

**M.Sc.,
MEDICINAL
BIOTECHNOLOGY**

MODEL SYLLABUS

AUGUST- 2022

**TAMILNADU STATE COUNCIL FOR HIGHER
EDUCATION, CHENNAI – 600 005**

M.Sc. MEDICINAL BIOTECHNOLOGY

Syllabus

1. Choice Based Credit System (CBCS)

Choice based credit system is a flexible system of learning.

„Credit“ defines the quantum of contents / syllabus prescribed for a course and determine the number of hours of instruction required.

The CBCS has unique features such as enhanced learning opportunities, ability to match students scholastic need and aspirations, inter institution transfer ability of students, part completion of an academic program in the institution of enrollment and part completion in specialized and recognized institution, improvement in educational quality and excellence, flexibility for working students to complete Programme over an extended time and standardization and comparability of educational programs across the country.

2. The preamble of the syllabus

Master of Science (M.Sc.) in Biotechnology, the curricula, and course content were designed to meet the standards of UGC-CSIR (NET) and (SLET) examinations. The choice- based credit system of learning develops a strong base in the core subject and specializes in the disciplines of his / her liking and abilities and develops an in-depth understanding of various aspects of Biotechnology. The students develop experimental skills, design, and implementation of novel synthetic methods, and develop the aptitude for academic and professional skills, by acquiring basic concepts for structural elucidation with hyphenated techniques, and understanding the fundamental biological process and rationale of the computer. The project introduced in the curriculum will motivate the students to pursue research and entrepreneurial skill development.

Examination Pattern:

Time allotted: Theory – 03Hrs. & Practical – 04 hrs

	External marks	Internals marks	Total marks
Theory	75	25	100
Practical	75	25	100

Marks distribution for internals:

	Test	seminars	Assignment	Total marks
Theory	15	05	05	25

	Test	Record	Total marks
Practical	10	15	25

Pattern of question paper (theory):**The course of study and the scheme of Examination – Department of Biotechnology**

<i>Study Components</i>		<i>ins. hrs / week</i>	<i>Credit</i>	<i>Title of the Paper</i>	<i>Maximum Marks</i>		
					<i>CIA</i>	<i>Uni. Exam</i>	<i>Total</i>
SEMESTER I							
Core	Paper -1	5	4	Advance Cell Biology	25	75	100
Core	Paper -2	5	4	Advance Molecular Biology and Techniques	25	75	100
Core	Paper -3	5	4	Bio informatics	25	75	100
Internal Elective for same major students (Choose any one)							
Core Elective	Elective – I	3	3	A. Human Physiology and developmental genetics. B. Stem cell biology and somatic and germ cell engineering. C. Basic human genetics.	25	75	100
Practical -I		10	4	A. Stem cell biology & A. Human genetics.	25	75	100
Value Added course	VAC-1	2	2	A. Genetic Engineering. B. Developmental biology and human physiology. C. Medicinal Immunology and clinical research.	25	75	100
		30	21				
SEMESTER II							
Core	Paper – 4	4	4	Immunology and Immunogenetics.	25	75	100
Core	Paper – 5	4	4	Gene based diagnosis and therapy	25	75	100
Core	Paper – 6	4	4	Drug Delivery	25	75	100
Core	Paper - 7	4	4	Medicinal microbiology and biology of infectious disease.	25	75	100
Internal Elective for same major students (Choose any one)							

	Core Elective	Elective -II	2	2	A. Biomolecules and metabolism B. Molecular modeling and drug designing. C. Essential of anatomy.	25	75	100
	Practical -II		4	3	A. Biomolecules and metabolism &	25	75	100
			4	3	A. Medicinal microbiology and biology of infectious disease.			
			30	26				

Study Components		ins. hrs /week	Credit	Title of the Paper	Maximum Marks		
					CIA	Uni. Exam	Total
SEMESTER III							
Core	Paper -9	4	4	Advance Immunology	25	75	100
Core	Paper –10	4	4	Bio Pharmaceutical Bio technology	25	75	100
Core	Paper – 11	4	4	Animal Tissue Culture.	25	75	100
Core	Paper -18	4	4	Developmental biology and stem cells.	25	75	100
Internal Elective for same major students (Choose any one)							
Core Elective	Elective - III	3	3	A. Research methadology and socio ethical aspects of Biotechnology. B. Industrial Biotechnology C. Developmental biology and human physiology	25	75	100
External Elective for other major students (Inter/multi-disciplinary papers) (Choose any one)							
Open Elective	Open Elective -II	2	2	A. Seminar and communication skill B. Plant molecular pharming. C. Indian system of medicine.	25	75	100
Practical - III		9	4	A. Animal tissue culture & A. Developmental Biology and stem cell	25	75	100
*MOOC Courses			2				100
*USRR			2				100
		30	29				

SEMESTER IV				CIA	Uni. Exam	Total	
Core	Paper -13	4	4	Thesis Work	25	75	100
Core Elective	Elective -IV	3	3	A. Disaster management and mitigation resource. B. Advanced medicinal lab technology C. Nano and Pharmaceutical Biotechnology.	25	75	100
Core	Project Compulsory	23	8	Project with <i>viva voce</i>		100 (75 Project +25 viva)	100
		30	15				
		180	91		905	2275	2900

Extra credits for * MOOC course = 2

* USSR Project = 2

SEMESTER I**CORE PAPER 1: Advance Cell Biology**

Paper code:

Subject: **Advance Cell Biology****Hours/Week: 5 Credits: 4**

Aim: To enable the students to understand the basic concepts of Cell biology, Molecular biology, Bio informatics, Genetic Engineering , Drug delivery and also the Bio - pharmaceutical bio technology and Animal Tissue Culture.

Course Objectives

1. To learn the basic concept of cell biology and cytoskeleton
2. To learn the concept of cell differentiation and maintenance of the tissues.
3. To develop knowledge on cell adhesion and also on extra cellular matrix .
4. To learn about the chemical signaling about the cells.
5. To develop a piece of knowledge in Oncology.

Course Out Comes

1. After completing unit 1, the students will be able to identify the basic concept of cytoskeleton and also about the microtubules.
2. After completing unit 2, the students will be able to know about the cell differentiation and the maintenance of the tissues and cell division .
3. After completing unit 3, the students will be able to describe the Concept of cell adhesion and extra cellular matrix .
4. After completing unit 4, the students will be able to know about the Chemical signaling between cells .
5. After completing unit 5, the students will be able to know about the tumour cells, oncogenic mutation .

Matching Table (Put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	No	Yes	Yes	Yes	No
3	No	Yes	No	Yes	Yes	Yes
4	No	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

Units	Course Contents	Teaching hours
Unit I	<ul style="list-style-type: none"> • The Cytoskeleton - Muscle contraction - Ciliary Movements - General features of microtubules and actin filaments as dynamic assemblies - Microtubules organizing centers and microtubule associated proteins - Actin filaments and actin binding proteins in non-muscle cells - Intermediate filaments - Organization of the cytoskeleton 	18 hours
Unit-II	<ul style="list-style-type: none"> • Cell Differentiation and the maintenance of the tissues - Maintenance of the differentiated state - Tissues with permanent cells - Renewal by simple duplication - Renewal by stem cells – epidermis - Renewal by pluripotent stem cells – blood cell formation - Quiescent stem cells – Skeletal muscle - Soft cells and tough matrix – growth turn over and repair in skeletal connective tissue - Territorial stability in adult body - Cell growth and division - Control of cell division - Tumor viruses as tools for studying the control of cell cycle - Events in the S-Phase - The logic of the cycle - Cell division 	18 hours
Unit-III	<ul style="list-style-type: none"> • Cell adhesion and extra-cellular matrix - Intercellular recognition and cell adhesion - Cell junctions - The extra-cellular matrix 	18 hours

Unit-IV	<ul style="list-style-type: none"> • Chemical signaling between cells <ul style="list-style-type: none"> - Three different strategies of chemical signaling – local chemical mediators, hormones and Neurotransmitters - Signaling mediated by intracellular receptors – mechanisms of steroid hormone action - Signaling mediated by cell surface receptors – cAMP and Ca⁺ ions as second messengers - Target cell adaptation 	18 hours
Unit-V	<ul style="list-style-type: none"> • Cancer <ul style="list-style-type: none"> - Tumor cells and the onset of cancer - Protooncogenes and tumor suppressor genes - Oncogenic mutation affecting cell proliferation - Mutations causing loss of cell cycle control - Mutations affecting genome stability • - Programmed cell death 	18 hours
Total Teaching hours		90

Internal Assessment Methods: (25 marks)

Distribution for internals	Test (CIA I + CIA II + CIA III)	Seminars	Assignment	Total marks
Marks	15	05	05	25

Textbook:

1. Bruce Alberts
2. Medical Cell Biology by Goodman
3. Cell and Molecular Biology by Sheeler and Bianchi

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	2	2	2	3	3	3
CO2	3	2	2	3	3	2	3	3	2	2
CO3	3	2	2	3	3	3	3	2	2	2
CO4	3	3	3	2	2	2	3	3	2	3
CO5	3	2	2	3	2	3	2	2	3	3

Strong - 3, Medium – 2, Low - 1

Mapping with Programme Specific Outcomes

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	3	3	3
CO2	3	2	3	3	3
CO3	3	2	3	3	3
CO4	3	2	3	3	3
CO5	3	2	3	3	3
Weightage	15	10	15	15	15
Weighted percentage (rounded of) Course Contribution to POs	3	2	3	3	3

Strong - 3, Medium – 2, Low - 1

SEMESTER I

PAPER 2: Advance Molecular Biology And Techniques

Paper code:

Subject: Advance Molecular Biology And Techniques

Hours/Week: 5 Credits: 4

Aim: To enable the students to understand the basic concepts of the structure and regulated expression of eukaryotic genes and also about the molecular anatomy of eukaryotic genomes and also the techniques in molecular biology and also about the transgenic animals and molecular markers.

Course Objectives

1. To learn the basic concept of structure and expression of class I, II and III gene.
2. To learn the concept of Gene coding, Genomes of eukaryotic organelles.
3. To develop knowledge on techniques in molecular biology
4. To learn about the transgenic animals and methods of gene transfer.
5. To develop a piece of knowledge in molecular markers.

Course Out Comes

1. After completing unit 1, the students will be able to identify the basic concept of structure and regulated expression of eukaryotic genes and also about the gene expression.
2. After completing unit 2, the students will be able to know about the molecular anatomy of eukaryotic genomes and also about the human genome projects.
3. After completing unit 3, the students will be able to describe the techniques in molecular biology.
4. After completing unit 4, the students will be able to know about the methods of gene transfer in transgenic animals and also about the analysis of expressed gene.

5. After completing unit 5, the students will be able to know about the molecular markers and micro satellites.

Matching Table (Put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	No	Yes	Yes	Yes	No
3	No	Yes	No	Yes	Yes	Yes
4	No	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

Units	Course Contents	Teaching hours
Unit I	<ul style="list-style-type: none"> • The Structure and Regulated Expression of Eukaryotic Genes - Comparative features of prokaryotic and eukaryotic genes - Structure and expression of class I genes - Structure and function of class II genes - Structure and expression of class III genes - Dealing with introns - Novel structural motifs in transcription factors - Global influences on gene expression 	18 hours
Unit-II	<ul style="list-style-type: none"> • The Molecular Anatomy of Eukaryotic genomes - Architectural elements - Genes encoding RNA - Genes encoding polypeptides - Tandem repetition of DNA sequence: A common characteristic of eukaryotic genomes - Repeated sequences dispersed in genomes - Sequences at centromeres and telomeres - Genomes of eukaryotic organelles - Human genome project - DNA microarrays and functional genomics 	18 hours
Unit-III	<ul style="list-style-type: none"> • Techniques in molecular biology - Plasmid isolation - Preparation and analysis of eukaryotic genomic DNA - DNA sequencing - Isolation and purification of mRNA from cell - Blotting methods - PCR - Gene isolation - Site directed mutagenesis - Labeling of nucleic acids - Protein interaction technology - Molecular pharming 	18 hours

Unit-IV	<ul style="list-style-type: none"> • Transgenic animals <ul style="list-style-type: none"> - Methods of gene transfer - Analysis of expressed gene • Molecular markers <ul style="list-style-type: none"> - RFLP - RAPD - KFLP - Microsatellites 	18 hours
Unit-V	Chemical signaling between cells - Three different strategies of chemical signaling – local chemical mediators, hormones and Neurotransmitters - Signaling mediated by intracellular receptors – mechanisms of steroid hormone action - Signaling mediated by cell surface receptors – cAMP and Ca ⁺ ions as second messengers - Target cell adaptation	18 hours
Total Teaching hours		90

Internal Assessment Methods: (25 marks)

Distribution for internals	Test (CIA I + CIA II + CIA III)	Seminars	Assignment	Total marks
Marks	15	05	05	25

Reference Book:

- Genes and Genomes Genes VIII Sambrook
- From Genes to Clones by Winnacker Freifelder
- Gardner
- Walker and Rapley

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	2	3	3	3	2	3	3	3
CO2	3	3	2	3	3	3	2	3	2	2
CO3	3	3	2	3	3	3	2	2	2	2
CO4	3	3	2	3	3	3	2	3	2	3
CO5	3	3	2	3	3	3	2	2	3	3

Strong - 3, Medium – 2, Low - 1

Mapping with Programme Specific Outcomes

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	2	2	3
CO2	3	3	2	2	3
CO3	3	3	2	2	3
CO4	3	3	2	2	3
CO5	3	3	2	2	3
Weightage	15	15	10	10	15
Weighted percentage (rounded of) Course Contribution to POs	3	3	2	2	3

Strong - 3, Medium – 2, Low - 1

SEMESTER I**PAPER 3: Bio informatics****Paper code:****Subject: Bio informatics****Hours/Week:****5****Credits: 4**

Aim: To enable the students to understand the basic concepts of the sequence analysis, pairwise alignment and data bases ,Multiple sequence analysis, tools for genomics and proteomics.

