (PSO)

PSO 1 - Biochemical organization and cellular complexity in function

PSO 2 - Biomolecules in Medicine

PSO 3 - Molecular dysregulation in diseases

- PSO 4 - Molecular technology in diagnosis and therapy  
 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 biological data use

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

**Evaluation Pattern: 50+50 = 100**

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

**SECOND SEMESTER**

**22MMD511**

**IMMUNOLOGY**

**3-0-0-3**

**Pre-requisites:** Basic understanding of cell biology

**Total number of classes:** 45

**Preamble:**  
 Preamble

The candidates undertaking this course will gain knowledge about fundamentals of microbiology and immunology with special reference to bacterial, viral and fungal diseases; and host responses against infections. The students will learn about components of immune system and their functions. Gain knowledge on development of immune system and mechanisms of innate, adaptive, allergic, hypersensitivity, autoimmune responses and organ transplantation. The scientific understanding developed through the course will motivate the student to take up advanced immunology courses that has extensive application in medicine.

## **Syllabus**

### **Unit 1**

**(8 lectures)**

General properties of microbes, mechanism of action of common antimicrobial agents, molecular mechanism of drug resistance. Human microbiome from skin, mouth, respiratory tract, intestinal tract, urogenital tract. Human diseases caused by bacteria, fungus, virus and parasites (Example pathogenesis of Staphylococcus, Pneumococcus, Pseudomonas, Chlamydiae, Clostridium, Mycobacterium, Salmonella, Streptococcus, Neisseria, Vibrio, Helicobacter, Hepatitis, HIV, HPV, Dengue, filaria and Malaria etc).

### **Unit 2**

**(10 lectures)**

Basic Concepts in Immunology, cells and organs of the immune system. Innate Immunity, pattern recognition by cells of the innate immune system, induced innate responses to infection, complement system. Antigen Recognition by B-cell and T-cell receptors, the structure of a typical antibody molecule, Structural variation in immunoglobulin constant regions, The interaction of the antibody molecule with specific antigen, Antigen recognition by T cells. Antigen presentation to T lymphocytes: The generation of T-cell receptor ligands, The major histocompatibility complex and its function. Development of B and T lymphocytes, Positive and negative selection of T cells.

### **Unit 3**

**( 7 lectures)**

Signaling through immune system receptors, general principles of transmembrane signaling, Antigen receptor structure and signaling pathways. The development and survival of Lymphocytes: Generation of lymphocytes in bone marrow and thymus, the rearrangement of antigen-receptor gene segments controls lymphocyte development, interaction with self-antigens selects some lymphocytes for survival but eliminates others, survival and maturation of lymphocytes in peripheral lymphoid tissues.

### **Unit 4**

**(10 lectures)**

T cell-mediated immunity, the production of armed effector T cells, General properties of armed effector T cells, T cell-mediated cytotoxicity, Macrophage activation by armed CD4 TH1 cells. The humoral immune response: B-cell activation by armed helper T cells, the distribution and functions of immunoglobulin isotypes, the destruction of antibody-coated pathogens via Fc receptors. Adaptive Immunity to Infection: Infectious agents and how they cause disease, the course of the adaptive response to infection, the mucosal immune system, immunological memory. Failures of Host Defense Mechanisms: Pathogens have evolved various means of evading or subverting normal host defenses, inherited immunodeficiency diseases, acquired immune deficiency syndrome.

### **Unit 5**

**(10 lectures)**

Allergy and Hypersensitivity: The production of IgE, effector mechanisms in allergic reactions, hypersensitivity diseases. Autoimmunity and Transplantation: Autoimmune

responses are directed against self antigens, responses to alloantigens and transplant rejection, self-tolerance and its loss. Manipulation of the Immune Response: Extrinsic regulation of unwanted immune responses, using the immune response to attack tumors, manipulating the immune response to fight infection. Currently available vaccines.

**TEXT BOOK:**

1. *Alcamo's fundamentals of microbiology / Jeffrey C. Pommerville. — 9th edition.*
2. *Janeway's Immunobiology, Ken Murphy, Paul Travers, Mark Walport, 9th edition.*

**REFERENCE:**

1. *Prescott's Microbiology 11th Edition.*
2. *Cellular and Molecular Immunology, Abul K Abbas, Andrew H. Lichtman, Shiv Pillai 9th edition 2017.*

**Course Outcome**

**CO1** Knowledge about the microorganisms, basic skills in aseptic/sterilization techniques, antimicrobial agents and microbial diseases. Students will learn the composition of human microbiome and their role in maintaining normal gut function.

**CO2** Will gain knowledge about principles of innate and adaptive immune system, the antigen receptor structure and the mechanisms of antigen recognition by B-cell and T-cells.

**CO3** Gain knowledge about immune signal mechanisms, lymphocyte generation, B- and T-cell receptor gene rearrangements; and lymphocyte development.

**CO4** Will gain knowledge about macrophage and B cell activation by T cells, adaptive Immunity to Infection: immunological memory. Failures of Host Defense Mechanisms, immunodeficiency diseases, acquired immune deficiency syndrome.

**CO5** Gain knowledge about the mechanism of allergic responses, hypersensitivity reactions, autoimmunity and transplantation. The students will also learn about the importance for immunization and manipulation of the immune system to fight infectious disease.

