

M.TECH- MOLECULAR MEDICINE 2022

This M.Tech.program will provide training in the field of Molecular Medicine. The course is offered by the Division of Molecular Medicine, Amrita Centre for Nanosciences and Molecular Medicine, Amrita Institute of Medical Sciences and Research Centre, Amrita Vishwa Vidyapeetham. Molecular medicine is the study of molecular and cellular phenomena in biological systems that enhances our understanding of human diseases and facilitates discovery research in disease prevention, diagnosis and therapy. Molecular Biology offers new technology tools to probe the living organism, both in diagnostics and therapy. The integration of these two disciplines offers opportunities for many new fundamental insights into the mechanisms of disease and avenues for diagnostics and therapy that could not have been imagined even a decade earlier.

One of the unique strengths of this course is its emphasis on an interdisciplinary approach whereby medical sciences, molecular biology, bioinformatics and nanotechnology areas comes together. This is possible because this Centre offers other courses in Nanotechnology and Bio-Nanotechnology. Students will be encouraged to participate in interdisciplinary learning activities, and some of the courses from different programs are jointly offered. 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 individuals who is capable of harnessing diverse concepts and technology for developing new diagnostics and therapeutics with sound scientific background.
- 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 or in pharmaceutical industry 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												
22MM601	FC	Advanced Cell Biology	300	3												
22MM602	FC	Molecular Biology	300	3												
22MM603	AC	Statistical Data Analysis	101	2												
22AVP103	AC	Mastery Over Mind	102	2												
22MM681	SC	Molecular Biology Lab	101	2												
22MM682	SC	Cell Culture and Animal Lab	101	2												
21HU601	HU	Amrita Values Program *		P/F												
21HU602	HU	Career Competency-I	P/F	P/F												
		ELECTIVES (Any Two)														
		<table border="1"> <tr> <td>22MM631</td> <td>Organ Systems Physiology</td> <td>300</td> <td>3</td> </tr> <tr> <td>22MM632</td> <td>Stem Cells and its Applications in Medicine.</td> <td>300</td> <td>3</td> </tr> <tr> <td>22MM633</td> <td>Bioinformatics and Structure based Drug Design</td> <td>201</td> <td>3</td> </tr> </table>	22MM631	Organ Systems Physiology	300	3	22MM632	Stem Cells and its Applications in Medicine.	300	3	22MM633	Bioinformatics and Structure based Drug Design	201	3		
22MM631	Organ Systems Physiology	300	3													
22MM632	Stem Cells and its Applications in Medicine.	300	3													
22MM633	Bioinformatics and Structure based Drug Design	201	3													
Total Credits				20												

Second Semester

Course Code	Type	New Course	LTP	Credits																				
22MM611	FC	Immunology	300	3																				
22MM612	FC	Clinical Biochemistry and Proteomics	300	3																				
22MM683	SC	Immunology Lab	101	2																				
22MM684	SC	Biochemistry Lab	101	2																				
22MM613	FC	Ethics in Research and Research Methodology	101	2																				
21HU603	HU	Career Competency-II	00 2	1																				
		ELECTIVES (Any Two)																						
		<table border="1"> <tr> <td>22MM641</td> <td>Pharmacokinetics and Pharmacodynamics</td> <td>300</td> <td>3</td> </tr> <tr> <td>22MM642</td> <td>Regenerative Medicine & Tissue Engineering</td> <td>300</td> <td>3</td> </tr> <tr> <td>22MM643</td> <td>Recombinant DNA Technology</td> <td>300</td> <td>3</td> </tr> <tr> <td>22MM644</td> <td>Molecular Basis of Diseases</td> <td></td> <td></td> </tr> <tr> <td>22MM645</td> <td>Genetics: Principles and Analysis</td> <td>300</td> <td>3</td> </tr> </table>	22MM641	Pharmacokinetics and Pharmacodynamics	300	3	22MM642	Regenerative Medicine & Tissue Engineering	300	3	22MM643	Recombinant DNA Technology	300	3	22MM644	Molecular Basis of Diseases			22MM645	Genetics: Principles and Analysis	300	3		
22MM641	Pharmacokinetics and Pharmacodynamics	300	3																					
22MM642	Regenerative Medicine & Tissue Engineering	300	3																					
22MM643	Recombinant DNA Technology	300	3																					
22MM644	Molecular Basis of Diseases																							
22MM645	Genetics: Principles and Analysis	300	3																					
Total				19																				