Course Objectives

1. To learn the basic concept of Biology in computer age
- 2.To learn the concept of Computational approaches to biological question.
- 3.To develop knowledge on Sequence analysis.
- 4.To learn about the predicting protein structure and function from sequence.
- 5.To develop a piece of knowledge in databases and data mining.

Course Out Comes

- 1.After completing unit 1, the students will be able to identify the basic concept of computer age and computational approaches to biological question and biological research on web.
- 2.After completing unit 2, the students will be able to know about the sequence analysis , pair wise alignment, database and also the multiple sequence alignment, trees and visualizing protein structure and computing structural properties.
- 3.After c o m p l e t i n g unit 3, the students will be able to know detail about the predicting protein structure and function from sequence, tools for genomics and building biological database.
- 4.After completing unit 4, the students will be able to know about the visualizing and data mining.
- 5.After completing unit 5, the students will be able to know about the proteomics and genomics.

Matching Table (Put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	No	Yes	Yes	Yes	No
3	No	Yes	No	Yes	Yes	Yes
4	No	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

Units	Course Contents	Teaching hours
Unit I	Biology in the computer age, Computational approaches to biological questions , Biological research on the web	18 hours
Unit-II	Sequence analysis, pairwise alignment, and database searching, Multiple sequence alignments, trees and profiles, Visualizing protein structures and computing structural properties	18 hours
Unit-III	Predicting protein structure and function from sequence, Tools for genomics and proteomics , Building biological databases	18 hours
Unit-IV	Visualizing and data mining. Genomics: Nucleotide sequence Databases, its Analysis Identification,Goals of the Human Genome Project, cloning vectors, concept of maps, physical maps, shotgun libraries, DNA polymorphism, nucleotides, DNA sequences	18 hours
Unit-V	Nucleic acid structures, RNA folding, RNA loops, conformational study. various ribose ring conformations, ribose-ring puckering. protein-protein interactions, protein ligand interactions. DNA-binding proteins, RNA-binding proteins. Ramachandran plot, 3-dimensional structures of membrane proteins, importance of 310 helix and loops, biophysical aspects of proteins and nucleic acids. Structural databases:- Protein Data bank (PDB), Nucleic Acid Data Bank (NDB),Molecular modeling Data Bank (MMDB). Secondary structure, three-dimensional structure prediction, protein folding and functional sites, protein folding classes.	18 hours
Total Teaching hours		90

Internal Assessment Methods: (25 marks)

Distribution for internals	Test (CIA I + CIA II + CIA III)	Seminars	Assignment	Total marks
Marks	15	05	05	25

Reference Book:

- Parry Smith and Attwood David Mount
- Gibas and Jambeck

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	2	3	3	3	2	3	3	3
CO2	3	3	2	3	3	3	2	3	2	2
CO3	3	3	2	3	3	3	2	2	2	2
CO4	3	3	2	3	3	3	2	3	2	3
CO5	3	3	2	3	3	3	2	2	3	3

Strong - 3, Medium – 2, Low - 1

Mapping with Programme Specific Outcomes

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	2	2	3
CO2	3	3	2	2	3
CO3	3	3	2	2	3
CO4	3	3	2	2	3
CO5	3	3	2	2	3
Weightage	15	15	10	10	15
Weighted percentage (rounded of) Course Contribution to POs	3	3	2	2	3

Strong - 3, Medium – 2, Low - 1

SEMESTER I

CORE ELECTIVE 1: Human Physiology and Developmental Genetics

Paper code:
B i o t e c h n o l o g y

Subject: M . s c E n v i r o n m e n t a l

Hours/Week: 5

Credits: 3

Aim: To enable the students to understand the basic concepts of the the function and regulation of the human body and physiological integration of the organ systems to maintain homeostasis.

Course Objectives

- 1.To learn the basic concept of neurobiology
- 2.To learn the concept of Molecular biology
- 3.To develop knowledge on cellular biology of fertilization
- 4.To learn about the renal physiology
- 5.To develop a piece of knowledge in Developmental Genetics

Course Out Comes

- 1.After completing unit 1, the students will be able to identify the basic concept Introduction to brain and neuro biology.
- 2.After completing unit 2, the students will be able to know about Hormones and homeostasis
- 3.After c o m p l e t i n g unit 3, the students will be able to know ovogenesis
- 4.After completing unit 4, the students will be able to know about Molecular and cellular biology of fertilization
- 5.After completing unit 5, the students will be able to know about the Organogenesis and foetal development

Matching Table (Put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	No	Yes	Yes	Yes	No
3	No	Yes	No	Yes	Yes	Yes
4	No	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

Units	Course Contents	Teaching hours
Unit I	Introduction to brain and neuro biology. Sight and perception, hearing and balance, smell, taste, touch, pain, analgesics. Skin, hair. Muscles, movement, rheumatoid disorders. nervous system, skin, glands. Heart and blood circulation, blood clotting, microvasculature. Lungs, surfactant. Body fluids, fluid balance, parenteral solutions, renal physiology.	18 hours
Unit-II	Hormones and homeostasis. Digestive system, reproductive system, nervous system. Genital system, reproductive biology and contraception. Diseases of the digestive system, breathing, circulation, Mechanisms of drug action	18 hours
Unit-III	Structure, chemistry, dynamics and regulation of sperm locomotion, capacitation and egg-surface targeting Molecular biology, cytology and biochemistry of oogenesis: Synthesis and storage of maternal transcripts, proteins and cell organelles. rDNA amplification in amphibia; transcription on lampbrush chromosomes, ovulation and hormonal control in mammals.	18 hours
Unit-IV	Molecular and cellular biology of fertilization: acrosome reaction and signal transduction, monospermy and species-specificity. Egg activation, early cleavages and blastocyst formation in mammals and biochemical and cellular changes during the passage down the oviduct to the uterus. Implantation and formation of the placenta in mammals Gastrulation in mammals-formation of primitive streak, morphogenetic movements and neural induction.	18 hours
Unit-V	Organogenesis and foetal development Pattern forming genes and expression in Drosophila and mammalian embryos Development of the mammalian brain-cerebral cortex-cell lineages Lens development-fibre differentiation, programmed morphogenetic histogenetic cell death (apoptosis). Erythropoiesis, myelopoiesis. Ageing. Heart; cardiac cycle; blood constituents; groups and hematopoiesis; blood pressure; blood pressure and its neural and chemical regulation.	18 hours
Total Teaching hours		90

Internal Assessment Methods: (25 marks)

Distribution for internals	Test (CIA I + CIA II + CIA III)	Seminars	Assignment	Total marks
Marks	15	05	05	25

Reference Book:

- Parry Smith and Attwood David Mount
- Gibas and Jambeck

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	2	2	2	3	3	3
CO2	3	2	2	3	3	2	3	3	2	2
CO3	3	2	2	3	3	3	3	2	2	2
CO4	3	3	3	2	2	2	3	3	2	3
CO5	3	2	2	3	2	3	2	2	3	3

Strong - 3, Medium – 2, Low - 1

Mapping with Programme Specific Outcomes

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	3	3	3
CO2	3	2	3	3	3
CO3	3	2	3	3	3
CO4	3	2	3	3	3
CO5	3	2	3	3	3
Weightage	15	10	15	15	15
Weighted percentage (rounded of) Course Contribution to POs	3	2	3	3	3

Strong - 3, Medium – 2, Low - 1

SEMESTER I**CORE ELECTIVE 2: Stem Cell Biology &Somatic and Germ Cell Engineering**

Paper code:
Engineering

Subject: Stem Cell Biology &Somatic and Germ Cell

Hours/Week: 5

Credits: 3

Aim: To enable the students to understand the basic concepts of Stem Cells,cellular memory,Organ culture.

Course Objectives

- 1.To learn the basic concept of Stem Cell Biology
- 2.To learn the concept of Molecular basis of pluripotency
- 3.To develop knowledge on embryonic stem cell
- 4.To learn about the Stem cell technologies
- 5.To develop a piece of knowledge in Epigenetic mechanism of cellular memory

Course Out Comes

- 1.After completing unit 1, the students will be able to identify the basic concept Embryonic stem cells
- 2.After completing unit 2, the students will be able to know about Somatic and Germ cell derived stem cells
- 3.After completing unit 3, the students will be able to know mechanisms in Embryonic and adult stem cells
- 4.After completing unit 4, the students will be able to know about Stem cell technologies
- 5.After completing unit 5, the students will be able to know about the Epigenetic mechanism of cellular memory

Matching Table (Put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	No	Yes	Yes	Yes	No
3	No	Yes	No	Yes	Yes	Yes
4	No	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

Units	Course Contents	Teaching hours
Unit I	Introduction to stem cells , Embryonic stem cells,embryonal carcinoma cells, embryonic germ cells, adult stem cells, hematopoietic stemcells,mesenchymal stem cells, cancer stem cells, induced pluripotent stem cells. Cellular potency,Stem cell differentiation, dedifferentiation & trans differentiation,Asymmetric cell division, telomerases in relevance to stem cell development and differentiation.	18 hours
Unit-II	Isolation, characterization and maintenance of embryonic stem cell isolated from: Mouse and Human.Serum and feeder free culture of human embryonic stem cells, evolution of xeno-free culture systems. Somatic and Germ cell derived stem cells: epithelial stem cells, mesenchymal stem cells, neural stem cells, haematopoitic stem cells, cardiac stem cells,Cancer stem cells, molecular and evolutionary mechanisms addressing origin and maintenance of cancer stem cells	18 hours
Unit-III	.Molecular basis of pluripotency, stem cell niche.,Regulatory mechanisms in Embryonic and adult stem cells: Core regulatory circuitry, DNA methylation, histone modifications, histone modifiers, chromatin remodelers, RNA PolII code, post transcriptional control of gene expressionin ESC: role of miRNAs, LincRNAs and RNA binding proteins. Spatial organization of genome during ESC development and differentiation.	18 hours
Unit-IV	Stem cell technologies: Generation of chimeric animals and animal cloning Stem cell and progenitor cell assays: Purification of tissue specific stem cells and transplantations, Tissue engineering,stem cells and gene therapy,Ethical and regulatory issues in the use of stem cells. Methods & Bioinformatics resources related to Stem cells	18 hours
Unit-V	Epigenetic mechanism of cellular memory, Germ line Stem Cells, Stem Cells and Cloning, Nuclear cloning and Epigenetic reprogramming; Growth Factors and Signal Cascades BMP, Nodal, Wnt, Notch and Retenoid signaling during gastrulation. Differentiation in early development, Primordial germ cells in mouse and Human, Bone Marrow Mesenchymal Stem Cells , Hematopoietic Stem Cells: Identification, Characterization, Assays and Cell Lineages,	18 hours
Total Teaching hours		90

Internal Assessment Methods: (25 marks)

Distribution for internals	Test (CIA I + CIA II + CIA III)	Seminars	Assignment	Total marks
Marks	15	05	05	25

Text Books

1. Handbook of Stem Cells, 2nd Edition, Atala A & Lanza R, Academic Press, 2018.
2. Essential of Stem Cell Biology, 3rd Edition, Lanza R, et al, Elsevier Academic Press, 2013.
3. Translational Approaches in Tissue Engineering & Regenerative Medicine, Mao JJ, et al, Artech House, 2007.
4. Stem Cell Repair and Regeneration, Volume-2, Habib NA, Levièar NY, Gordon M, Jiao L & Fisk N, Imperial College Press, 2007.

Reference Books

1. Lanza R, Gaerhart J, Hogan B, Melton R, Thomas D, Thomas J, and Wilmut S. Essentials of Stem Cell Biology. Elsevier Inc.
2. Stillman B, Stewart D and Grodzicker T, Control and Regulation of Stem Cells.
3. Tursen Kursad, Stem Cell Biology and Regenerative Medicine, Humana Press.

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	2	2	2	3	3	3
CO2	3	2	2	3	3	2	3	3	2	2
CO3	3	2	2	3	3	3	3	2	2	2
CO4	3	3	3	2	2	2	3	3	2	3
CO5	3	2	2	3	2	3	2	2	3	3

Strong - 3, Medium – 2, Low - 1

Mapping with Programme Specific Outcomes

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	3	3	3
CO2	3	2	3	3	3
CO3	3	2	3	3	3
CO4	3	2	3	3	3
CO5	3	2	3	3	3
Weightage	15	10	15	15	15
Weighted percentage (rounded of) Course Contribution to POs	3	2	3	3	3

Strong - 3, Medium – 2, Low - 1

SEMESTER I**CORE ELECTIVE 3: BASIC HUMAN GENETICS**

Paper code:

Subject: BASIC HUMAN GENETICS

Hours/Week: 5

Credits: 3

Aim: To enable the students to understand the basic concepts Genetics, the environment on phenotype development, pedigree symbols, Genetic and Physical mapping.