**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

<b>c</b>	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>	<b>PO11</b>	<b>PO12</b>
<b>CO</b>												

<b>CO 1</b>	3	1	1	1	-	-	-	-	-	-	-	1
<b>CO 2</b>	3	1	1	-	-	-	-	-	-	-	-	1
<b>CO 3</b>	3	1	1	-	-	-						1
<b>CO 4</b>	3	1	1	1	-	-	-	-	-	-	-	1
<b>CO 5</b>	3	1	1	1	1	-	-	-	-	-	-	1

**Program Specific Outcomes. (PSO)**

PSO 1 - Biochemical organization and cellular complexity in function

PSO 2 - Biomolecules in Medicine

PSO 3 - Molecular basis of disease

PSO 4 - Molecular technology in diagnosis and therapy

PSO 5 - Cellular 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 biological data use

-	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
<b>CO</b>										
<b>CO 1</b>	3	1	2	-	-	3	-	-	1	-
<b>CO 2</b>	3	-	1	-	-	-	-	-	-	-
<b>CO 3</b>	3	1	1	-	1	-	-	-	-	-
<b>CO 4</b>	3	-	1	-	-	-	-	-	-	-
<b>CO 5</b>	3	-	3	-	2	-	-	-	-	-

**Evaluation Pattern: 50+50 = 100**

**Internal Assessment – 50%**

<b>Periodical 1</b>	Exam	20%
<b>Periodical 2</b>	Exam	20%
<b>Continuous Assessment</b>	Assignment/Test/Quiz	10%
		<b>50%</b>

<b>End Semester Examination- 50%</b>		
Theory Exam	50%	
		<b>50%</b>
	<b>Total</b>	<b>100%</b>

**22MMD512                      CLINICAL BIOCHEMISTRY AND PROTEOMICS                      3-0-0-3**

**Pre-requisites:** Basic understanding of biology, chemistry and biotechnology

**Total number of classes:** 45

**Preamble**

The course intends to provide a basic understanding of the biochemical reactions; role of macromolecules and enzymes that govern the biochemical transformations and biochemical mechanisms responsible for common biochemical disorders; mass-spectrometry based proteomics for protein identification and quantitation, application of proteomics in the clinics for aiding in diagnosis, prognosis and treatment of diseases.

**Syllabus**

**Unit 1**

**15 lectures**

Carbohydrate and fatty acid metabolism, Glycolysis; TCA cycle, Oxidative

Phosphorylation - Energetics and its regulation; Cori cycle; Glycogen Metabolism; Pentose phosphate pathway; Gluconeogenesis pathway and significance; Biosynthesis of fatty acids; Oxidation of fatty acids - Beta oxidation, alpha oxidation.

**Unit 2**

**8 lectures**

Structures & function of enzymes, mechanism of action of enzymes and its regulation; Kinetics of enzyme catalyzed reactions, Michaelis-Menten equation, Importance of Vmax, Km; Enzyme inhibition and activation.

**Unit 3**

**6 lectures**

Concept and scope of clinical biochemistry; Control of the blood glucose and associated clinical diseases; Reference range.

**Unit 4**

**6 lectures**

Proteome and proteomics research, how it is different from genomics; different types of proteomics, significance of sample preparation in proteomics, significance of choosing different methods for proteome analysis, gel-free and gel-based proteome analysis, labelled and label-free quantitative proteomics.

**Unit 5**

**10 lectures**

Principles of mass spectrometry; protein identification using mass spectrometry, protein fragmentation; peptide enrichment and separation; ionization and its importance; Time of Flight, MS/MS analysis, types of mass analyzers, peptide fragmentation and peptide sequencing; identification of proteins using search engines/programs; accuracy of identified proteins with respect to protein identity,



significance of mass spectrometry in clinics, clinical proteomics and examples of clinical proteomics

### TEXT BOOKS:

1. *Fundamentals of Biochemistry: Life at the Molecular Level Kindle Edition* by Donald Voet (Author), Judith G. Voet (Author), Charlotte W. Pratt (Author) 5th edition 2016
2. Nawin C. Mishra, "Introduction to Proteomics: Principles and Applications" Wiley, 2010, ISBN: 0471754021

### REFERENCE:

*Lehninger Principles of biochemistry 7<sup>th</sup> Edition* (2017), Publisher: WH Freeman, Authors Michael Cox, David L. Nelson.

### Course Outcome

**CO1:** Understand overall concept of cellular metabolism, energy storage and release, enzymes and their regulation

**CO2:** Understand glucose homeostasis (pathways and hormonal regulation); glycogen metabolism, gluconeogenic pathway, fat metabolism.

**CO3:** Understand the basic concepts and principles of clinical biochemistry and molecular mechanism of some common biochemical disorders

**CO4:** Understand the basic concepts of proteome, mass spectrometry and protein identification using database search engines.