Third Semester

Course Code	Type	New Course		Credits		
22MM798	P	Minor Project			10	
E		ELECTIVES (Any Two)				
		22MM731	Organoids And Organs-On-Chips	300		3
		22MM732	Regulatory Aspects in Translational Medicine	300		3
		22MM733	Molecular Diagnostics.	300		3
Total Credits				16		

Fourth Semester

Course Code	Type		New Course		Credits
22MM799	P	Project	Dissertation		18

Total Credits - 73

FIRST SEMESTER

22MM601

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

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

Theory Exam	50%	
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		50%
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Total		100%
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22MM602

MOLECULAR BIOLOGY

3-0-0-3

Course code:

Course name: MOLECULAR BIOLOGY

Credits: 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.

TEXT BOOK:

Lewin's Essential Genes, Jocelyn E. Krebs, Benjamin Lewin, Elliott S. Goldstein, Stephen T. Kilpatrick, Jones & Bartlett Publishers, 2013 - Science - 847 pages

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

Evaluation Pattern: 50+50 = 100

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

22MM603

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 8thEd. 2005.

Evaluation Pattern: 50+50 = 100

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

Mastery Over Mind

22AVP103

Mastery Over Mind (MAOM)

1-0-2 2

1. Course Overview

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

With a meditation technique offered by Amrita Chancellor and world-renowned humanitarian and spiritual leader, Sri Mata Amritanandamayi Devi (Amma), this course has been planned to be offered to all students of all campuses of AMRITA, starting off with all first years, wherein one hour per week is completely dedicated for guided practical meditation session and one hour on the theory aspects of MAOM.

The theory section comprises lecture hours within a structured syllabus and will include invited guest lecture series from eminent personalities from diverse fields of excellence. This course will enhance the understanding of experiential learning based on university's mission: "Education for Life along with Education for Living", and is aimed to allow learners to realize and rediscover the infinite potential of one's true Being and the fulfilment of life's goals.

2. Course Syllabus

Unit 1 (4 hours)

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

Unit 2 (4 hours)

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

Unit 3 (4 hours)

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

TEXT BOOKS:

- 1.Mata Amritanandamayi Devi, "Cultivating Strength and vitality," published by Mata Amritanandamayi Math, Dec 2019
- 2.Swami Amritaswarupananda Puri , "The Color of Rainbow " published by MAM, Amritapuri.

REFERENCES:

- 1.Craig Groeschel, "Winning the War in Your Mind: Change Your Thinking, Change Your Life" Zondervan Publishers, February 2019
- 2.R Nagarathna et al, "New Perspectives in Stress Management "Swami Vivekananda Yoga Prakashana publications, Jan 1986
3. Swami Amritaswarupananda Puri "Awaken Children Vol 1, 5 and 7 - Dialogues with Amma on Meditation", August 2019
4. Swami Amritaswarupananda Puri "From Amma's Heart - Amma's answer to questions raised during world tours" March 2018

5. Secret of Inner Peace- Swami Ramakrishnananda Puri, Amrita Books, Jan 2018.
6. Mata Amritanandamayi Devi "Compassion :The only way to Peace:Paris Speech", MA Center, April 2016.
7. Mata Amritanandamayi Devi "Understanding and collaboration between Religions", MA Center, April 2016.
8. Mata Amritanandamayi Devi "Awakening of Universal Motherhood: Geneva Speech" M A center, April 2016.

3. Evaluation and Grading

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	S	S	S
C O	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CO 1	3	3	3	2		-	2	3	-	3	-	3	-	-	-
CO 2	3	3	3	2	2	-	2	3	3	3	-	3	-	-	-
CO 3	3	3	2	2	2	2	2	3	3	3	-	3	-	-	-

CO 4	3	3	3	2	-	2	3	3	3	3	-	3	-	-	-
CO 5	3	2	2	2	-	2	-	3	2	2	-	2	-	-	-
CO 6	3	2	2	2	3	2	-	3	2	2	-	2	-	-	-

22MM681

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.

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.

CO6 Can critically evaluate and discuss experimental results.