Course Objectives

1. To learn the basic concept of Law of segregation
2. To learn the concept of Gene interactions
3. To develop knowledge on Pedigrees
4. To learn about the Mendelian Population
5. To develop a piece of knowledge in scope of population genetics

Course Out Comes

12

1. After completing unit 1, the students will be able to identify the basic concept on Mendelism
2. After completing unit 2, the students will be able to know about Genotype to phenotype

3. After completing unit 3, the students will be able to know History of Human Genetics

4. After completing unit 4, the students will be able to know about Linkage and crossing over

5. After completing unit 5, the students will be able to know about the population genetics

Matching Table (Put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	No	Yes	Yes	Yes	No
3	No	Yes	No	Yes	Yes	Yes
4	No	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

Units	Course Contents	Teaching hours
Unit I	Introduction to Genetics; Mendelism- Mendel and his experiments, Law of segregation Law of independent assortment; Chromosomal basis of segregation and independent assortment. Extensions of Mendelism-Allelic variation and gene function- Dominance relationships, basis of dominant and recessive mutations; Multiple allelism, allelic series.	18 hours
Unit-II	Genotype to phenotype: effect of the environment on phenotype development- Penetrance and expressivity, phenocopy; lethal and sub lethal mutations; Gene interactions and modifying genes; Pleiotropy; Polygenic inheritance; Multifactorial inheritance	18 hours
Unit-III	History of Human Genetics; Pedigrees- gathering family history, pedigree symbols, construction of pedigrees; Monogenic traits - Autosomal inheritance-dominant and recessive; Sex-linked inheritance-dominant and recessive; Sex-limited and sex-influenced traits; Y-linked ; Mitochondrial inheritance	18 hours
Unit-IV	Linkage and crossing over – types of crossing over ; Genetic and Physical mapping; heredity and environment (twin studies). Yeast two-hybrid system. Statistical methods for genetic analysis of complex traits. Cancer genetics. Immunogenetics; pre-natal diagnosis-chorionic villus sampling, amniocentesis Pre-implantation diagnosis. Genetic counselling. Gene therapy-concept, vectors, gene targeting and tissue-specific expression Ethics and human genetics. Introduction to pharmacogenomics and toxicogenomics.	18 hours
Unit-V	Mendelian Population and scope of population genetics. Gene and genotype frequencies, mating patterns, Hardy-Weinberg principle, heterozygotes, extension of H-W principle to multiple alleles, sex-linked alleles. Non-random matings, inbreeding and assortative matings, inbreeding coefficient. Factors that change allelic frequencies	18 hours
Total Teaching hours		90

Internal Assessment Methods: (25 marks)

Distribution for internals	Test (CIA I + CIA II + CIA III)	Seminars	Assignment	Total marks
Marks	15	05	05	25

Text Books:

1. The Genetics of Human Populations by LL Cavalli-Sforza and WF Bodmer Freeman and Company, 1971.
2. Population Genetics Theory by James F. Crow and W. Kimura Harper and Row, 1970.

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	2	3	3	3	2	3	3	3
CO2	3	3	2	3	3	3	2	3	2	2
CO3	3	3	2	3	3	3	2	2	2	2
CO4	3	3	2	3	3	3	2	3	2	3
CO5	3	3	2	3	3	3	2	2	3	3

Strong - 3, Medium – 2, Low - 1

Mapping with Programme Specific Outcomes

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	2	2	3
CO2	3	3	2	2	3
CO3	3	3	2	2	3
CO4	3	3	2	2	3
CO5	3	3	2	2	3
Weightage	15	15	10	10	15
Weighted percentage (rounded of) Course Contribution to POs	12.3	3	2	2	3

Strong - 3, Medium – 2, Low - 1

PRACTICALS –I (4 credit)**Stem Cell Biology & Somatic and Germ Cell Engineering**

- 1) Animal cell tissue culture – sterile working techniques.
- 2) Chick embryo fibroblast primary cell cultures and mouse chorionic villus cells.
- 3) Induced ovulation in mouse, collection of oviducal eggs and in vitro fertilization, culture in vitro of mouse embryos to the blastocyst state.
- 4) Transferring a foreign gene (e.g., chicken globin gene) into mouse fertilized eggs and transplantation of transformed mouse blastocysts in foster females.
- 5) Microinjection or electroporation of ES cells with foreign DNA (e.g., chicken globin gene, transplantation into mouse blastocyst and transfer to foster females.
- 6) Diagnosing tail DNA of chimeric mouse pups for transferred genes fusing HeLa and chicken erythrocyte cells in vitro for heterokaryons

PRACTICALS -

1. Genetics of Blood Groups
 - a) ABO –typing b) Rh (D) typing c) ABH Secretor status
2. Genetic Traits
 - a) Colour Blindness
 - b) Phenyl Thio Carbamide (PTC)
3. Dermatoglyphics
 - a) Finger ball patterns
 - b) Palmar patterns

SEMESTER I**VALUE ADDED COURSE 1 : GENETIC ENGINEERING**

Paper code:

Subject: **GENETIC ENGINEERING****Hours/Week:****5****Credits: 2**

Aim: To enable the students to understand the basic concepts DNA sequencing and Gene therapy.

Course Objectives

- 1.To learn the basic concept of cloning,Molecular Tools and Their Applications
- 2.To learn the concept of Strategies of Gene Cloning
- 3.To develop knowledge on Reporter assays
- 4.To learn about the Protein Engineering
- 5.To develop a piece of knowledge in scope of Vector engineering

Course Out Comes

- 1.After completing unit 1, the students will be able to identify the basic concept on Milestones in Genetic Engineering
- 2.After completing unit 2, the students will be able to know about Nucleic Acid Purification
- 3.After completing unit 3, the students will be able to know Cloning interacting genes
- 4.After completing unit 4, the students will be able to know about Expression strategies for heterologous genes
- 5.After completing unit 5, the students will be able to know about the Processing of recombinant proteins

Matching Table (Put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	No	Yes	Yes	Yes	No
3	No	Yes	No	Yes	Yes	Yes
4	No	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

Units	Course Contents	Teaching hours
Unit I	Scope of Genetic Engineering, Milestones in Genetic Engineering Isolation of enzymes, DNA sequencing, synthesis and mutation, detection and separation cloning, gene expression. Cloning and patenting of life forms. Genetic engineering guidelines, Molecular Tools and Their Applications, Restriction enzymes, modification enzymes, DNA and RNA markers	18 hours
Unit-II	Nucleic Acid Purification, Yield Analysis, Nucleic Acid Amplification and its Applications, Gene Cloning Vectors, Restriction Mapping of DNA Fragments and Map Construction, Nucleic Acid Sequencing, cDNA Synthesis and Cloning , mRNA enrichment, reverse transcription, DNA primers, linkers, adaptors and their chemical synthesis, Library construction and screening, Alternative Strategies of Gene Cloning	18 hours
Unit-III	Cloning interacting genes-Two-and three hybrid systems, cloning differentially 'expressed genes. Nucleic acid microarray arrays Site-directed Mutagenesis and Protein Engineering , How to Study Gene Regulation? DNA transfection, Northern blot, Primer extension, S1 mapping, RNase protection assay, Reporter assays	18 hours
Unit-IV	Expression strategies for heterologous genes, Vector engineering and codon optimization, host engineering, in vitro transcription and translation, expression in bacteria expression in yeast, expression in insect cells, expression in mammalian cells, expression in plants. Processing of recombinant proteins: Purification and refolding, characterization of recombinant proteins, stabilization of proteins. Phage Display, T-DNA and Transposon Tagging Role of gene tagging ingene analysis, T-DNA and Transposon Tagging, Identification and isolation of genes through T-DNA or Transposon.	18 hours
Unit-V	Transgenic and gene knockout technologies Targeted gene replacement, chromosome engineering. Gene therapy: Vector engineering strategies of gene delivery, gene replacement/augmentation, gene correction, gene editing, gene regulation and silencing.	18 hours
Total Teaching hours		90

Internal Assessment Methods: (25 marks)

Distribution for internals	Test (CIA I + CIA II + CIA III)	Seminars	Assignment	Total marks
Marks	15	05	05	25

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	2	3	3	3	2	3	3	3
CO2	3	3	2	3	3	3	2	3	2	2
CO3	3	3	2	3	3	3	2	2	2	2
CO4	3	3	2	3	3	3	2	3	2	3
CO5	3	3	2	3	3	3	2	2	3	3

Strong - 3, Medium – 2, Low - 1

Mapping with Programme Specific Outcomes

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	2	2	3
CO2	3	3	2	2	3
CO3	3	3	2	2	3
CO4	3	3	2	2	3
CO5	3	3	2	2	3
Weightage	15	15	10	10	15
Weighted percentage (rounded of) Course Contribution to POs	3	3	2	2	3

Strong - 3, Medium – 2, Low - 1

SEMESTER I
VALUE ADDED COURSE 2 : Developmental Biology and Human Physiology

Paper code:

Subject: **Developmental Biology and Human Physiology**

Hours/Week: 5

Aim: To enable the students to understand the Basic understanding of cell development and differentiation

Course Objectives

- 1.To learn the basic concept of overview of developmental biology and its key concepts
- 2.To learn the concept of actual pathway of physiological metabolism of
- 3.To develop knowledge on major invertebrates and vertebrates including humans.
- 4.To learn about the functioning and maintenance of various living system
- 5.To develop a piece of knowledge in differentiation

Course Out Comes

- 1.After completing unit 1, the students will be able to identify the basic concept Learn the importance of embryology (historical review) and more recently developmental biology as an emerging discipline and science
- 2.After completing unit 2, the students will be able to know about anatomy, physiology and evolution in selected Invertebrates and Vertebrates species.
- 3.After completing unit 3, the students will be able to know the mechanisms of early embryonic development (fertilization, early cleavage, blastula, gastrula, neurula) in Vertebrates
- 4.After completing unit 4, the students will be able to know about Identify the molecular pathways controlling axis formation (anteriorposterior, dorsal-ventral and left-right axes) in amphibians
- 5.After completing unit 5, the students will be able to know about the to communicate scientific information about key concepts in developmental biology.

Matching Table (Put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	No	Yes	Yes	Yes	No
3	No	Yes	No	Yes	Yes	Yes
4	No	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	12 Yes	Yes	Yes

Units	Course Contents	Teaching hours
Unit I	Defining developmental biology. Structure and function of reproductive system: Male reproductive system, Female reproductive system. Production of gametes: Spermatogenesis, Oogenesis. Cell surface molecules in sperm - egg recognition in animals; zygote formation, cleavage, blastula formation, gastrulation and formation of germ layers in animals. Early developmental events in vertebrates	18 hours
Unit-II	Overview of homeotic genes, axis formation in sea urchin, <i>C. elegans</i> , <i>D. melanogaster</i> , amphibians and mammals; formation of vulva in <i>C. elegans</i> ; Embryonic fields, potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; genomic equivalence and the cytoplasmic determinants; imprinting. Role of epigenetics in development. Postembryonic development: metamorphosis, regeneration and aging; Developmental constraints on evolution. Developmental defects and disorders	18 hours
Unit-III	Homeostasis, nutrition, structure and functions of digestive system. Physiology of digestion. Blood corpuscles, haemopoiesis, plasma function, blood volume, haemostasis. Comparative anatomy of heart structure, myogenic heart, ECG its principle and significance, cardiac cycle, heart as a pump, blood pressure, neural and chemical regulation of all above.	18 hours
Unit-IV	Comparison of respiration in different species, anatomical considerations, transport of gases, exchange of gases, waste elimination, neural and chemical regulation of respiration. Comparative physiology of excretion, kidney, urine formation, urine concentration, waste elimination, micturition, regulation of water balance, electrolyte balance and acid-base balance.	18 hours
Unit-V	Neurons, action potential, gross neuroanatomy of the brain and spinal cord, central and peripheral nervous system. Types, structure and functions of muscles, Physiology of muscle contraction. Sense organs: vision, hearing and tactile response. Endocrine glands, basic mechanism of hormone action, hormone and diseases; Thermoregulation	18 hours
Total Teaching hours		90

Internal Assessment Methods: (25 marks)

Distribution for internals	Test (CIA I + CIA II + CIA III)	Seminars	Assignment	Total marks
Marks	15	05	05	25

Textbooks

1. Developmental biology, (2018), 11th edition by Michael J. F. Barresi, Scott F. Gilbert.
2. Human Embryology & Developmental Biology (2019), 6th edition by Bruce M. Carlson.
3. Principles of Development (2019), 6th edition by Cheryll Tickle; Lewis Wolpert; Alfonso Martinez Arias.
4. Essentials of Animal Physiology (2019) 4th edition by Rastogi.
5. Ganong's Review of Medical Physiology (2019), 26th edition by Kim E. Barrett, Susan M. Barman, Heddwen L. Brooks, Jason Yuan, Scott Boitano.

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	2	2	2	3	3	3
CO2	3	2	2	3	3	2	3	3	2	2
CO3	3	2	2	3	3	3	3	2	2	2
CO4	3	3	3	2	2	2	3	3	2	3
CO5	3	2	2	3	2	3	2	2	3	3

Strong - 3, Medium – 2, Low - 1

Mapping with Programme Specific Outcomes

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	3	3	3
CO2	3	2	3	3	3
CO3	3	2	3	3	3
CO4	3	2	3	3	3
CO5	3	2	3	3	3
Weightage	15	10	15	15	15
Weighted percentage (rounded of) Course Contribution to POs	3	2	3	3	3

Strong - 3, Medium – 2, Low - 1

SEMESTER I**VALUE ADDED COURSE 3: Medical Immunology and Clinical Research****Paper code:****Subject: Medical Immunology and Clinical****Research****Hours/Week: 5**

Aim: To enable the students to understand the the theoretical knowledge of immunological concepts and clinical research significantly related to the field of medicine

Course Objectives

- 1.To learn the basic concept of Basic aspects of Immunity
- 2.To learn the concept of concept and nomenclature of MHC
- 3.To develop knowledge on artificial active immunization
- 4.To learn about the clinical research
- 5.To develop a piece of knowledge in Drug studies

Course Out Comes

- 1.After completing unit 1, the students will be able to identify the basic concept Fundamentals of immunity – immune response, tolerance
- 2.After completing unit 2, the students will be able to know about antigens and immunoglobulin – Immune cells and organs.
- 3.After completing unit 3, the students will be able to know MHC – HLA and its significant aspects on typing relevant to organ transplantation.
- 4.After completing unit 4, the students will be able to know about drug approval and regulations will be gained by the students.
- 5.After completing unit 5, the students will be able to know about the clinical research, drug approval and regulations will be gained by the students.