**CO5:** Discuss how proteomics can contribute to a clinical setting.

### 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

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

<b>CO3</b>	3	2	1	2	-	2	-	-	-	-	-	1
<b>CO4</b>	3	1	2	2	3	-	-	-	-	-	-	1
<b>CO5</b>	3	1	2	3	3	2	-	-	-	-	-	1

**Program Specific Outcomes. (PSO)**

PSO 1 - Biochemical organization and cellular complexity in function

PSO 2 - Biomolecules in Medicine

PSO 3 - Molecular dysregulation in diseases

PSO 4 - Molecular technology in diagnosis and therapy

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 biological data use

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
<b>CO1</b>	3	2	1	-	-	-	-	-	-	-
<b>CO2</b>	3	2	1	-	-	-	-	-	-	-
<b>CO3</b>	1	3	3	2	1	-	-	-	-	-
<b>CO4</b>	-	1	1	3	-	-	-	-	-	3
<b>CO5</b>	-	2	1	3	-	-	-	-	-	3

**Evaluation Pattern: 50+50 = 100**

**Internal Assessment – 50%**

<b>Periodical 1</b>	Exam	20%
<b>Periodical 2</b>	Exam	20%
<b>Continuous Assessment</b>	Assignment/Test/Quiz	10%
		<b>50%</b>
<b>End Semester Examination- 50%</b>		
Theory Exam	50%	
		<b>50%</b>
<b>Total</b>		<b>100%</b>

22MMD583

IMMUNOLOGY LAB

1-0-1-2

**Pre-requisites:** Basic understanding of biology and biochemistry and immunology

**Total number of classes:30**

**Preamble:**

The students will be familiarized with the basics as well as advanced methods in microbiology and immunology that can be used for disease diagnosis. Provide hands-on training for isolation of microbes in pure culture and antibiotic susceptibility assays. Provide the students with practical skills on lymphocyte isolation and analysis.

**Practicals:**

- (1) Bacterial and fungal culture medium preparation,
- (2) Pure culture technique (eg, streaking and sub culturing),
- (3) Gram staining, Fungal staining and Motility assay.
- (4) Bacterial conjugation, transduction and transformation
- (5) Bacterial growth curve by measuring turbidity and viable count
- (6) Antibiotic sensitivity assay, MIC and MBC determination
- (7) Phage titration assay
- (8) Biofilm assay, MBIC and MBEC determination
- (9) Ames test
- (10) Giemsa staining of blood smear
- (11) Blood grouping
- (12) Double diffusion assay
- (13) Immuno-electrophoresis
- (14) Radial immunodiffusion
- (15) IgG purification
- (16) ELISA

**TEXT BOOKS:**

1. Practical Handbook of Microbiology- Lorrence H Green, Emanuel Goldman by CRC Press, 4th Edition, ISBN 9780367567637
2. Practical Immunology-Frank C. Hay, Olwyn M.R. Westwood, Fourth Edition, Blackwell Science.

**Course Outcomes**

**CO1** Provide the students the knowledge about practical skills on basic microbiology.

**CO2** Students will learn about different antimicrobial activity assays.

**CO3** Students will develop an understanding about components of immune system and their function.

**CO4** The students will learn about mutagenic assays, biofilm assays and blood grouping.

**CO5** The students will learn about different antigen and antibody interaction assays.

**PO1:** Bioscience Knowledge

**PO2:** Problem Analysis

**PO3:** Design/Development of Solutions

**PO4:** Conduct Investigations of complex problems

**PO5:** Modern tools usage

**PO6:** Bioscientist and Society

**PO7:** Environment and Sustainability

**PO8:** Ethics

**PO9:** Individual & Team work

**PO10:** Communication

**PO11:** Project management & Finance

**PO12: Lifelong learning**

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

**Program Specific Outcomes. (PSO)**

PSO 1 - Biochemical organization and cellular complexity in function

PSO 2 - Biomolecules in Medicine

PSO 3 - Molecular basis of disease

PSO 4 - Molecular technology in diagnosis and therapy

PSO 5 - Cellular 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 biological data use

-	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
<b>CO</b>										
<b>CO 1</b>	3	1	2	2	-	3	-	-	1	-
<b>CO 2</b>	3	-	1	2	-	-	-	-	1	-
<b>CO 3</b>	3	1	1	2	1	-	-	-	-	-
<b>CO 4</b>	3	-	1	2	-	-	-	-	-	-
<b>CO 5</b>	3	-	3	2	2	-	-	-	-	-

**Evaluation Pattern: 30+70 = 100**

**Internal Assessment – 30%**

Records	Evaluation	30%
		<b>30%</b>

**End Semester Examination- 50%**

Practical	Exam	60%
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Assessment	Viva	10%
		<b>70%</b>
	<b>Total</b>	<b>100%</b>

**22MMD584**

**BIOCHEMISTRY LAB**

**1-0-1-2**

**Pre-requisites:** Basic understanding of biology and chemistry

**Total number of classes:** 30

**Syllabus:**

Experiment 1: Preparation of Laboratory Reagents with different concentrations, PH measurement.

Experiment 2: Protein estimation: Lowry method and spectrometry principles.

Experiment 3: Protein estimation: Biuret method / Bicinchoninic acid

Experiment 4: Enzyme Estimation (Serum Amylase) - Iodometric Method

Experiment 5: Amino acid Estimation by Biuret Test, Millon's Test, Hopkin's Cole Test, Xanthoproteic Test, Lead Acetate Test

Experiment 6: Protein Separation by SDS-PAGE and Western Blotting.

Experiment 7: Chromatographic techniques (Eg., Thin Layer chromatography or high performance liquid chromatography (HPLC)

**TEXT BOOKS:**

1. *D. T. Plummer. An Introduction to Practical Biochemistry, McGraw Hill Education; 3rd edition, 2017.*
2. *Rodney Boyer. Biochemistry laboratory: Modern Theory and Techniques (2nd Edition), Pearson, 2011.*
- 3.