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 Clini. 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.

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

Program Specific Outcomes. (PSO)

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

- 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
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CO										
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

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

22MM682

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.

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	-	-	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%
		30%
End Semester Examination- 50%		
Practical	Exam	60%
Assessment	Viva	10%
		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

Course code:

Course name: CAREER COMPETENCY-I

Credits: 0

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- Merrill 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

22MM631

Organ Systems Physiology

3-0-0-3

Course code:

Course name: Organ systems physiology

Credits: 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

Course Outcome

CO1: To understand and clearly articulate individual organ systems and their specific functions

CO2: To understand how tissue and cellular processes in individual organ system contributes to overall organ function

CO3: To understand downstream effects of cell and tissue failure in terms of organ dysfunction

CO4: To understand the basis of coupling between cellular electrical activity and cell function in each organ system

CO5: To be familiar with current biomedical advancements in terms of devices and interventions in specific organ systems

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

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

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

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

5										
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Evaluation Pattern: 50+50 = 100

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

22MM632 STEM CELLS AND ITS APPLICATIONS IN MEDICINE 3-0-0-3

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. 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%

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

22MM632 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
CO												
CO 1	3	1	1	1	1	-	-	-	-	-	-	1
CO 2	3	3	3	2	1	-						1
CO 3	3	3	3	2	1	-						1
CO 4	3	3	3	2	1	-						1
CO 5	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

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

SECOND SEMESTER

22MM611

IMMUNOLOGY

3-0-0-3

Pre-requisites: Basic understanding of cell biology

Total number of classes: 45

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.

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.

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.*

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

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

Evaluation Pattern: 50+50 = 100

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

22MM612

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 V_{max} , K_m ; 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 7th 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.

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

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

Evaluation Pattern: 50+50 = 100

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

22MM683

IMMUNOLOGY LAB

1-0-1-2

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

Total number of classes:30

Preamble:

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.

Program outcome

PO1: Bioscience Knowledge

PO2: Problem Analysis

PO3: Design/Development of Solutions

PO4: Conduct Investigations of complex problems

PO5: Modern tools usage

PO6: Bioscientist and Society

PO7: Environment and Sustainability

PO8: Ethics

PO9: Individual & Team work

PO10: Communication

PO11: Project management & Finance

PO12: Lifelong learning

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

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

Evaluation Pattern: 30+70 = 100

Internal Assessment – 30%

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

22MM684

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
CO1	3	3	2	1	1	-	-	2	3	2	-	2
CO2	3	3	2	1	1	-	-	2	3	2	-	2
CO3	3	3	2	1	1	-	-	2	3	2	-	2
CO4	3	3	2	1	3	-	-	2	3	2	-	2
CO5	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
CO1	-	2	-	-	-	-	-	-	-	-
CO2	1	2	2	2	-	-	-	-	-	-
CO3	1	2	2	2	-	-	-	-	-	-
CO4	1	2	2	2	-	-	-	-	-	-
CO5	1	2	2	2	-	-	-	-	-	-

Evaluation Pattern: 30+70 = 100

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

22MM613 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, 1 st Edition, 2002*
3. *Kaplan GMAT 2012 & 13*

4. www.campusgate.co.in
5. 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

22MM641 PHARMACOKINETICS AND PHARMACODYNAMICS 3-0-0-3

Pre-requisites: Basic level biology and biochemistry

Total number of classes: 45

Preamble: This course introduces the student to basic principles of pharmacokinetics and pharmacodynamics, along with an introduction to the main drug categories. The central focus of this course is to help students understand how concentration of a drug changes in various body compartments and the factors regulating that change. Students will also be exposed to topics related to the mechanisms of drug action, with suitable and appropriate examples.

Syllabus

Unit 1

(Lectures 12)

Introduction to pharmacology, body compartments and their volumes, principles of pharmacokinetics, movement of drug molecules across biological membranes via diffusion, features of drug absorption, distribution, metabolism, and elimination, model systems in pharmacokinetics.