Matching Table (Put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	No	Yes 13	Yes	Yes	No
3	No	Yes	No	Yes	Yes	Yes
4	No	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

Units	Course Contents	Teaching hours
Unit I	Basic aspects of Immunity – Immune response - Immune tolerance - Immune cells and organs – Antigens, Haptens – Immunoglobulins – structure and function – Complement system – cytokines.	18 hours
Unit-II	MHC: History, concept and nomenclature of MHC - Genetic constitution of human HLA complex: HLA class I, class II and class III gene- Genetic characteristics and typing of HLA complex: genetic characteristics (Haplotype, Codominant inheritance, High polymorphism, Linkage disequilibrium), typing technology (serological typing, cytological typing, DNA typing) Significance of HLA in medicine: relevance to disease, organ transplantation.	18 hours
Unit-III	Concept of artificial active immunization, types of vaccines - Concept of artificial passive immunization, types of immunoproducs for artificial passive immunization - Concept of adoptive immunization, commonly used methods of adoptive immunization (LAK, TIL, cytokine gene transfection of immune cells) - Types of immunopotentiators and immunosuppressant commonly used in clinic	18 hours
Unit-IV	Introduction to clinical research, history of clinical research and an over view. Scope of clinical research. GCP and ICH. Different phases of clinical research. Ethics to be followed in clinical research trails. Drug studies - Pre clinical toxicology: General principles, Systemic toxicology (Single dose and repeat dose toxicity studies), Types of clinical trials, single blinding, double blinding, Open access, Randomized trials and their examples, interventional study, Basics terminologies in Pharmacology. New drug development process.	18 hours
Unit-V	Tumor immunology: Oncogene and cancer induction, Tumor antigens, Immune response to tumors, relation between tumor type and nature of immune response; Angiogenesis and tumor metastasis; anti-tumor drug resistance; immunotherapy	18 hours
Unit-VI		05 hours
Total Teaching hours		90

Internal Assessment Methods: (25 marks)

Distribution for internals	Test (CIA I + CIA II + CIA III)	Seminars	Assignment	Total marks
Marks	15	05	05	25

Textbooks

1. Subhash Chandra Parija, "Textbooks of Microbiology and Immunology", Elsevier; Second edition, 2018.
2. Arumugam N. A.Mani, L.M.Narayanan, Dulsy Fatima, A.M.Selvaraj, "Immunology & Microbiology", Saras Publication, 2015.
3. Arumugam N, "Immunology & Microbiology", Saras Publication, 2007.
4. Ramasamy, P and R.E.B. Hanna, "Immunity and inflammation", University of Madras publications, Pearl Press Ltd., 2002.

5. Ravindra B. Ghoojand Sachin C. Itkar. Essential of Clinical Research, Nirali Prakashan, Publications 2010.

6. Pal.T.K and Sangita Agarwal, Clinical Research, CBS publishers and Distribution, 2009.

REFERENCE BOOKS:

1. Tak W Mark and Mary Saunders, "The Immune Response Basic and Clinical Principles", 1st edition, AP. 2005.

2. Parslow, T.G, D.P. Sites, A.L.Terr, "Medical immunology", 10th edition by Mc Graw-Hill Publishing, 2001.

3. Zola H, "Monoclonal antibodies", Bios Scientific Publishers LTD., 2000.

4. Goldsby R.A., T.J. Kindt and B.A. Osborne, "Kuby Immunology", Freeman and company, 2000.

5. Roitt I, "Immunology", Blackwell Scientific Publications, 1996

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	2	3	3	3	2	3	3	3
CO2	3	3	2	3	3	3	2	3	2	2
CO3	3	3	2	3	3	3	2	2	2	2
CO4	3	3	2	3	3	3	2	3	2	3
CO5	3	3	2	3	3	3	2	2	3	3

Strong - 3, Medium – 2, Low - 1

Mapping with Programme Specific Outcomes

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	2	2	3
CO2	3	3	2	2	3
CO3	3	3	2	2	3
CO4	3	3	2	2	3
CO5	3	3	2	2	3
Weightage	15	15	10	10	15
Weighted percentage (rounded of) Course Contribution to POs	3	3	2	2	3

¹³
Strong - 3, Medium – 2, Low - 1

SEMESTER II**PAPER 1: : Immunology and Immuno-genetics**

Paper code:

Subject: **Immunology and Immuno-genetics****Hours/Week:****5****Credits: 4**

Aim: To enable the students to understand the basic concepts of the Structure, function and Cells of the immune system, Antigens and Antigen presentation.

Course Objectives

1. To learn the basic concept of Cells of the immune system
2. To learn the concept of Primary and Secondary lymphoid organs.
3. To develop knowledge on .Monoclonal and polyclonal antibodies.
4. To learn about the Properties of cytokines
5. To develop a piece of knowledge in structure of antibodies

Course Out Comes

6. After completing unit 1, the students will be able to identify the basic concept of Structure, function and Cells of the immune system
7. After completing unit 2, the students will be able to know about Antigens and Antigen presentation
8. After completing unit 3, the students will be able to know detail about HLA major histocompatibility complex
9. After completing unit 4, the students will be able to know about the Cytokine, cellular adhesion and interactions
10. After completing unit 5, the students will be able to know about the Immunoglobulin function

Matching Table (Put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	No	Yes	Yes	Yes	No
3	No	Yes	No	Yes	Yes	Yes
4	No	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

Units	Course Contents	Teaching hours
Unit I	Structure, function and Cells of the immune system: The classification of human immune response: Humoral and cellular immunity, Innate and Adaptive immune response, Cellular components of the adaptive immune system, Phases of adaptive immune responses, Clonal expression, Toll like receptors, ABO blood Group. Lymphoid cells, clinical focus on the stem cells. Clinical uses and potential. B-lymphocytes and T-lymphocytes. Primary and Secondary lymphoid organs.	18 hours
Unit-II	Antigens and Antigen presentation Super antigens. Immunogenicity versus Antigenicity. Haptens. Autoimmunity, Epitopes and paratopes, Properties of antigens recognized by T lymphocytes. Cell biology of antigen processing. Immunoglobulin function Basic structure of antibodies. Antibody binding site. Antibody-mediated effector function. Antibody classes and biological activity. Antigenic determinants on immunoglobulins. Immunoglobulin super family. Monoclonal antibodies. Monoclonal and polyclonal antibodies.	18 hours
Unit-III	The HLA major histo compatibility complex Discovery of the MHC its role in immune responses. Structure of MHC molecule (properties, binding of peptides to MHC molecules genomic organization of the MHC , expression of MHC molecules.	18 hours
Unit-IV	Cytokine, cellular adhesion and interactions Properties of cytokines .Cytokine receptor. Cytokine antagonists. Cytokine secretion by TH 1 and TH 2 subsets. Cytokine related diseases-Septic shock, Chagas's diseases. Cell adhesion molecule. Chemo-kines. Leukocyte Extravasation – the multi step paradigm. Lymphocyte Extravasation. Immune regulation.	18 hours
Unit-V	Regulatory and Cytotoxic T cell, macrophages and NK cell function T cell maturation and the thymus. T cell activation. T cell differentiation. Cell death and T population. Effector responses. General principles of effector T cells. Cytotoxic T cell. NK cell . Antibody dependent cell mediated cytotoxicity (ADCC). Experimental assessment of cell mediated cytotoxicity	18 hours
Total Teaching hours		90

Internal Assessment Methods: (25 marks)

Distribution for internals	Test (CIA I + CIA II + CIA III)	Seminars	Assignment	Total marks
Marks	15	05	05	25

Reference Book:

1. Kuby, RA Goldsby, Thomas J. Kindt, Barbara, A. Osborne Immunology, 6th Edition, Freeman, 2002.
2. Brostoff J, Seaddin JK, Male D, Roitt IM., Clinical Immunology, 6th Edition, Gower Medical Publishing, 2002.
3. Janeway et al., Immunobiology, 4th Edition, Current Biology, publications., 1999.
4. Paul, Fundamental of Immunology, 4th edition, Lippencott Raven, 1999.
5. Goding, Monoclonal antibodies, Academic Press. 1985.

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	2	2	2	3	3	3
CO2	3	2	2	3	3	2	3	3	2	2
CO3	3	2	2	3	3	3	3	2	2	2
CO4	3	3	3	2	2	2	3	3	2	3
CO5	3	2	2	3	2	3	2	2	3	3

Strong - 3, Medium – 2, Low - 1

Mapping with Programme Specific Outcomes

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	3	3	3
CO2	3	2	3	3	3
CO3	3	2	3	3	3
CO4	3	2	3	3	3
CO5	3	2	3	3	3
Weightage	15	10	15	15	15
Weighted percentage (rounded of) Course Contribution to POs	¹³ 3	2	3	3	3

Strong - 3, Medium – 2, Low - 1

SEMESTER II**PAPER 2: : Gene Based Diagnosis and Therapy**

Paper code:

Subject: : **Gene Based Diagnosis and Therapy****Hours/Week: 5 Credits: 4****Aim: To enable the students to understand the basic concepts of the human genetics, Genetic mapping.****Course Objectives**

1. To learn the basic concept of Autosomal dominant inheritance
2. To learn the concept of Genetic mapping
3. To develop knowledge on Gene environment interaction in complex diseases
4. To learn about the gene therapy
5. To develop a piece of knowledge in Receptor mediated endocytosis

Course Out Comes

6. After completing unit 1, the students will be able to identify the basic concept of History of human genetics
7. After completing unit 2, the students will be able to know about the concept Genetic mapping
8. After completing unit 3, the students will be able to Genetics of Alzheimer's disease
9. After completing unit 4, the students will be able to know about the g human disease genes
10. After completing unit 5, the students will be able to know about the Gene blocking therapies

Matching Table (Put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	No	Yes	Yes	Yes	No
3	No	Yes	No	Yes	Yes	Yes
4	No	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

Units	Course Contents	Teaching hours
Unit I	Autosomal dominant inheritance (HD, MD, CDD etc), Autosomal recessive inheritance (SCA, CF, etc), Sex linked and mitochondrial (DMD, hemophilia, LHON), PKU, Alzheimer, Parkinsonism, Tay-Sachs, Mongolism, Cri-du-chat, Edwards, X and Y chromosomal, Prenatal and Postnatal studies, Chromosome analysis.	18 hours
Unit-II	Haplotype, Physical and Cytogenetic mapping, SNP, RFLP, TRE, PCR-OLA, SSCP, RAPD	18 hours
Unit-III	Genetics of Alzheimer's disease- Causative genes for familial Alzheimer's disease (APP, PSEN1, PSEN2)-Alzheimer's disease susceptibility genes (APOE, BACE1, BACE2, NCSTN, PEN2, SORL1), Environmental factors in Alzheimer's disease pathogenesis, Genetics of Parkinson's disease-Causative genes for familial Parkinson's disease susceptibility genes, Environmental factors in Parkinson's disease pathogenesis, Genetics of Amyotrophic lateral sclerosis-Causative genes for familial Amyotrophic lateral sclerosis-Amyotrophic lateral sclerosis susceptibility genes and Environmental factors Amyotrophic lateral sclerosis pathogenesis, Role of environment on epigenetics of neurodegenerative diseases, Teratology, Molecular genetics of coronary heart disease, Schizophrenia, Diabetes mellitus.	18 hours
Unit-IV	General gene therapy strategies, Targeted killing of specific cells, Targeted mutation correction, Targeted inhibition of gene expression. Gene replacement therapy by viral vectors: Oncovirus, Lentivirus, Adenovirus, Adenoassociated virus, Herpes Simplex virus, Naked DNA or direct injection or particle bombardment-gene gun, Liposome mediated DNA transfer, Receptor mediated endocytosis, Repair of mutations in situ through the cellular DNA repair machinery, Antisense induced exon splicing, In-utero fetal gene therapy	18 hours
Unit-V	Gene Knockouts, Gene disruption-p53, prion diseases, immunological, short RNA, Gene therapy for non-inheritable diseases, stem cell therapy, somatic cell gene therapy and germ line gene therapy. In vitro fertilization, Prenatal sex determination, Surrogate therapy, Genetic counseling, Germline gene therapy, ELSI, NBAC, IPR, Patenting, Human transgene	18 hours
Total Teaching hours		90

Internal Assessment Methods: (25 marks)

Distribution for internals	Test (CIA I + CIA II + CIA III)	Seminars	Assignment	Total marks
Marks	15	05	05	25

Reference Book:

1. Human Molecular Genetics- Tom Strachan
2. Concepts of Genetics- William s. Klug
3. Emery's Elements of Medical Genetics- Robert F. Mueller & Ian D. Young

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	2	3	3	3	2	3	3	3
CO2	3	3	2	3	3	3	2	3	2	2
CO3	3	3	2	3	3	3	2	2	2	2
CO4	3	3	2	3	3	3	2	3	2	3
CO5	3	3	2	3	3	3	2	2	3	3

Strong - 3, Medium – 2, Low - 1

Mapping with Programme Specific Outcomes

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	2	2	3
CO2	3	3	2	2	3
CO3	3	3	2	2	3
CO4	3	3	2	2	3
CO5	3	3	2	2	3
Weightage	15	15	10	10	15
Weighted percentage (rounded of) Course Contribution to POs	3	3	2	2	3

Strong - 3, Medium – 2, Low - 1

SEMESTER II**PAPER 3: Drug Delivery**

Paper code: Subject: **Drug Delivery**

Hours/Week: 5 Credits: 4

Aim: To enable the students to understand the basic concepts of the Drug delivery, Rate control in drug delivery and drug targeting system, Routes of drug delivery and future direction in drug delivery .

Course Objectives

- 1.To learn the basic concept of Drug delivery concepts and market perspective.
- 2.To learn the concept of Fundamentals and applications to implanatable systems.
- 3.To develop knowledge on routes of drug delivery.
- 4.To learn about the future direction of drug delivery.
- 5.To develop a piece of knowledge in new generation technologies.

Course Out Comes

6. After completing unit 1, the students will be able to identify the basic concept of Drug delivery concepts and market perspective.
7. After completing unit 2, the students will be able to know about the Fundamentals and applications to implanatable systems. And also the parental drug delivery.
8. After completing unit 3, the students will be able to know detail about drug delivery routes .
9. After completing unit 4, the students will be able to know about the future direction of drug delivery. And targeting.
10. After completing unit 5, the students will be able to know about new generation technologies.