**REFERENCES**

1. *S. Chaykin Biochemistry Laboratory Techniques, 169pages. John Wiley & Sons Inc., New York.*

**Course Outcome**

**CO1:** Understand the basics of the measure of solution concentration

**CO2:** Understand the importance of protein estimation, different types of protein estimation (Eg., Lowry method, Biuret method etc)

**CO3:** Understand how to quantify enzyme level in serum (amylase enzyme)

**CO4:** Determine the presence of amino acids in a given sample and know the advantages / disadvantages of different method of detection.

**CO5:** Evaluate separation of proteins in the sample by sodium dodecyl sulfate–polyacrylamide gel electrophoresis and chromatographic 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

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

**Program Specific Outcomes (PSO)**

**PSO 1** - Biochemical organization and cellular complexity in function

**PSO 2** - Biomolecules in Medicine

**PSO 3** - Molecular basis of disease

**PSO 4** - Molecular technology in diagnosis and therapy

**PSO 5** - Cellular 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 biological data use

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
<b>CO1</b>	-	2	-	-	-	-	-	-	-	-
<b>CO2</b>	1	2	2	2	-	-	-	-	-	-

<b>CO3</b>	1	2	2	2	-	-	-	-	-	-
<b>CO4</b>	1	2	2	2	-	-	-	-	-	-
<b>CO5</b>	1	2	2	2	-	-	-	-	-	-

**Evaluation Pattern: 30+70 = 100**

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

**22MMD513 ETHICS IN RESEARCH AND RESEARCH METHODOLOGY 1-0-1-2**

Course code:

Course name: ETHICS IN RESEARCH AND RESEARCH METHODOLOGY

Credits: 2

Pre-requisites: Basic level biology

Total number of classes: 30

**Syllabus**

**Unit 1**

**Lectures 15**

Plagiarism, regulatory principles, safety in research, ethics in stem cell research, ethics in clinical research, ethics in nanomaterials based research, Case studies

**Unit 2**

**Lectures 15**

Principles of data documentation, protocol development, research questions and hypothesis driven research.

**Course Outcome:**

**CO1** Understand the basic concepts of ethics in proper conduct of research

**CO2** Understand about plagiarism in research and how it should be avoided

**CO3** Gain a clear idea about the importance of proper data documentation

**CO4** Students will have a clear idea about the research methodologies that need to be adopted during their research

**TEXTBOOKS:**

1. Research Ethics for Scientists, C. Neal Stewart Jr., Wiley-Backwell Publishers, 2011
2. Ethics in Science, Ethical Misconduct in Scientific Research, John D'Angelo, CRC Press, 2012.

**21HU603**

**CAREER COMPETENCY-II**

**0 0 2 1**

**Pre-requisites:** None

**Total number of lab sessions:** 30

### **Unit 1**

**Lectures 10**

#### **Soft Skills**

Interpersonal skill: ability to manage conflict, flexibility, empathetic listening, assertiveness, stress management, problem solving, understanding one's own interpersonal needs, role of effective team work in organizations Group problem solving: the process, the challenges, the skills and knowledge required for the same. Conflict management: the concept, its impact and importance in personal and professional lives, (activity to identify personal style of conflict management, developing insights that helps in future conflict management situations.) Team building and working effectively in teams: the concept of groups (teams), different stages of group formation, process of team building, group dynamics, characteristics of effective team, role of leadership in team effectiveness. (Exercise to demonstrate the process of emergence of leadership in a group, debrief and reflection), group discussions. Interview skills: what is the purpose of a job interview, types of job interviews, how to prepare for an interview, dos and don'ts of interview, One on one mock interview sessions with each student

### **Unit 2**

**Lectures 10**

#### **Verbal**

Reasoning: Introduction to higher order thinking skills and deductive reasoning through critical thinking and syllogisms exercises. Students are trained to think critically and analyze an argument critically. They practice these skills extensively. Logical ordering of sentences: to improve logical thinking and ability to put ideas cohesively. Reading comprehension: intermediate & advanced level reading passages are provided to the students for practice. Students are taught techniques to read a dense passage in a fast & accurate manner. Punctuation and e-mail writing: students hone their e-mail writing skills and are taught the essentials of punctuation and e-mail etiquette.

### **Unit 3**

**Lectures 10**

#### **Aptitude**

Time and distance: speed, distance, displacement, relative speed, average speed, races, boats and streams-upstream and down-stream movement, problems on trains, concept of relative speed, motion in circular track – clockwise and anti-clockwise rotations Time and work- unitary method, concept of man-days, efficiency in task completion, sharing of wages proportionately, questions on pipes and cisterns Geometry, mensuration-line/ray/angles, length of segments, area and properties of geometrical figures, properties of angles, diagonals, LSA, TSA and volume of solids Seating arrangements/ puzzles- linear arrangements, circular arrangements, selection, comparison and distribution of objects under given constraints, analysing given constraints and present definitive or probable solutions for a given problem. Permutations and combinations- fundamental principle of counting-selection and arrangement of objects, factorial notations, permutations with/without repetition, rank of a word, sum of all permutations, team formation with certain constraints Probability- chances, odds in favour and odds against favour, events-independent and mutually exclusive types, conditional probability Nonverbal reasoning – picture



based series, mirror image, water image, paper folding, paper cutting, grouping of figures, figure matrix Quant Based Reasoning – case study, application oriented problems