Unit 2

(Lectures 14)

Molecular mechanisms of drug action, principles of pharmacodynamics, drug toxicity and poisoning, membrane transporters and drug response, concepts in drug agonism and antagonism

Unit 3

(Lectures 6)

Drug metabolism and pharmacogenetics

Unit 4

(Lectures 8)

Neuropharmacology, muscarinic and nicotinic drug systems, adrenergic, serotonergic, and dopaminergic agonists and antagonism, pharmacotherapies in neural disorders

Unit 5

(Lectures 5)

Pharmacotherapy of neoplastic disease

TEXT BOOKS:

1. Goodman and Gilman's 'The Pharmacological Basis of therapeutics' "13th Edition, McGraw Hill

2. Malcolm Rowland, Thomas Tozer, "Clinical Pharmacokinetics and Pharmacodynamics, Concepts and Applications", 4th Edition, Wolters Kluver

Course Outcome

CO1: Be able to articulate the drug-intrinsic and extrinsic factors that determine drug molecule movement across biological membranes

CO2: To demonstrate understanding in concepts that determine dosage, absorption, distribution, and excretions of drugs, along with model systems connected with these concepts and apply pharmacokinetic principles to explain variation in drug disposition

CO3: To demonstrate ability to describe functional outcome of drugs due to drug-cell interactions

CO4: To demonstrate understanding of signaling pathways that link drug-receptor interaction and cell response, along with an understanding of toxicological response and ways to quantify and describe drug-induced toxic effects

CO5: Be able to work with a team and put together in depth information related to PKPD concepts in a web-platform

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	-	-	-	-	-	-	3	-	-	-
CO2		3	3	2	3	-	-	2	-	3	-	-	-
CO3		3	3	2	-	-	-	-	-	3	-	-	-
CO4		3	2	-	-	-	-	-	-	3	-	-	-
CO5		2	1	-	-	3	2	-	3	3	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	3	-	-	-	2	-	-	-	3	-
CO 2	3	-	-	-	-	-	-	-	3	-
CO 3	3	1	1	-	2	-	-	-	3	-
CO 4	3	1	1	-	-	2	-	-	3	1
CO 5	1	1	1	-	1	-	-	-	2	-

Evaluation Pattern: 50+50 = 100

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

22MM642 REGENERATIVE MEDICINE & TISSUE ENGINEERING 3-0-0-3

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

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

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

Evaluation Pattern: 50+50 = 100

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

22MM643

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

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

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

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

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

22MM645

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 Professional publishers, 2017.

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
CO												
CO 1	3	3	3	3	2	2	3	0	0	0	0	3
CO 2	3	2	2	2	2	3	3	0	0	0	0	3
CO 3	3	2	2	2	3	3	3	0	0	0	0	3
CO 4	3	1	1	2	3	3	3	0	0	0	0	3
CO 5	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 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

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

THIRD SEMESTER

22MM798

MINOR PROJECT

Credit 10

Initiation of research on a selected research topic under the guidance of a faculty, with meticulous experimentation for the generation of data. Manuscript writing on the research work conducted thus far, for a possible publication by the end of the final semester. Mid-thesis presentation to judge the progress of the research work done.

ELECTIVES

Pre-requisites: Undergraduate level basic biology, biotechnology and medical science

Total number of classes: 45

Preamble

The objective of this course is to familiarize students with the state-of-the art in vitro model systems that have the potential to mimic the normal and diseased human tissues and organs for biomedical research and development.

Syllabus

Unit -1

(9 Lectures)

In vitro model systems in medicine; basic concepts in developing in vitro models, biofabrication strategies for developing in vitro models, impact of in vitro models in disease modeling and drug testing, basics in 3D cell culture

Unit-2

(9 Lectures)

Microfluidic cell culture systems; Introduction to microfluidic systems, the design concept and key components, fundamentals of organs-on-chips as in vitro microphysiological systems, applications of organs-on-chips in disease modelling, and safety and efficacy testing

Unit-3

(9 Lectures)

Organoids; Basics of organoid development, experimental strategies, essential reagents and choice of 3D matrices, characterization of organoids, technical challenges.

Unit-4

(9 Lectures)

3D Bioprinting in organoid development; Basics and importance of 3D printing of living cells for medical applications, choice of bio-inks, current advances and challenges in 3D bioprinting.