Matching Table (Put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	No	Yes	Yes	Yes	No
3	No	Yes	No	Yes	Yes	Yes
4	No	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

Units	Course Contents	Teaching hours
Unit I	Drug delivery: Basic concepts Drug delivery: Market perspective Advance drug delivery and targeting	18 hours
Unit-II	Rate control in drug delivery and targeting: Fundamentals and application to implantable systems Drug targeting systems: Fundamental and applications to parental drug delivery	18 hours
Unit-III	Routes of drug delivery Oral drug delivery Oral Trans-Mucosal drug delivery Transdermal drug delivery Nasal drug delivery Pulmonary drug delivery Vaginal drug delivery Ophthalmic drug delivery CNS drug delivery	18 hours
Unit-IV	Future direction of drug delivery and targeting Transdermal Drug Delivery Systems: Introduction, Permeation through skin, factors affecting permeation, permeation enhancers, basic components of TDDS, formulation approaches	18 hours
Unit-V	Plasmid based gene therapy Integrating drug discovery and delivery New generation technologies	18 hours
Total Teaching hours		90

Internal Assessment Methods: (25 marks)

Distribution for internals	Test (CIA I + CIA II + CIA III)	Seminars	Assignment	Total marks
Marks	15 ¹⁴	05	05	25

Reference Book:

Drug Delivery and Targetting by Anya Hilary, Andrew Lloyd

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	2	2	2	3	3	3
CO2	3	2	2	3	3	2	3	3	2	2
CO3	3	2	2	3	3	3	3	2	2	2
CO4	3	3	3	2	2	2	3	3	2	3
CO5	3	2	2	3	2	3	2	2	3	3

Strong - 3, Medium – 2, Low - 1

Mapping with Programme Specific Outcomes

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	3	3	3
CO2	3	2	3	3	3
CO3	3	2	3	3	3
CO4	3	2	3	3	3
CO5	3	2	3	3	3
Weightage	15	10	15	15	15
Weighted percentage (rounded of) Course Contribution to POs	3	2	3	3	3

Strong - 3, Medium – 2, Low - 1

SEMESTER II**PAPER 4: Medical Microbiology and Biology of infectious diseases****Paper code: Subject: Medical Microbiology and Biology of infectious diseases****Hours/Week: 5 Credits: 4****Aim: To enable the students to understand the basic concepts of Disease burden, vectors, water-borne diseases and immune system.****Course Objectives**

1. To learn the basic concept of Methods of culturing and assaying
2. To learn the concept of Replication of DNA, RNA
3. To develop knowledge on mechanism of drug resistance
4. To learn about the diagnosis of infectious diseases
5. To develop a piece of knowledge in PCR assays.

Course Out Comes

6. After completing unit 1, the students will be able to identify the Bacteria, Viruses, Fungi, Protozoa.
7. After completing unit 2, the students will be able to know about Disease burden, Methods of culturing and assaying, Replication of DNA, RNA.
8. After completing unit 3, the students will be able to know detail about Viral vaccines, Sterilization techniques.
9. After completing unit 4, the students will be able to know about the vectors, Biological warfare agents, Anti-viral, Anti-fungal chemotherapy.
10. After completing unit 5, the students will be able to know about Hospital-acquired infections, Water and waste management for water-borne diseases.

Matching Table (Put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	No	Yes	Yes	Yes	No
3	No	Yes	No	Yes	Yes	Yes
4	No	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

Units	Course Contents	Teaching hours
Unit I	Bacteria: Representative diseases to be studied in detail are - tetanus, diphtheria, cholera, typhoid, tuberculosis, leprosy, plague, and syphilis. Infections caused by anaerobic bacteria, spirochetes, chlamydia, rickettsiae. Viruses: Representative diseases to be studied in detail are - viral hepatitis, influenza, rabies, polio and AIDS and viral cancers. Fungi: Diseases to be taken up in following categories: superficial, subcutaneous, systemic and opportunistic mycoses. Protozoa: Diseases to be discussed are - amoebiasis, toxoplasmosis, trichomoniasis & leishmaniasis.	18 hours
Unit-II	Disease burden : microbial, viral, fungal and parasitic. Investigation of epidemics Methods of culturing and assaying: bacterial, viral and parasitic. Classification: fungal, protozoal, helminthic, bacterial and viral Replication of DNA, RNA+ve and RNA-ve viruses, retroviruses	18 hours
Unit-III	Viral vaccines: conventional: killed/attenuated; DNA; peptide; recombinant proteins. Syllabus For Sterilization techniques: biohazard hoods; containment facilities, BSL 2, 3, 4	18 hours
Unit-IV	Bacterial and viral vectors Biological warfare agents Mode of action of antibiotics and antiviral: molecular mechanism of drug resistance (MDR) Anti-viral chemotherapy. Anti-fungal chemotherapy.	18 hours
Unit-V	Hospital-acquired infections (nosocomial), immune compromised states. Water and waste management for water-borne diseases. . Modern approaches for diagnosis of infectious diseases: Basic concepts of gene probes, dot hybridization and PCR assays. Anatomy, development and functions of immune system Host and parasite relationship , Biology of immune response , Microbial pathogenicity and host immune response , Infection and immunity	18 hours
Total Teaching hours		90

Internal Assessment Methods: (25 marks)

Distribution for internals	Test (CIA I + CIA II + CIA III)	Seminars	Assignment	Total marks
Marks	15	05	05	25

Reference Book:

1. Ananthanarayan & Paniker's Textbook of Microbiology, 8th Ed., Orient Longman, India; 2009.
2. Collee J G Mackie and McCartney Practical Medical Microbiology 14th Ed. 1999.
3. Bailey and Scott's Diagnostic Microbiology 9th Ed. C V Mosby, St. Louis, 2003. Brooks, Geo F Jawetz Medical Microbiology 22nd Ed. Mc Graw Hill 2001.

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	2	3	3	3	2	3	3	3
CO2	3	3	2	3	3	3	2	3	2	2
CO3	3	3	2	3	3	3	2	2	2	2
CO4	3	3	2	3	3	3	2	3	2	3
CO5	3	3	2	3	3	3	2	2	3	3

Strong - 3, Medium – 2, Low - 1

Mapping with Programme Specific Outcomes

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	2	2	3
CO2	3	3	2	2	3
CO3	3	3	2	2	3
CO4	3	3	2	2	3
CO5	3	3	2	2	3
Weightage	15	15	10	10	15
Weighted percentage (rounded of) Course Contribution to POs	3	3	2	2	3

Strong - 3, Medium – 2, Low - 1

SEMESTER II**ELECTIVE PAPER 1: Biomolecules and metabolism****Paper code:****Subject: Biomolecules and metabolism****Hours/Week: 5 Credits: 2**

Aim: To enable the students to understand the basic concepts of Classes of organic compounds, Separation techniques.

Course Objectives

1. To learn the basic concept of organic compounds, functional groups.
2. To learn the concept of Heterocyclic compounds
3. To develop knowledge on Physical techniques
4. To learn about the properties of polynucleotides
5. To develop a piece of knowledge enzymes and coenzymes.

Course Out Comes

6. After completing unit 1, the students will be able to Chemical foundations of Biology
7. After completing unit 2, the students will be able to know about Separation techniques for different biomolecules
8. After completing unit 3, the students will be able to know detail about Physical techniques in proteins, nucleic acids and polysaccharides
9. After completing unit 4, the students will be able to know about the Conformational properties of polynucleotides, Polysaccharides
10. After completing unit 5, the students will be able to know about Water and its properties,

Matching Table (Put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	No	Yes	Yes	Yes	No
3	No	Yes	No	Yes	Yes	Yes
4	No	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

Units	Course Contents	Teaching hours
Unit I	Chemical foundations of Biology –pH, pK, acids, bases, buffers, weak bonds, covalent bonds. Principles of thermodynamics. Classes of organic compounds and functional groups-atomic and molecular dimensions, space filling and ball and stick models. Macro molecular and supra molecular assemblies.	18 hours
Unit-II	Amino acids and peptides-classification, chemical reactions and physical properties Sugars - classification and reactions Heterocyclic compounds-and secondary metabolites in living systems - nucleotides, pigments, isoprenoids Separation techniques for different biomolecules	18 hours
Unit-III	Physical techniques in proteins, nucleic acids and polysaccharides structure analysis (UV, IR, MMR, LASER, MASS, Fluorescence spectroscopy, Differential calorimetry, X - ray Crystallography, Ultra Centrifugation, Electron cryomicrography, Scanning Tunneling microscopy	18 hours
Unit-IV	.Lipids- classification, structure and functions Proteins-protein and protein legand interactions, end group analysis, hierarchy in structure, Ramachandran map. Conformational properties of polynucleotides, Polysaccharides - types, secondary and tertiary structural features, analysis- theoretical and experimental; Protein folding – biophysical and cellular aspects.	18 hours
Unit-V	Water and its properties, enzymes coenzymes, metabolism of carbohydrate, amino acids and lipids, in born errors of metabolism. Bio-energetics and oxidative phosphorylation. Blood clotting – biochemistry, body fluids – pH and acid base balance and their importance in clinical biochemistry, muscle contraction. Techniques in the study of proteins, carbohydrates and lipids.	18 hours
Total Teaching hours		90

Internal Assessment Methods: (25 marks)

Distribution for internals	Test (CIA I + CIA II + CIA III)	Seminars	Assignment	Total marks
Marks	15	05	05	25

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	2	2	2	3	3	3
CO2	3	2	2	3	3	2	3	3	2	2
CO3	3	2	2	3	3	3	3	2	2	2
CO4	3	3	3	2	2	2	3	3	2	3
CO5	3	2	2	3	2	3	2	2	3	3

Strong - 3, Medium – 2, Low - 1

Mapping with Programme Specific Outcomes

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	3	3	3
CO2	3	2	3	3	3
CO3	3	2	3	3	3
CO4	3	2	3	3	3
CO5	3	2	3	3	3
Weightage	15	10	15	15	15
Weighted percentage (rounded of) Course Contribution to POs	3	2	3	3	3

Strong - 3, Medium – 2, Low - 1

SEMESTER II**ELECTIVE PAPER 2: Molecular Modeling and Drug Designing**

Paper code:

Subject: **Molecular Modeling and Drug Designing**

Hours/Week: 5

Aim: To enable the students to understand the basic concepts molecular structures,Protein Data Bank,free energy of molecules.

Course Objectives

- 1.To learn the basic concept of algorithms
- 2.To learn the concept of Molecular Structure Determination
- 3.To develop knowledge on the Protein Data Bank and the Nucleic Acid Data Bank
- 4.To learn about the Techniques for Molecular energy minimization
- 5.To develop a piece of knowledge in Molecular Modelling

Course Out Comes

- 6.After completing unit 1, the students will be able to Concept of external and internal coordinates and algorithms
- 7.After completing unit 2, the students will be able to Methods for Molecular
- 8.After completing unit 3, the students will be able to know detail about PDB and NDB
9. After completing unit 4, the students will be able to know about the Concept of free energy of molecules
- 10.After completing unit 5, the students will be able to know about Methods of molecular modeling

Matching Table (Put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	No	Yes	Yes	Yes	No
3	No	Yes	No	Yes	Yes	Yes
4	No	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

Units	Course Contents	Teaching hours
Unit I	Concept of external and internal coordinates and algorithms for their inter-conversion. Different representations of molecular structures and their relative merits and demerits	18 hours
Unit-II	Brief account of structure determination by X-ray crystallography and NMR spectroscopy. Validation of experimentally obtained NMR structures. The Protein Data Bank (PDB) and the Nucleic Acid Data Bank (NDB). The PDB and the mmCIF file formats for the storage and dissemination of molecular structures.	18 hours
Unit-III	Concept of free energy of molecules. Introduction to various force fields and their relative merits and demerits. Techniques for Molecular energy minimization, Monte Carlo and Molecular Dynamics simulation.	18 hours
Unit-IV	Methods of molecular modeling including homology modeling, threading and ab initio protein structure prediction together with their relative merits and demerits. Methods for structure structure comparison of macromolecules with special reference to proteins.	18 hours
Unit-V	General ideas of drug designing, 2D and 3D QASR, concept of a pharmacophore and pharmacophore based searches of ligand databases. Concepts of COMFA. Methods for simulated docking.	18 hours
Total Teaching hours		90

Internal Assessment Methods: (25 marks)

Distribution for internals	Test (CIA I + CIA II + CIA III)	Seminars	Assignment	Total marks
Marks	15	05	05	25

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	2	3	3	3	2	3	3	3
CO2	3	3	2	3	3	3	2	3	2	2
CO3	3	3	2	3	3	3	2	2	2	2
CO4	3	3	2	3	3	3	2	3	2	3
CO5	3	3	2	3	3	3	2	2	3	3

Mapping with Programme Specific Outcomes

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	2	2	3
CO2	3	3	2	2	3
CO3	3	3	2	2	3
CO4	3	3	2	2	3
CO5	3	3	2	2	3
Weightage	15	15	10	10	15
Weighted percentage (rounded of) Course Contribution to POs	3	3	2	2	3

Strong - 3, Medium – 2, Low - 1

SEMESTER II**ELECTIVE PAPER 3: ESSENTIALS OF ANATOMY**

Paper code:

Subject: ESSENTIALS OF ANATOMY

Hours/Week: 5

Aim: To enable the students to understand the basic concepts of human Anatomy

Course Objectives

- 1.To learn the basic concept of General orientation of thorax and thoracic cavity
- 2.To learn the concept of Abdomeno -Pelvic cavity
- 3.To develop knowledge on Pelvis
- 4.To learn about the Cranial cavity
- 5.To develop a piece of knowledge in meninges of brain

Course Out Comes

- 6.After completing unit 1, the students will be able to know about General orientation of thorax and thoracic cavity
- 7.After completing unit 2, the students will be able to know about General orientation of Abdomeno-Pelvic cavity
- 8.After completing unit 3, the students will be able to know about-detailed anatomy of Uterus