### TEXT BOOKS/REFERENCE

1. Brian Cole Miller, "Quick Team-Building Activities for Busy Managers: 50 Exercises That Get Results in Just 15 Minutes", AMACOM; 1 edition, 2003.
2. Patrick Lencioni, "The Five Dysfunctions of a Team: A Leadership Fable", Jossey-Bass, 1st Edition, 2002
3. Kaplan GMAT 2012 & 13
4. [www.campusgate.co.in](http://www.campusgate.co.in)
5. [www.indiabix.com](http://www.indiabix.com)
6. R.S. Aggarwal, "Quantitative Aptitude For Competitive Examinations", S. Chand Publishing, 2015
7. R.S. Aggarwal, "A Modern Approach To Verbal & Non-Verbal Reasoning", S. Chand Publishing, Revised -2015
8. Sarvesh Verma, "Quantitative Aptitude-Quantum CAT", Arihant Publications, 2016

## ELECTIVES

22MMD541

MOLECULAR BASIS OF DISEASES

3-0-0-3

**Pre-requisites:** Basic understanding of biology and biochemistry

**Total number of classes:** 45

**Preamble:** This course is primarily designed to help students understand the molecular mechanism behind disease processes. The idea is to use specific examples of disease conditions that are globally prevalent and effects large populations worldwide. These chosen diseases will be used to study and understand disease manifestation, progress, and outcome, based on molecular mechanisms at the tissue and cellular level. This course utilizes an active learning strategy where students and the instructor will discuss recent developments in molecular pathogenesis of the specific diseases, based on published articles.

### Syllabus

#### Unit 1

(Lectures 5)

Introduction to disease pathogenesis, clinical terminologies, concept of prognosis, evidence-based treatment approach, bench-to-bedside approach in medicine, and introduction to a holistic approach in treating diseases

#### Unit 2

(Lectures 6)

Regeneration, cellular differentiation, and cell adaptations in the context of tissue healing secondary to injury

#### Unit 3

(Lectures 6)

Cellular and biochemical basis of glucose intolerance and subsequent changes in hyperglycemia associated protein changes and signaling pathways, leading to organ damage

**Unit 4**

**(Lectures 5)**

Epidemiology, etiology, and pathogenesis of diseases associated with vascular wall dysfunction and flow

**Unit 5**

**(Lectures 6)**

Diseases associated with dysfunction in gas exchange across the alveolar membrane, flow-volume loops, and inflammatory response in the pulmonary system

**Unit 6**

**(Lectures 6)**

Cellular changes and their consequence in chronic neuropathic pain conditions, behavioral response in pain, role of glia and neural changes in the CNS in pain conditions

**Unit 7**

**(Lectures 6)**

Circadian rhythm and its role in peripheral cells, CLOCK proteins, and their connection with inflammatory disorders

**Unit 8**

**(Lectures 5)**

Mental health diseases, known mechanisms and prospects

**TEXT BOOK**

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

*Selected research articles will be provided before each class*

**Course Outcome**

**CO1:** To demonstrate ability to approach a scientific report in a systematic manner

**CO2:** To be able to identify scientific hypothesis and understand the rationale behind the research approach in a scientific report

**CO3:** Be able to summarize disease pathogenesis and connect it to clinical signs and symptoms associated with the disease

**CO4:** Be able to work with team and put together in depth information related to disease mechanism at the cellular and molecular level, treatment options and current developments in the field

**CO5:** Be able to give a presentation related to molecular basis of a disease and field audience questions related to the topic

**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

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

**Program Specific Outcomes. (PSO)**

- PSO 1 - Biochemical organization and cellular complexity in function  
 PSO 2 - Biomolecules in Medicine  
 PSO 3 - Molecular dysregulation in diseases  
 PSO 4 - Molecular technology in diagnosis and therapy  
 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 biological data use

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

**Evaluation Pattern: 50+50 = 100**

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

	50%
<b>Total</b>	<b>100%</b>

**22MMD542 NEUROBIOLOGY: CHEMICAL AND ARCHITECTURAL  
.ORGANIZATION OF BRAIN 3-0-0-3**

**Pre-requisites:** Basic understanding of cell biology

**Total number of classes:** 45

**Preamble**

The heterogeneous group of cells that constitute the nervous tissue and functions as a system is an architectural organization composed of highly organized networks with different functions compartmentalized in different cell types for the efficient execution of impulse conduction, cognition, memory and conscience at time space level. Basic understanding of this organization is essential for understanding neurobiology.

**Syllabus**

**Unit 1**

**(Lectures 5)**

**Introduction:** Introduction to Nervous System. Why it is considered as system and its conceptual difference from tissue. Concept of neurobiology; Levels of neural organization. Neurons and Glia. Importance of neuronal polarity and Axonal integrity.

**Unit 2**

**(Lectures 10)**

Molecular and architectural organization of neuron and oligodendrocytes and its role in impulse conduction. Importance of myelin and myelination. Myelin axolemmal junctions and its biochemical make up. Significance of Myelin-axolemmal complexities in impulse conduction. How disturbances in this organization leads to variety of disorders.