Unit-5

(9 Lectures)

Organoids as in vitro model systems; cerebral organoids, liver organoids, intestinal organoids, pancreas and salivary gland organoids. Applications of organoids in cancer research, drug development and testing

TEXT BOOKS:

1. *Microfluidics: Fundamentals, Devices, and Applications*, Wiley, 2018
2. *Organ-on-a-chip, Engineered Microenvironments for Safety and Efficacy Testing*, Academic Press, 2018
3. *Jamie Davies and Melanie Lawrence, Organoids and Mini Organs*, Academic Press, 2018

Course Outcome

- CO1** Understanding on the different types of in vitro model systems and their advantages over conventional 2D cell culture systems
- CO2** Understanding on the basic principles and components of microfluidics-based in vitro model systems
- CO3** Understanding on the basic principles and components of organs-on-chips

based in vitro model systems

CO4 Understanding on organoid development procedure, organoid types, advantages and challenges

CO5 Understanding on the working principle and components of 3D bioprinting and its applications

CO6 Understanding on the latest approaches and protocols used for developing various types of organoids for modeling diseases and drug testing.

Program Outcome

PO1: Bioscience Knowledge

PO2: Problem Analysis

PO3: Design/Development of Solutions

PO4: Conduct Investigations of complex problems

PO5: Modern tools usage

PO6: Bioscientist and Society

PO7: Environment and Sustainability

PO8: Ethics

PO9: Individual & Team work

PO10: Communication

PO11: Project management & Finance

PO12: Lifelong learning

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

c	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	1	1	3	1	2	-	-		-	-	-	2
CO 2	-	1	3	1	2	-	-		-	-	-	2
CO 3	-	1	3	1	2	-	-	-	-	-	-	2
CO 4	3	1	3	1	2	2	-	2	-	-	-	2
CO5	1	1	3	1	2	-	-	-	-	1	-	2
CO6	2	1	3	1	2	2	-	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
CO 1	-	1	-	-	3	-	-	2	-	-
CO 2	-	-	-	-	3	-	-	2	-	-
CO 3	-	-	-	-	3	-	-	2	-	-
CO 4	2	2	-	2	3	-	1	3	3	-
CO5	-	-	-	-	3	-	1	3	-	-
CO6	2	2	3	2	3	-	1	3	3	-

Evaluation Pattern: 50+50 = 100

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

22MM732 REGULATORY ASPECTS IN TRANSLATIONAL MEDICINE 3-0-0-3

Pre-requisites: Basic level biology and chemistry

Total number of classes: 45

Preamble

Developing prototypes and transforming it to a product requires meticulous understanding of the process technology and its execution at every levels. From the research and development to a product design, validation and translation into clinic requires approval from regulatory body to assure that products developed holds to the approved standards at all time irrespective of it being manufactured at different time, different places or by different subjects. Developing standard operating procedures and documenting at every level are the key features in it. This course will expose the student to understand these aspects and its use.

Unit-1

(15 lectures)

Medical Devices and Nanomedicine: Introduction; Risk based classification; Product Lifecycle: Design and Development, Biological evaluation (both in vitro and in vivo studies) as per ISO 10993, Phase 1 to Phase 3 clinical Trials; Marketing; Regulators bodies like CDSCO, FDA and EU; Good Laboratory Practice (GLP) and Good Manufacturing Practice (GMP)

Unit-2

(15 lectures)

Quality System Regulations of Medical Devices: ISO 13485; Schedule Y for drugs; Standard Operating Procedures; Validation and Verification Process; Quality Control System; Documentation and Records; Quality Risk Management: ISO 14971

Unit-3

(15 lectures)

Clinical Investigation of Medical Devices and nanomedicine; New Drug or Device Application and its approval; Good Clinical Practice for Clinical Investigation of medical devices (ISO 14155:2011); Medical Device Rule 2017; Adverse Event Reporting.

TEXTBOOKS

- Medical Device Development: A Regulatory Overview by Jonathan S. Kahan, Parexel Intl Corp; 3rd edition, 2014
- Medical Product Regulatory Affairs: Pharmaceuticals, Diagnostics, Medical Devices by John J. Tobin and Gary Walsh, Wiley-Blackwell (1st edition), 2008
- Compliance Handbook for Pharmaceuticals, Medical Devices and Biologics by Carmen Medina, CRC Press, 2019.