9. After completing unit 4, the students will be able to know about the General orientation of head and neck region

10. After completing unit 5, the students will be able to know about Enumerate meninges of brain

Matching Table (Put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	No	Yes	Yes	Yes	No
3	No	Yes	No	Yes	Yes	Yes
4	No	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

Units	Course Contents	Teaching hours
Unit I	General orientation of thorax and thoracic cavity – Boundaries, inlet, outlet and wall, <input type="checkbox"/> Intercostal space in detail, <input type="checkbox"/> Pleura and its part, pleural cavity. <input type="checkbox"/> Lung external features <input type="checkbox"/> Elementary idea of Trachea and tracheobronchial tree. <input type="checkbox"/> Concept of Mediastinum, its subdivision and enumerate its content. <input type="checkbox"/> Basic concept of Pericardium and its sinuses, <input type="checkbox"/> External features and chambers of Heart with Right atrium in detail, <input type="checkbox"/> Blood vessels of Heart in detail, <input type="checkbox"/> Aorta and its branches, <input type="checkbox"/> Enumerate and classify joints of thorax	18 hours
Unit-II	General orientation of Abdomeno-Pelvic cavity, <input type="checkbox"/> Surface landmarks, Concept of Regions and quadrants, <input type="checkbox"/> Enumerate the layers of Anterior abdominal wall, <input type="checkbox"/> Anterolateral abdominal muscles, external oblique, internal oblique and transversus abdominis in detail, Inguinal canal in detail <input type="checkbox"/> Concept of Peritoneum- definition, parts, peritoneal cavity, retroperitoneal structures, nerve supply and functions, <input type="checkbox"/> Liver, spleen, pancreas– location, borders & surfaces, <input type="checkbox"/> Stomach Location, Parts, Blood supply, Lymphatic drainage in detail, <input type="checkbox"/> Enumerate the components of Extrahepatic biliary apparatus <input type="checkbox"/> Kidney in detail <input type="checkbox"/> Different parts of small and large Intestine, difference between small and large intestine	18 hours
Unit-III	Pelvis – true and false pelvis, inlet, outlet, cavity and enumerate its contents <input type="checkbox"/> Detailed anatomy of Uterus <input type="checkbox"/> Detailed anatomy of Urinary bladder <input type="checkbox"/> Perineum– definition, boundaries and its subdivision. General orientation of head and neck region, Surface landmarks, <input type="checkbox"/> Scalp in detail, <input type="checkbox"/> Facial artery and vein, enumerate muscles of facial expressions, nerve supply of face, <input type="checkbox"/> Parotid gland in detail <input type="checkbox"/> Deep Cervical fascia – enumerates different layers, enumerate boundaries and contents of anterior triangle, sternocleidomastoid muscle and Posterior triangle in detail	18 hours
Unit-IV	<input type="checkbox"/> Vertebral canal boundaries and enumerate its contents <input type="checkbox"/> Cranial cavity- enumerate layers of meninges, enumerate paired & unpaired dural venous sinuses and their location, <input type="checkbox"/> Orbit enumerate contents of orbit, enumerate extraocular muscle, nerve supply, <input type="checkbox"/> Temporal and	18 hours

	infratemporal fossa - boundaries and enumerate its contents, <input type="checkbox"/> Muscles of mastication in detail. <input type="checkbox"/> Submandibular salivary gland location, borders & surfaces <input type="checkbox"/> Enumerate suprahyoid muscles, <input type="checkbox"/> Thyroid gland in detail, <input type="checkbox"/>	
Unit-V	<input type="checkbox"/> Enumerate meninges of brain & its characteristics features in brief <input type="checkbox"/> Enumerate subarachnoid space & cisterns <input type="checkbox"/> Cerebrum: Poles, surfaces, borders & lobes of cerebral hemisphere, Enumerate Important sulci, gyri and functional cortical areas <input type="checkbox"/> White matter of cerebrum, corpus callosum in brief, internal capsule in detail. External features of Midbrain, Pons, medulla oblongata and cerebellum. <input type="checkbox"/> External features of spinal cord and formation of spinal nerve <input type="checkbox"/> Elementary ideas of Cavities of brain <input type="checkbox"/> Enumerate Cranial nerves and their attachment on the surface of brain. Endocrine system: Classification, Hormones produced, Control of hormone secretion, basic functions	18 hours
Total Teaching hours		90

Internal Assessment Methods: (25 marks)

Distribution for internals	Test (CIA I + CIA II + CIA III)	Seminars	Assignment	Total marks
Marks	15	05	05	25

RECOMMENDED BOOKS:

1. Clinical Anatomy for Medical Students, by: Richard S. Snell
2. General Anatomy, by: Vishram Singh
3. General Anatomy, by: B.D. Chaurasia
4. Embryology for Medical Students, by: Inderbir Singh
5. Text Book of Histology, by: Inderbir Singh

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	2	2	2	3	3	3
CO2	3	2	2	3	3	2	3	3	2	2
CO3	3	2	2	3	3	3	3	2	2	2
CO4	3	3	3	2	2	2	3	3	2	3
CO5	3	2	2	3	2	3	2	2	3	3

Strong - 3, Medium – 2, Low - 1

Mapping with Programme Specific Outcomes

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	3	3	3
CO2	3	2	3	3	3
CO3	3	2	3	3	3
CO4	3	2	3	3	3
CO5	3	2	3	3	3
Weightage	15	10	15	15	15
Weighted percentage (rounded of) Course Contribution to POs	3	2	3	3	3

Strong - 3, Medium – 2, Low - 1

PRACTICAL - II**Biomolecules and metabolism (4 credit)**

- 1) Titration of amino acids
- 2) Colorimetric determination of pK
- 3) Model building using space filling/ball and stick models
- 4) Reactions of amino acids, sugars and lipids
- 5) Isolation, purity determination and quantitation of cholesterol, DNA and mRNA
- 6) Quantitation of Proteins and Sugars
- 7) Analysis of oils-iodine number, saponification value, acid number
- 8) UV, Visible, Fluorescence and IR spectroscopy, Absorption spectra
- 9) Separation techniques - Centrifugation, Chromatography (Gel permeation, Ion exchange, TLC etc. and Electrophoresis

Medical Microbiology and Biology of infectious diseases

- 10) Staining techniques.
- 11) Haemagglutination test.
- 12) Commercial kits-based diagnosis.
- 13) Antibioticsensitivity(bacterial).
- 14) Electron microscopy (demo)
- 15) Bacterialculture
- 16) Agar gel diffusion
- 17) ELISA
- 18) Preparation of axenic cultures

SEMESTER II**OPEN ELECTIVE 1: Biochemistry**

Paper code:

Subject: **Biochemistry****Hours/Week: 5****Credits: 2**

Aim: To enable the students to understand the basic concepts of Chemical basis of life, Structure of protein, Factors stabilizing proteins.

Course Objectives

1. To learn the basic concept of properties of bio molecules in water
2. To learn the concept of Primary, Secondary, Tertiary, Quaternary structure of proteins
3. To develop knowledge on Visualization of proteins
4. To learn about the Protein translocation
5. To develop a piece of knowledge in enzyme-substrate reaction

Course Out Comes

6. After completing unit 1, the students will be able to know about Bio molecules
7. After completing unit 2, the students will be able to know about Structure of protein and Protein conformation
8. After completing unit 3, the students will be able to know about the Factors stabilizing proteins
9. After completing unit 4, the students will be able to know about the Protein translocation
10. After completing unit 5, the students will be able to know about General properties and characteristics of enzymes.

Matching Table (Put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	No	Yes	Yes	Yes	No
3	No	Yes	No	Yes	Yes	Yes
4	No	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

Units	Course Contents	Teaching hours
Unit I	Chemical basis of life; Composition of living matter; Water – properties, pH, ionization and hydrophobicity; Emergent properties of biomolecules in water; Biomolecular hierarchy; Macromolecules; Molecular assemblies; Structure-function relationships.	18 hours
Unit-II	Structure of protein, Protein conformation, Primary, Secondary, Tertiary, Quaternary structure of proteins, Fibrous proteins- Keratin and Collagen (associated diseases), Structure and function of hemoglobin and myoglobin (associated diseases), Chaperons and Chaperonins, □ Protein translocation– Secretory pathway, Protein modification- glycosylation and lipid addition, Protein sorting to Golgi bodies, Endoplasmic reticulum, Lysosomes, Mitochondria, Chloroplasts, peroxisomes, Nucleus, plasma membranes, Diseases associated with misfolding of proteins, Lysosomal degradation, Ubiquitinylation, Proteosome degradation	18 hours
Unit-III	Factors stabilizing proteins, Purification procedures, Visualization of proteins, Protein sequencing methods, objectives, principles, Different steps used to engineer proteins, Site directed mutagenesis technique	18 hours
Unit-IV	□ General properties and characteristics of enzymes, Transition state of an enzyme-substrate reaction, Key features of active site of enzymes, Michelis-Menton kinetics- k_m , V_{max} , k_{cat} , Competitive, Uncompetitive, Mixed (non-competitive), Allosteric regulation. Enzyme catalysis- Acid –Base catalysis, Covalent catalysis, Metal ion catalysis, Proximity and concentration effect on catalysis, Preferential binding of Transition State complex on catalysis, Enzyme engineering- in vitro mutagenesis.	18 hours
Unit-V	Anabolism and catabolism of carbohydrates, lipids, amino acids and nucleic acids.	18 hours
Total Teaching hours¹⁵		90

Internal Assessment Methods: (25 marks)

Distribution for internals	Test (CIA I + CIA II + CIA III)	Seminars	Assignment	Total marks
Marks	15	05	05	25

RECOMMENDED BOOKS:

1. Biochemistry – Lubert Stryer
2. Biochemistry- Donald Voet & Judith Voet
3. Harper’s Biochemistry- Murray, Robert K., Granner, Darryl K., Mayes, Peter A., and Rodwell, Victor W.
4. Lehninger’s Principles of Biochemistry- David L Nelson & Michael M Cox
5. Cell and Molecular Biology: Concepts and Experiments- Gerald Karp
6. The Cell – Bruce Alberts
7. The Cell – Geoffrey M. Cooper and Robert E. Hausman

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	2	3	3	3	2	3	3	3
CO2	3	3	2	3	3	3	2	3	2	2
CO3	3	3	2	3	3	3	2	2	2	2
CO4	3	3	2	3	3	3	2	3	2	3
CO5	3	3	2	3	3	3	2	2	3	3

Strong - 3, Medium – 2, Low - 1

Mapping with Programme Specific Outcomes

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	3	3	2	2	3	
CO2	3	3	2	2	3	
CO3	3	3	2	2	3	
CO4	3	3	2	2	3	
CO5	3	3	2	2	3	
Weightage	15	15	10	10	15	
Weighted percentage (rounded of) Course Contribution to POs	15	3	3	2	2	3

Strong - 3, Medium – 2, Low - 1

SEMESTER II**OPEN ELECTIVE 2: BIO ANALYTICAL TOOLS**

Paper code:

Subject: **BIO ANALYTICAL TOOLS****Hours/Week: 5**

Aim: To enable the students to understand the basic concepts microscopy,colorimetry,chromatography,electrophoresis.

Course Objectives

- 1.To learn the basic concept of microscope
- 2.To learn the concept of cell fractionation techniques
- 3.To develop knowledge on chromatography
- 4.To learn about the electrophoresis.
- 5.To develop a piece of knowledge in Nanotechnology

Course Out Comes

- 6.After completing unit 1, the students will be able to know about microscopy, florescence and spectroscopy.
- 7.After completing unit 2, the students will be able to know about cell fractionation techniques.
- 8.After completing unit 3, the students will be able to known about principle of chromatography
- 9.After completing unit 4, the students will be able to know about the Electrophoresis
- 10.After completing unit 5, the students will be able to know about Biosensors and Nanotechnology

Matching Table (Put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	No	Yes	Yes	Yes	No
3	No	Yes	No	Yes	Yes	Yes
4	No	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

Units	Course Contents	Teaching hours
Unit I	Simple microscopy, phase contrast microscopy, fluorescence and electron microscopy (TEM and SEM), pH meter, absorption and emission spectroscopy	18 hours
Unit-II	Principle and law of absorption fluorimetry, colorimetry, spectrophotometry (visible, UV, infrared), centrifugation, cell fractionation techniques, isolation of sub-cellular organelles and particles.	18 hours
Unit-III	Introduction to the principle of chromatography. Paper chromatography, thin layer chromatography, column chromatography: silica and gel filtration, affinity and ion exchange chromatography, gas chromatography, HPLC	18 hours
Unit-IV	□ Introduction to Electrophoresis. Starch-gel, polyacrylamide gel (native and SDS-PAGE), agarose-gel electrophoresis, pulse field gel electrophoresis, immuno- electrophoresis, isoelectric focusing, Western blotting.	18 hours
Unit-V	□ Introduction to Biosensors and Nanotechnology and their applications. Principles of Thermal Cycler , DNA Amplification using PCR technology , c DNA production & its use , Gene libraries & their uses , Production of oligotides	18 hours
Total Teaching hours		90

Internal Assessment Methods: (25 marks)

Distribution for internals	Test (CIA I + CIA II + CIA III)	Seminars	Assignment	Total marks
Marks	15	05	05	25

RECOMMENDED BOOKS:

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

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	2	2	2	3	3	3
CO2	3	2	2	3	3	2	3	3	2	2
CO3	3	2	2	3	3	3	3	2	2	2
CO4	3	3	3	2	2	2	3	3	2	3
CO5	3	2	2	3	2	3	2	2	3	3

Strong - 3, Medium – 2, Low - 1

Mapping with Programme Specific Outcomes

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	3	3	3
CO2	3	2	3	3	3
CO3	3	2	3	3	3
CO4	3	2	3	3	3
CO5	3	2	3	3	3
Weightage	15	10	15	15	15
Weighted percentage (rounded of) Course Contribution to POs	3	2	3	3	3

Strong - 3, Medium – 2, Low - 1

SEMESTER II**OPEN ELECTIVE 3: Cell Biology**

Paper code:

Subject :**Cell Biology**

Hours/Week: 5

Aim: To enable the students to understand the basic concepts of Structural organization and basic functions of Biomembranes, Cell Function, Microscopy.