**Unit 3**

**(Lectures 9)**

Myelin biology and its components. Role of myelin protein in the architectural organization of myelin. Organization of myelin at node, paranodes and internodes. Different levels of brain organization. Diseases affecting the myelin.

**Unit 4**

**(Lectures 10)**

Axonal transport, vesicle trafficking and regulation; Neuronal growth, survival and development; Glia biology, role of astrocytes, oligodendrocytes and their concerted action in supporting neuronal function,

**Unit 5**

**(Lectures 11)**

Electrical properties of membrane in the context of myelin organization; Membrane potential; Ion channels; Properties of axons and dendrites; Action potential; Synapse; Synaptic potential and integration; Directly and indirectly gated neurotransmitter receptors; Secretion, Memory formation and the role of signaling mechanisms. Synaptic plasticity, Long term potentiation.

**TEXT BOOK:**

**REFERENCES:**

*Basic Neurochemistry: Principles of Molecular, Cellular, and Medical Neurobiology by Scott Brady and George Siegel (2011)*

**Course Outcome**

**CO1** Provides a basic understanding about the organization of the brain

**CO2** A deeper explanation of different types of cells that constitute brain organization

**CO3** Significance of the different cell types in the formation of functional unit of neuron and how this is achieved and maintained

**CO4** Importance of functional unit of neuron in organizing structural and functional polarity

**CO5** Significance of structural and functional organization in the chemical complexity related to impulse conduction, transport of molecules and complexes for transmission of impulses and its association with disease.

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

**Program Specific Outcomes. (PSO)**

PSO 1 - Biochemical organization and cellular complexity in function

PSO 2 - Biomolecules in Medicine

PSO 3 - Molecular dysregulation in diseases

PSO 4 - Molecular technology in diagnosis and therapy

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 biological data use

C	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO										
CO 1	3	1	1	1	1	-	-	2	-	-
CO 2	3	-	-	-	-	-	-	1	-	-
CO 3	3	-	-	-	1	-	-	2	-	-
CO 4	-	-	-	2	-	-	-	2	-	-
CO 5	3	3	3	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%
		<b>50%</b>
<b>End Semester Examination- 50%</b>		
Theory Exam	50%	
		<b>50%</b>
<b>Total</b>		<b>100%</b>

**22MMD543      REGENERATIVE MEDICINE & TISSUE ENGINEERING      3 0 0 3****Course code:****Course name:** REGENERATIVE MEDICINE & TISSUE ENGINEERING**Credits:** 3**Pre-requisites:** Undergraduate level biology, biotechnology and physiology**Total number of classes:** 45

**Preamble:** This course introduces the student to basic principles of regenerative medicine and tissue engineering and its various applications. The central focus of this course is to help the students to get familiarise with the fundamentals and applications of various tissue repair and regeneration approaches. Students will also be exposed to the case studies related to the engineered /regenerated tissues.

## Syllabus

### Unit-1

9 Lectures

**Biologic and Molecular Basis for Regenerative Medicine;** Current perspectives in Regenerative Medicine/Introduction: Types of Tissues, Tissue Repair and Regeneration; Different stages of Tissue Regeneration, Molecular organisation of cells, Cell extra-cellular matrix interactions in repair and regeneration, How cells change their phenotype

### Unit-2

9

#### Lectures

**Cellular aspect of regenerative medicine;** Stem cells and progenitors; Basic biology and characteristics, Types of stem cells, Embryonic stem cells, induced pluripotent stem cells, Mesenchymal stem cells, Hematopoietic stem cells, Cardiac stem cells, Skeletal muscle stem Cells, Stem cells derived from fat, Peripheral blood stem cells and Pancreatic stem cells

### Unit-3

12 Lectures

**Architecture of Cells, Tissues, Organs and body's inherent regenerative mechanisms;** Basic cell structure and functions, tissue organisation and functions, organ structure and functions, Blood regeneration, Blood vessel regeneration, Wound healing and skin regeneration, Bone regeneration, Liver regeneration, Peripheral nerve regeneration, The multifactorial role of peripheral nervous system in bone growth

### Unit-4

15

#### Lectures

**Tissue Engineering:** General strategies in tissue engineering, scaffolds; types and characteristics, cells, growth factors. Role of tissue engineering in regenerative medicine, *Case Studies* – Ectoderm derived tissues; *Nerve tissue, Cornea*, Endoderm derived tissues; Liver, Pancreas, Tubular structures, Mesoderm; Bone, Cartilage, Muscle, blood vessels, Bone marrow, ligament, Tendon. Recent advances in biofabrication ; 3D bioprinting

## TEXT BOOK

*Principles of Regenerative Medicine, Anthony Atala, Robert Lanza James, Thomson Robert Nerem, 2nd Edition, Elsevier -2010*

## REFERENCES:

1. *Ying Deng and Jordan Kuiper, Functional 3D Tissue Engineering Scaffolds: Materials, Technologies, and Applications (Woodhead Publishing Series in Biomaterials), 2017*
2. *Cato T. Laurencin, Lakshmi S. Nair. Nanotechnology and Regenerative Engineering: The Scaffold, Second Edition, CRC Press 2017*

### **COURSE OUTCOMES:**

Upon successful completion, students will have the

- CO1.** Understanding on the molecules and signalling pathways that regulate epithelial and mesenchymal states of tissues and cell-extracellular matrix interactions
- CO2.** Knowledge on the various types and sources of stem cells and their role in tissue growth, repair and regeneration
- CO3.** Knowledge on the inherent regenerative mechanisms in human body
- CO4.** Understanding on the fundamental aspects of tissue engineering and their application in developing various tissues.