Course Outcomes:

Upon successful completion, students will have the knowledge to the:

CO1 Product Lifecycle and quality considerations of medical devices or nanomedicine

CO2 Regulatory requirement for approval of medical devices or nanomedicine

CO3 Good Manufacturing Practice Requirement and Quality Assurance

CO4 Clinical investigation of medical devices or nanomedicine

PO1: Bioscience Knowledge

PO2: Problem Analysis

PO3: Design/Development of Solutions

PO4: Conduct Investigations of complex problems

PO5: Modern tools usage

PO6: Bioscientist and Society

PO7: Environment and Sustainability

PO8: Ethics

PO9: Individual & Team work

PO10: Communication

PO11: Project management & Finance

PO12: Lifelong learning

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

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

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

Evaluation Pattern: 50+50 = 100

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

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

22MM733

MOLECULAR DIAGNOSTICS

3-0-0-3

Pre-requisites: Basic understanding of biology and biotechnology

Total number of classes: 45

Preamble

This course will provide an overview of the principles of molecular diagnostics, the use of various molecular techniques to diagnose disease, quality assurance in the molecular lab and DNA based identity testing.

Syllabus

Unit 1

(Lectures 10)

Introduction: An Historical Perspective on the Clinical Diagnostic Laboratory. Molecular

Techniques for diagnosis – Methods for extracting nucleic acids (DNA & RNA); Methods for Nucleic Acid Amplification: PCR, Modifications of PCR (Multiplex-PCR, SSP-PCR, Nested PCR, Reverse transcriptase PCR [RT-PCR], Realtime PCR)

Unit 2

(Lectures 10)

Methods for mutation detection: PCR-RFLP, DNA Sequencing, Reverse Hybridization Assay, Multiplex ligation-dependent probe amplification [MLPA], Allele specific PCR; NGS Applications, Global review of NGS platforms, Clinical NGS in practice. Other Clinical Diagnostic Technologies: Flow Cytometry, Fluorescence In Situ Hybridization, Immunohistochemistry, Laser Capture Microdissection (FFPE).

Unit 3

(Lectures 10)

Quality Assurance in the Molecular Diagnostics Laboratory: Framework for Quality Assurance in Molecular Diagnostics, Verification of Molecular Assays, Standards and Standardization of Molecular Diagnostics, Laboratory-Developed Tests in Molecular Diagnostics.

Unit 4

(Lectures 10)

Applications of Molecular Diagnostics for Genetic Diseases, Molecular diagnostics of Coagulation, Cystic Fibrosis; Prenatal Genotyping for Identification of Fetuses at Risk for Immune Cytopenic Disorders. Applications of Molecular Diagnostics for Human Cancers. Applications of Molecular Diagnostics for Infectious Diseases, Identity-Based Testing: HLA Typing Using Molecular Methods. Molecular Analysis for Forensic Casework and Parentage Testing, Molecular Assessment of Bone Marrow Transplant Engraftment. Personalized Medicine.

Unit 5

(Lectures 5)

Genetic Counseling Considerations in Molecular Diagnosis, Ethical, Social, and Legal Issues Related to Molecular Genetic Testing.

Course Outcome**CO1** Understand the molecular diagnostic aspects, its significance and goal**CO2** Understand the technology behind the various molecular techniques used in the clinical diagnostic laboratory for the diagnosis of various pathogenic situations**CO3** Develop awareness of sample types, preparation, and storage for molecular diagnostic tests.**CO4** Understand the Quality assurance that needs to be followed in the molecular diagnostic lab**CO5** Develop awareness of ethical issues related to genetic testing**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
CO												
CO 1	3	1	1	-	2	-	-	-	-	-	-	2
CO 2	3	2	2	2	3	-	-	-	-	-	-	1
CO 3	3	2	2	2	3	-	-	-	-	-	-	1
CO 4	3	2	1	1	2	-	-	-	-	-	-	1
CO 5	1	-	-	-	-	2	-	3	-	-	-	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	-	1	1	3	-	-	-	-	-	3
CO 3	-	2	1	3	2	1	-	-	-	-
CO 4	-	-	-	3	-	-	-	-	-	-
CO 5	-	1	1	1	-	-	-	-	-	-

Evaluation Pattern: 50+50 = 100

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

FOURTH SEMESTER

22MM799

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.