Course Objectives

- 1.To learn the basic concept of Biomembranes and Extracellular matrix
- 2.To learn the concept of Biochemical functions of mitochondria.
- 3.To develop knowledge on Ras and MAP kinase pathways
- 4.To learn about the Stem Cell ,Cell cloning,Cell Culture.
- 5.To develop a piece of knowledge in Cell Function

Course Out Comes

1. After completing unit 1, the students will be able to know about Structural organization and basic functions of Bio membranes and Extracellular matrix
2. After completing unit 2, the students will be able to know about Mitochondria and Nucleus
3. After completing unit 3, the students will be able to know about Receptor Tyrosine kinase, Ras and MAP kinase pathways
4. After completing unit 4, the students will be able to know about the Integration of cells into tissues
5. After completing unit 5, the students will be able to know about Cell Function

Matching Table (Put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	No	Yes	Yes	Yes	No
3	No	Yes	No	Yes	Yes	Yes
4	No	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

Units	Course Contents	Teaching hours
Unit I	The phospholipids bilayer, Membrane proteins, RBC membrane, Mobility of membrane proteins, Fluorescence recovery after photobleaching (FRAP), the Glycocalyx. Singer & Nicholson's Fluid mosaic model. Matrix structural proteins, matrix Polysaccharides, Matrix adhesion proteins, Adhesion junction, Tight junctions, Gap junctions – disease relevance. Passive diffusion, Facilitated diffusion and Carrier proteins, Passive and active transport, Inter-cellular transport of glucose, Ion Channels (Plasma membrane Na ⁺ and K ⁺ pump ATPase, Na ⁺ and K ⁺ channel, Ca ⁺⁺ pump and three main types of Ca ⁺⁺ channels, H ⁺ pump, ABC transporter, Multidrug resistant protein (MDR), Nicotinic acetylcholine receptor. Action potential and propagation of nerve impulse, patch clamp recording technique, Transmitter gated ion channels excitatory, inhibitory.	18 hours
Unit-II	Structure, Biochemical functions of mitochondria, Electron Transport chain, Chemiosmotic coupling, Transport of metabolites, Protein import (TIM, TOM, OXA complexes) mitochondrial assembly, Brown fat. Structure of the Nuclear envelope, The Nuclear pore complex, Selective transport of proteins to and from the nucleus, Regulation of Nuclear protein import, Transport of RNAs, Internal organization of the nucleus, Chromosomes, Nuclear lamina diseases. Importance of telomere and telomerase	18 hours
Unit-III	Structure, Dimerization, Autophosphorylation, Src protein tyrosine kinase, SH2 domain binding, Insulin receptor is a tyrosine specific protein kinase, Signaling proteins that act via receptor tyrosine kinases, Dominant negative inhibition by mutant receptor, PTK inhibitors, JAK-	18 hours

	STAT pathway. Ras activation by GEFs, Membrane localization and activation of Ras, Regulation of Ras activity by GAPs, Grb-2, Sos, Oncogenic property and function of Ras. Pathway and function significance, ERK, P38, JNK and disease relevance, Induction of immediate early genes by ERK.	
Unit-IV	<p>□ Stem Cell : three major sources of stem cell, types of Stem cells Division, Epidermis and its renewal by stem cell , Blood cell formation from Bone marrow stem cell, Embryonic stem cell and therapeutic cloning , Bone marrow transplantation versus Stem cell transplantation and GVHD. Cell cloning: Somatic cell Nuclear transfer for Cloning (Reproductive Cloning), Cloning and Transgenic animal product (Hybrid cloning), Nuclear reprogramming and factors affecting it. Cell Culture: General considerations of cell culture: Sterilization , Media , Carbon dioxide incubator, Feeder layer, Substrates on which cells grow , Contamination , Types of Culture (organ, Organotypic , single cell , Histotypic / 3D) etc.</p>	18 hours
Unit-V	<p>□ Cell cycle Different phases, Maturation promoting factor, Families of cyclins and cyclin dependent kinases, Regulation and cell cycle checkpoints, Inhibitors of cell cycle progression, M phase- Mitosis and Meiosis, Cytokinesis, Fertilization. Microscope and its modifications – Light, phase contrast and interference, Fluorescence, Confocal, Electron (TEM and SEM), Atomic Force Microscopy, Immunofluorescence microscopy.</p>	18 hours
Total Teaching hours		90

Internal Assessment Methods: (25 marks)

Distribution for internals	Test (CIA I + CIA II + CIA III)	Seminars	Assignment	Total marks
Marks	15	05	05	25

RECOMMENDED BOOKS:

1. Cell and Molecular Biology: Concepts and Experiments- Gerald Karp
2. The cell – Bruce Alberts
3. The Cell – Geoffrey M. Cooper and Robert E. Hausman
4. Molecular Cell Biology- Harvey Lodish, Arnold Berk, S. Lawrence Zipursky, Paul Matsudaira, David Baltimore, and James Darnell
5. Lehninger's Principles of Biochemistry- David L Nelson & Michael M Cox

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	2	3	3	3	2	3	3	3
CO2	3	3	2	3	3	3	2	3	2	2
CO3	3	3	2	3	3	3	2	2	2	2
CO4	3	3	2	3	3	3	2	3	2	3
CO5	3	3	2	3	3	3	2	2	3	3

Strong - 3, Medium – 2, Low - 1

Mapping with Programme Specific Outcomes

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	2	2	3
CO2	3	3	2	2	3
CO3	3	3	2	2	3
CO4	3	3	2	2	3
CO5	3	3	2	2	3
Weightage	15	15	10	10	15
Weighted percentage (rounded of) Course Contribution to POs	3	3	2	2	3

Strong - 3, Medium – 2, Low - 1

SEMESTER II**COMPULSORY PAPER 1: Clinical Research**

Hours/Week: 5 Credits: 2

Aim: To enable the students to understand the basic concepts is to impart the knowledge of clinical research which can be used for drug discovery and development.

Course Objectives

- 1.To learn the basic concept of Clinical Research and Clinical Practice
- 2.To learn the concept of Drug Discovery and Development
- 3.To develop knowledge on Preclinical drug testing 16
- 4.To learn about the Safety monitoring in clinical trials
- 5.To develop a piece of knowledge in Clinical Data Coding

Course Out Comes

6. After completing unit 1, the students will be able to know about Introduction to Clinical Research.

7. After completing unit 2, the students will be able to know about Introduction, Hurdles in Drug Development Sources of Drugs

8. After completing unit 3, the students will be able to know about Preclinical Studies

9. After completing unit 4, the students will be able to know about Clinical Development

10. After completing unit 5, the students will be able to know about Clinical Trials Conflict of interest in Clinical research

Matching Table (Put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	No	Yes	Yes	Yes	No
3	No	Yes	No	Yes	Yes	Yes
4	No	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

Units	Course Contents	Teaching hours
Unit I	Introduction to Clinical Research Terminologies and definition in Clinical Research Origin and History of Clinical Research Difference between Clinical Research and Clinical Practice Types of Clinical Research Phases of clinical research Clinical Trials in India –The National Perspective Post marketing surveillance Pharmaceutical Industry – Global and Indian Perspective	18 hours
Unit-II	Introduction to Pharmacology Concept of Essential Drugs Routes of Drug Administration Introduction to Drug Discovery and Development Hurdles in Drug Development Sources of Drugs Approaches to Drug Discovery Pharma co vigilance Factors affecting drug response	18 hours
Unit-III	Guidelines For Care And Use Of Laboratory Animals Introduction To Preclinical Pharmacology Introductory Talk on Animal studies : present status Pre – Clinical Toxicity Lab Animals in Pharmacology Preclinical drug testing Calculation of first human dose Investigational New Drug Application Clinical trials 16 New Drug Application and Approval	18 hours

Unit-IV	<input type="checkbox"/> Research question Case report form Informed Consent Preparing data collection forms Protocol writing New drug discovery process-purpose, main steps involved in new drug discovery process, timelines of each steps, advantages and purposes of each steps, ethics in clinical research, unethical trials, Phase-I, II, III, IV trials. -Introduction and designing -Principles of sampling -Inclusion and exclusion criteria -Methods of allocation and randomization -Informed consent process in brief -Termination of trial -Safety monitoring in clinical trials	18 hours
Unit-V	<input type="checkbox"/> Audit/ Inspection Fraud and Misconduct in Clinical Trials Conflict of interest in Clinical research Vaccine trails in children Bio availability and Bio equivalence How to fill an ADR reporting form and methods for causality assessment Risk to benefit ratio bias and confounding factor Uses of placebo. Clinical data management (CDM): Introduction, CRF Design, Electronic Data Capture, Data Validation, Discrepancy Management, Clinical Data Coding, SAE Reconciliation, Archiving clinical data	18 hours
Total Teaching hours		90

Internal Assessment Methods: (25 marks)

Distribution for internals	Test (CIA I + CIA II + CIA III)	Seminars	Assignment	Total marks
Marks	15	05	05	25

RECOMMENDED BOOKS:

- 1 Basic and Clinical Pharmacology, Prentice hall, International, Katzung, B.G.
2. Remington Pharmaceutical Sciences, Lippincott, Williams and Wilkins
3. Drug interaction, Basic Business Publ, Bombay, J.K. Mehra
4. Central Drugs Standard Control Organization. Good Clinical Practices-Guidelines for Clinical Trials on Pharmaceutical Products in India. New Delhi: Ministry of Health; 2001.
5. International Conference on Harmonization of Technical requirements for registration of Pharmaceuticals for human use. ICH Harmonized Tripartite Guideline. Guideline for Good Clinical Practice.E6; May 1996
6. Ethical Guidelines for Biomedical Research on Human Subjects 2000. Indian Council of Medical Research, New Delhi

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	2	2	2	3	3	3
CO2	3	2	2	3	3	2	3	3	2	2
CO3	3	2	2	3	3	3	3	2	2	2
CO4	3	3	3	2	2	2	3	3	2	3
CO5	3	2	2	3	2	3	2	2	3	3

Strong - 3, Medium – 2, Low - 1

Mapping with Programme Specific Outcomes

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	3	3	3
CO2	3	2	3	3	3
CO3	3	2	3	3	3
CO4	3	2	3	3	3
CO5	3	2	3	3	3
Weightage	15	10	15	15	15
Weighted percentage (rounded of) Course Contribution to POs	3	2	3	3	3

Strong - 3, Medium – 2, Low - 1

SEMESTER III**CORE PAPER 1: Advance Immunology**

Paper code:

Subject: **Advance Immunology**

Hours/Week: 5 Credits: 4

Aim: To enable the students to understand the basic concepts of the Antibody structure and function , molecular genetics of antibodies, cell interaction in antibody production, biology of T and B cells, Cytokines, lymphatic system, cell mediated immunity.

Course Objectives

- 1.To learn the basic concept of discovery of antibodies, interaction of antibodies with antigens.
- 2.To learn the concept of antibody gene organization and non germ line generation of diversity.
- 3.To develop knowledge on interaction of T and B cells.
- 4.To learn about the cell receptors and regulation of immune response.
- 5.To develop a piece of knowledge in cytokines , lymphatic system .

Course Out Comes

6. After completing unit 1, the students will be able to identify the basic concept of Antibodies and its biological functions, Antibodies as cell membrane antigen receptors.

7. After completing unit 2, the students will be able to know about the antibody gene rearrangement, immunoglobulin gene transcription, humanizing of antibodies for therapy.

8. After completing unit 3, the students will be able to know about the MHC and mouse strain, T and B cells, Antigen processing.

9. After completing unit 4, the students will be able to know about the T cell receptor, CD3 complex,

T cell and B cell markers, B cell tolerance.

10. After completing unit 5, the students will be able to know about cytokines, IL2, Helper T cells.

Matching Table (Put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	No	Yes	Yes	Yes	No
3	No	Yes	No	Yes	Yes	Yes
4	No	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

Units	Course Contents	Teaching hours
Unit I	<p>The lymphatic system and the immune response</p> <ul style="list-style-type: none"> - The lymphatic system - Cells of the immune system - Cell migration and adhesion molecules <p>Antibody structure and function</p> <ul style="list-style-type: none"> - Discovery of antibodies - Interaction of antibodies with antigen - Biological functions of antibodies - Antibodies as cell membrane antigen receptors - Antibodies as biotechnological tools 	18 hours
Unit-II	<p>Molecular genetics of antibodies</p> <ul style="list-style-type: none"> - Discovery of antibody gene rearrangement - Antibody gene organization - The basic DNA rearrangement mechanism - Diversity based on germline genes - Non-germline generation of diversity - VH gene usage and CD5 B cells - A novel VH to VHDj joining mechanism in pre-B cells and mature B cells - Class (isotype) switching - The production of membrane and secreted forms of antibodies - Regulation of immunoglobulin gene transcription <p>Molecular genetic approaches to the humanizing of antibodies for therapy</p>	18 hours
Unit-III	<p>Cell interaction in antibody production</p> <ul style="list-style-type: none"> - Landmark experiment on cell interactions in the humoral response - The major histocompatibility complex - MHC and mouse strains - T and B cell interactions - Antigen processing and presentation 	18 hours
Unit-IV	<p>Biology of T and B cells</p> <ul style="list-style-type: none"> - The T cell receptor - T cell receptor genes - Cell surface molecules on lymphoid cells - The CD3 complex - Other accessory molecules involved in cell interactions and T cell activation - Maturation of T cells in the thymus - T cell and B cell markers - T helper and B cell activation - Regulation of the immune response by suppressor T cells - B cell tolerance - A comparison of T and B cells 	18 hours

Unit-V	Cytokines – the intercellular messengers - Antigen specific factors - General properties of cytokines - IL-2 - Cytokines involved in T / B activation - Cytokines and T cell activation - Cytokines and B cell activation - Ig class switching and production of isotypes - Helper T cell subsets - Antibody synthesis - Antibody production in vivo - Disease caused by antibodies – the hypersensitivity reactions	18 hours
Total Teaching hours		90

Internal Assessment Methods: (25 marks)

Distribution for internals	Test (CIA I + CIA II + CIA III)	Seminars	Assignment	Total marks
Marks	15	05	05	25

Reference Book:

- Immunobiology by Janeway Roitt
- Kuby
- Cellular Immunology - Biotol Fudenberg

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	2	3	3	3	2	3	3	3
CO2	3	3	2	3	3	3	2	3	2	2
CO3	3	3	2	3	3	3	2	2	2	2
CO4	3	3	2	3	3	3	2	3	2	3
CO5	3	3	2	3	3	3	2	2	3	3

Strong - 3, Medium – 2, Low - 1

Mapping with Programme Specific Outcomes

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	2	2	3
CO2	3	3	2	2	3
CO3	3	3	2	2	3
CO4	3	3	2	2	3
CO5	3	3	2	2	3
Weightage	15	15	10	10	15
Weighted percentage (rounded of) Course Contribution to POs	3	3	2	2	3

Strong - 3, Medium – 2, Low - 1

SEMESTER III

CORE PAPER 2 : Bio pharmaceutical Biotechnology.