### **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

<b>c</b>	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>	<b>PO11</b>	<b>PO12</b>
<b>CO</b>												
<b>CO 1</b>	3	1	1	-	1	1	-	-	-	-	-	2
<b>CO 2</b>	3	1	1	-	1	1	-	3	1	-	-	2
<b>CO 3</b>	3	1	2	3	1	1	-	1	1	-	-	2
<b>CO 4</b>	3	1	3	3	3	1	-	1	1	-	-	2



**Program Specific Outcomes. (PSO)**

PSO 1 - Biochemical organization and cellular complexity in function

PSO 2 - Biomolecules in Medicine

PSO 3 - Molecular basis of disease

PSO 4 - Molecular technology in diagnosis and therapy

PSO 5 - Cellular 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 biological data use

c	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
<b>CO</b>										
<b>CO 1</b>	3	1	-	-	3	-	1	3	-	-
<b>CO 2</b>	-	2	-	-	3	-	-	3	-	-
<b>CO 3</b>	2	2	-	-	3	-	-	3	-	-
<b>CO 4</b>	2	2	-	-	3	-	2	3	3	-

**Evaluation Pattern: 50+50 = 100****Internal Assessment – 50%**

<b>Periodical 1</b>	Exam	20%
<b>Periodical 2</b>	Exam	20%
<b>Continuous Assessment</b>	Assignment/Test/Quiz	10%
		<b>50%</b>
<b>End Semester Examination- 50%</b>		
Theory Exam	50%	
		<b>50%</b>
	<b>Total</b>	<b>100%</b>

**22MMD544****GENETICS: PRINCIPLES AND ANALYSIS****3-0-0-3****Pre-requisites:** Basic understanding of biology and genetics**Total number of classes:** 45**Syllabus****Unit-1****Lectures 3**

**Overview of genetics:** Relationship between genes and traits, Fields and science of genetics; Patterns of inheritance: Mendelian inheritance, Law of segregation, Law of independent assortment, Studying inheritance patterns in humans;

## **Unit-2**

## **Lectures 8**

**Extensions of Mendelian inheritance:** Overview of simple inheritance patterns, Dominant and recessive alleles, Environmental effects on gene expression, Incomplete dominance, overdominance and codominance, X-linked inheritance, Sex-influenced and sex-limited inheritance, Lethal alleles, Pleiotropy, Gene interactions, Non-Mendelian inheritance: Maternal effect, Epigenetic inheritance-dosage compensation and genomic imprinting, Extranuclear inheritance;

## **Unit-3**

## **Lectures 9**

**Chromosomes of eukaryotes:** Chromosome organization and molecular structure: General features of chromosomes, Organization sites along eukaryotic chromosomes; Chromosome transmission during cell division and sexual reproduction: Chromosomes during cell divisions - mitosis and meiosis, The chromosome theory of inheritance and sex chromosomes; Genetic linkage and mapping in eukaryotes: Overview of linkage, Relationship between linkage and crossing over, Genetic mapping in animals, Mitotic recombination; Variation in chromosome structure and number: Changes in chromosome structure - an overview, Deletions and duplications, Inversions and translocations, Changes in chromosome number - an overview, Variation in number of chromosomes within a set and in the number of sets of chromosomes;

## **Unit-4**

## **Lectures 9**

**Gene regulation in eukaryotes:** Epigenetics: Epigenetics and development, Paramutation, Epigenetics and environmental agents, Role of epigenetics in cancer; Noncoding RNAs: Overview, Effects of noncoding RNAs on chromatin structure, transcription, translation, mRNA degradation and RNA modifications, Noncoding RNAs in protein targeting and genome defense, Role of noncoding RNAs in human diseases;

## **Unit-5**

## **Lectures 8**

**Medical, immuno and developmental genetics:** Medical genetics: Inheritance patterns of genetic diseases, Genetic basis of cancer, Personalized medicine; Immunogenetics: Genetics of V(D)J recombination and antibody diversity; Developmental genetics: Genetics of vertebrate development, differential gene expression and its role in development;

## **Unit-6**

## **Lectures 8**

**Population and evolutionary genetics:** Genes in populations and the Hardy-Weinberg equation, Overview of microevolution, Natural selection, Genetic drift, Migration, Nonrandom mating, Sources of new genetic variation; Complex and quantitative traits: Overview of complex and quantitative traits, Polygenic inheritance, Heritability, Selective breeding; Evolutionary genetics: Origin of species, Phylogenetic trees, Molecular evolution.

## **TEXT BOOKS:**

*Genetics: Analysis and Principles, 6th edition, Robert Brooker, McGraw-Hill*

## REFERENCE

*Principles of genetics, 8th edition, Gardner, Simmons, Snustad, Wiley, 2006.*

### Course Outcome

- CO1** To understand patterns of inheritance and laws of heredity at molecular levels  
**CO2** To understand about chromosomes and their transmission during cell divisions, genetic linkage and mapping in Eukaryotes, variations in chromosome structure and number, and chromosome organization and molecular structure  
**CO3** To comprehend various modes of epigenetic regulation on gene expression in Eukaryotes and roles of noncoding RNA in gene regulation  
**CO4** To learn about genetic principles underlying medical, immune and developmental aspects  
**CO5** To gather knowledge of complex and quantitative traits, polygenic Inheritance, population genetics, phylogenetic trees and molecular evolution

### 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

0 – No affinity; 1 – low affinity; 2 – Medium affinity; 3 – High affinity

c	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
<b>CO 1</b>	3	3	3	3	2	2	3	0	0	0	0	3
<b>CO 2</b>	3	2	2	2	2	3	3	0	0	0	0	3
<b>CO 3</b>	3	2	2	2	3	3	3	0	0	0	0	3
<b>CO 4</b>	3	1	1	2	3	3	3	0	0	0	0	3
<b>CO 5</b>	3	3	3	3	2	3	3	0	0	0	0	3

### Program Specific Outcomes. (PSO)

PSO 1 - Biochemical organization and cellular complexity in function

- PSO 2 - Biomolecules in Medicine
- PSO 3 - Molecular dysregulation in diseases
- PSO 4 - Molecular technology in diagnosis and therapy
- 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 biological data use

C	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO										
CO 1	3	1	3	2	1	0	0	0	0	1
CO 2	3	1	3	3	3	0	0	3	0	3
CO 3	3	3	3	3	2	0	0	2	0	3
CO 4	3	2	3	3	1	0	0	2	3	0
CO 5	3	2	2	3	0	0	0	0	0	3

**Evaluation Pattern: 50+50 = 100**

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

**22MMD545**

**RECOMBINANT DNA TECHNOLOGY**

**3-0-0-3**

**Pre-requisites:** Undergraduate level basic biology, biotechnology

**Total number of classes:** 45

**Syllabus**

**Unit 1****(5 Lectures)**

Restriction enzymes and cloning vectors: Host controlled restriction modification, Restriction endonucleases - types and classification, modifying enzymes used in molecular cloning - methylases, polymerases, ligases, kinases, phosphatases and nucleases,

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

Vectors and Hosts: Vectors for cloning, expression vectors (plasmids, lambda phage vectors, cosmids, BAC & YAC); Host organisms used in r-DNA technology: E. coli, Yeast, Insect cells as model organisms.

**Unit 3****(10 Lectures)**

Cloning, Construction of Genomic and cDNA libraries: Introduction to cloning (conventional & recombination based: traditional cloning, TA cloning, Gateway cloning etc), vGene transfer techniques: Transformation, transfection and transduction, Strategies for construction of genomic libraries, Strategies for construction of cDNA libraries.

**Unit 4****(10 Lectures)**

Selection and characterization of recombinant clones: Genetic Selection- insertional inactivation and alpha complementation, Labeling of nucleic acids, Immunological probes, Selection of recombinant clones-hybridization techniques, colony hybridization & library screening, hybrid arrest & hybrid release translation, DNA sequencing methods, DNA arrays.

**Unit 5****(10 Lectures)**

Advanced techniques and applications: Genome editing- CRISPR-Cas system, TALENs & ZFNs, Site directed mutagenesis and RNA interference, Recombinant vaccines, Recombinant antibodies (Fab, scFv, sdAb), Disease diagnosis, Gene therapy- technologies, applications and regulations Next generation sequencing-principle, types and applications.

**TEXT BOOKS:**

1. *Principles of Gene Manipulation*, Sandy B. Primrose, Richard Twyman, Bob Old, Wiley, 08-Feb-2002
2. *From Genes to Genomes: Concepts and Applications of DNA Technology*. Jeremy W Dale and Malcom von Schantz 2002 John Wiley & Sons, Ltd.

**REFERENCE**

1. *Gene Therapy Technologies, Applications and Regulations: From Laboratory to Clini*. Anthony Meager 1999 John Wiley & Sons, Ltd.

**Course Outcome**

**CO1** Understand the fundamentals of molecular cloning

**CO2** Understand the technical know-how on versatile techniques in recombinant DNA technology.

**CO3** Gain knowledge of tools and strategies used in molecular cloning

**CO4** Understand how to select and characterize recombinant clones

**CO5** Understand basic and advanced molecular cloning concepts, applications and techniques

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

**Program Specific Outcomes. (PSO)**

- PSO 1 - Biochemical organization and cellular complexity in function  
 PSO 2 - Biomolecules in Medicine  
 PSO 3 - Molecular basis of disease  
 PSO 4 - Molecular technology in diagnosis and therapy  
 PSO 5 - Cellular 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 biological data use

-	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
<b>CO</b>										
<b>CO 1</b>	-	-	-	3	1	2	-	-	-	1

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

**Evaluation Pattern: 50+50 = 100**

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

### **THIRD SEMESTER**

**22MMD698**

**DISSERTATION**

**Credit 18**

Full-time research on the proposed research, meticulous experimentation, generation of data, interpretation of data and conclusion of the research outcome. Manuscript writing on the research work conducted for publication, followed by manuscript submission by the end of the semester. Dissertation preparation and presentations.

### **FOURTH SEMESTER**

**22MMD699**

**DISSERTATION**

**Credit 18**

Full-time research on the proposed research, meticulous experimentation, generation of data, interpretation of data and conclusion of the research outcome. Manuscript writing on the research work conducted for publication, followed by manuscript submission by the end of the semester. Dissertation preparation and presentations.