Hours/Week: 5 Credits: 4

Aim: To enable the students to understand the basic concepts of the Production and downstream processing of biotech products, formulation of biotech products, pharmacokinetics and pharmacodynamics of peptides and protein drugs, biotechnology related techniques, gene therapy, and hematopoietic growth factors.

Course Objectives

- 1.To learn the basic concept of expression, cultivation and down stream processing.
- 2.To learn the concept of microbial consideration, delivery of proteins .
- 3.To develop knowledge on elimination and distrubution of proteins therapeutics.
- 4.To learn about the protein engineering, genetically engineered animals, drug delivery.
- 5.To develop a piece of knowledge in gene therapy, hematopoietic growth factors.

Course Out Comes

- 6.After completing unit 1, the students will be able to identify the basic concept of expression, cultivation, contaminants and down¹⁷ stream processing.
- 7.After completing unit 2, the students will be able to know about the formulation of biotech products, including biopharmaceutical consideration.

8. After completing unit 3, the students will be able to know about the pharmacokinetics and pharmacodynamics of peptides and protein drugs..

9. After completing unit 4, the students will be able to know about the genomic, proteomic and biotechnology related techniques.

10. After completing unit 5, the students will be able to know about gene therapy and pharmaceutical production.

Matching Table (Put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	No	Yes	Yes	Yes	No
3	No	Yes	No	Yes	Yes	Yes
4	No	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

Units	Course Contents	Teaching hours
Unit I	<p>Production and downstream processing of biotech products</p> <ul style="list-style-type: none"> - Expression system - Cultivation systems - Cultivation medium - Contaminants - Downstream processing - Issues to consider in production and purification of proteins <p>Formulation of biotech product including bio pharmaceutical Considerations</p> <ul style="list-style-type: none"> - Microbiological consideration - Excipients used in Parental formulations of Biotech products - Shelf life of protein based pharmaceuticals - Delivery of proteins: Routes of administration and adsorption enhancement Approaches for rate controlled and target site specific - Delivery by the parental route 	18 hours
Unit-II	<p>Pharmacokinetics and Pharmacodynamics of peptide and protein drugs</p> <ul style="list-style-type: none"> - Elimination of protein therapeutics - Distribution of protein therapeutics - Pharmacodynamics of protein therapeutics - Inter species scaling - Heterogeneity of protein therapeutics - Chemical modification of protein therapeutics - Immunogenicity 	18 hours

Unit-III	Genomics, Proteomics and additional biotechnology-related techniques <ul style="list-style-type: none"> - Genomics, proteomics and pharmacogenetics/genomics - Genetically engineered animals - Protein engineering - Peptide chemistry and peptidomimetics - Nucleic acid technologies - Catalytic antibodies - Tissue engineering - Glycobiology - Biotechnology and drug discovery 	18 hours
Unit-IV	Gene therapy <ul style="list-style-type: none"> - <i>Ex vivo</i> versus <i>in vivo</i> gene therapy - Potential target diseases for gene therapy - Gene transfer methods - Non-viral gene transfer - Gene transfer using Recombinant viruses - Clinical studies - Pharmaceutical Production and regulation 	18 hours
Unit-V	Hematopoietic Growth Factors <ul style="list-style-type: none"> - Hematopoiesis - Chemical description of hematopoietic growth factors - Pharmacology - Cellular sources and stimuli for release - Physiologic role of G-CSF, GM-CSF, EPO, SCF, Thrombopoietins - Pharmaceutical issues - Clinical and practical aspects - Toxicities - Other uses and new formulation 	18 hours
Total Teaching hours		90

Internal Assessment Methods: (25 marks)

Distribution for internals	Test (CIA I + CIA II + CIA III)	Seminars	Assignment	Total marks
Marks	15	05	05	25

Reference Book:

1. Crommelin Gary Walsh

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	2	2	2	3	3	3
CO2	3	2	2	3	3	2	3	3	2	2
CO3	3	2	2	3	3	3	3	2	2	2
CO4	3	3	3	2	2	2	3	3	2	3
CO5	3	2	2	3	2	3	2	2	3	3

Strong - 3, Medium – 2, Low - 1

Mapping with Programme Specific Outcomes

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	3	3	3
CO2	3	2	3	3	3
CO3	3	2	3	3	3
CO4	3	2	3	3	3
CO5	3	2	3	3	3
Weightage	15	10	15	15	15
Weighted percentage (rounded of) Course Contribution to POs	3	2	3	3	3

Strong - 3, Medium – 2, Low - 1

SEMESTER III**PAPER 3 : Animal Tissue culture.**

Hours/Week: 5 Credits: 4

Aim: To enable the students to understand the basic concepts of the introduction and outline of animal tissue culture, animal cell culture media, characterization and preservation of cell lines, hybridoma and large scale animal cell culture.

Course Objectives

1. To learn the basic concept of animal tissue culture and maintaining of culture.
2. To learn the concept of natural media , synthetic media and role of serum in cell culture.
3. To develop knowledge on characterization of cell lines and cell types .
4. To learn about the preservation of animal cell lines.
5. To develop a piece of knowledge in hybridoma, large scale animal cell culture.

Course Out Comes

6. After completing unit 1, the students will be able to identify the basic concept of animal tissue culture and stages in cell culture and also the safety in cell culture laboratory.
7. After completing unit 2, the students will be able to know about the cell culture media , role of serum in cell culture and also the medium for different cell types.
8. After completing unit 3, the students will be able to know about the characterization of cell lines and stage of differentiation microbial contamination.
9. After completing unit 4, the students will be able to know about the preservation and freezing of cell .
10. After completing unit 5, the students will be able to know about hybridoma .

Matching Table (Put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	No	Yes	Yes	Yes	No
3	No	Yes	No	Yes	Yes	Yes
4	No	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

Units	Course Contents	Teaching hours
Unit I	Introduction to animal tissue culture Historical background The application of tissue culture Terminology Stages in cell culture Outline of the key techniques of animal cell culture Setting up the laboratory Culturing cells Maintaining the culture Quantification of cells in cell culture Cloning and selecting cell lines Physical methods of cell separation Hazards and safety in the cell culture laboratory	18 hours
Unit-II	Animal cell culture media General cell culture media design Natural media Synthetic media Further considerations in media formulation Nutritional components of media The role of serum in cell culture Choosing a medium for different cell types	18 hours

Unit-III	Characterization of cell lines Species verification Intra-species contamination Characterization of cell type and stage of differentiation Microbial contamination	18 hours
Unit-IV	Preservation of animal cell lines Variation and instability in cell lines Preservation of cell lines Freezing of cells Thawing of cells Quantification of cell viability Cell banks	18 hours
Unit-V	Hybridomas The limitation of traditional antibody preparation The basis of hybridoma technology The details of hybridoma technology Long term storage of hybridoma cell lines Contamination Hybridomas from different species Human hybridomas Commercial scale production of monoclonal antibodies Large scale animal cell culture Culture parameters Scale up of anchorage-dependant cells Culture vessels Suspension culture	18 hours
Total Teaching hours		90hours

Internal Assessment Methods: (25 marks)

Distribution for internals	Test (CIA I + CIA II + CIA III)	Seminars	Assignment	Total marks
Marks	15	05	05	25

Reference Book:

- 1) Cell and Tissue Culture: Lab Procedures in Biotechnology Alan Doyle (ed) J. Bryan Griffith (ed)
- 2) Freshney John Paul

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	2	3	3	3	2	3	3	3
CO2	3	3	2	3	3	3	2	3	2	2
CO3	3	3	2	3	3	3	2	2	2	2
CO4	3	3	2	3	3 ₁₇	3	2	3	2	3
CO5	3	3	2	3	3	3	2	2	3	3

Strong - 3, Medium – 2, Low – 1

Mapping with Programme Specific Outcomes

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	2	2	3
CO2	3	3	2	2	3
CO3	3	3	2	2	3
CO4	3	3	2	2	3
CO5	3	3	2	2	3
Weightage	15	15	10	10	15
Weighted percentage (rounded of) Course Contribution to POs	3	3	2	2	3

Strong - 3, Medium – 2, Low - 1

SEMESTER III

CORE PAPER 4: DEVELOPMENTAL BIOLOGY AND STEM CELLS

Hours/Week: 5 Credits: 4

Aim: To enable the students to understand the basic concepts of the to develop insight of embryonic development of various organisms, with emphasis on human embryonic development. The course is designed include development at various levels

Course Objectives

- 1.To learn the basic concept of Developmental Biology
- 2.To learn the concept of Mechanisms of Cleavage
- 3.To develop knowledge on Gastrulation in Major Groups of Organisms
- 4.To learn about the Axis Formation
- 5.To develop a piece of knowledge in Epidermis, Mesoderm, Endoderm differentiation, Cell Death, Front Limb vs. Hind Limb Formation

Course Out Comes

- 6.After completing unit 1, the students will be able to identify the basic concept Introduction, Origins and History to Developmental Biology,
- 7.After completing unit 2, the students will be able to know about the Cleavage

8. After completing unit 3, the students will be able to know about Gastrulation

9. After completing unit 4, the students will be able to know about the Axis Formation

10. After completing unit 5, the students will be able to know about Later Embryonic Development

Matching Table (Put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	No	Yes	Yes	Yes	No
3	No	Yes	No	Yes	Yes	Yes
4	No	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

Units	Course Contents	Teaching hours
Unit I	Introduction to Developmental Biology Origins and History, Early Beliefs Gametogenesis, Fertilization, Mechanisms of Preventing Polyspermy, Fertilized-Egg Activation	18 hours
Unit-II	Mechanisms of Cleavage, Cleavage Patterns, Holoblastic, Cleavage: Isolecithal and Mesolecithal; Meroblastic Cleavage: Telolecithal and Centrolecithal; Cleavage Patterns in Major Groups of Organisms; Cell Specification	18 hours
Unit-III	Cell Movements, Germ Layers, Gastrulation in Major Groups of Organisms	18 hours
Unit-IV	Types of Axes, Axis Formation in Drosophila, Amphibians, Birds Mammals	18 hours
Unit-V	The Central Nervous System (CNS) and Epidermis, Mesoderm, Endoderm differentiation, Cell Death, Front Limb vs. Hind Limb Formation	18 hours
Unit-VI	Sex Determination, Dosage Compensation, Unusual Sex Determination, Environmental Sex Determination, Metamorphosis, Regeneration	05 hours
Total Teaching hours		90hours

Internal Assessment Methods: (25 marks)

Distribution for internals	Test (CIA I + CIA II + CIA III)	Seminars	Assignment	Total marks
Marks	15	05	05	25

Reference Book:

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1) Developmental Biology, Eighth Edition, Scott F. Gilbert, Susan Singer, Publisher: Sinauer Associates Inc.; ISBN-13: 978- 0878932504

2) Developmental Biology: A Very Short Introduction, Lewis Wolpert, Publisher: Oxford University, ISBN-13: 978- 0199601196

3) Essential Developmental Biology, Jonathan M. W. Slack Publisher: Wiley-Blackwell; 3 edition, ISBN-13: 978- 0470923511

4) Stem cells – Elsevier : CS Potten , 1997.

5) Essentials of stem cell biology , Robert Paul Lanza ,2006.

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	2	2	2	3	3	3
CO2	3	2	2	3	3	2	3	3	2	2
CO3	3	2	2	3	3	3	3	2	2	2
CO4	3	3	3	2	2	2	3	3	2	3
CO5	3	2	2	3	2	3	2	2	3	3

Strong - 3, Medium – 2, Low - 1

Mapping with Programme Specific Outcomes

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	3	3	3
CO2	3	2	3	3	3
CO3	3	2	3	3	3
CO4	3	2	3	3	3
CO5	3	2	3	3	3
Weightage	15	10	15	15	15
Weighted percentage (rounded of) Course Contribution to POs	3	2	3	3	3

Strong - 3, Medium – 2, Low - 1

SEMESTER III
ELECTIVE 1 : RESEARCH METHODOLOGY AND SOCIO- ETHICAL
ASPECTS OF BIOTECHNOLOGY

Paper code: Subject: **RESEARCH METHODOLOGY AND SOCIO-ETHICAL ASPECTS OF BIOTECHNOLOGY**

Hours/Week: 5 Credits: 3

Aim: To enable the students to understand the basic concepts of research methodology and biostatistics used in biotechnology research as well as to aware them the legal, safety and public policy issues raised due to the progress in Biotechnology and development of new products as well as regulatory framework governing processing of bio-products

Course Objectives

- 1.To learn the basic concept of Introduction, Defining Research Problem, Research Design, Sampling Design.
- 2.To learn the concept of instrumentation
- 3.To develop knowledge on ethical concerns of biotechnology research
- 4.To learn about the Biosafety
- 5.To develop a piece of knowledge in Environment protection.

Course Out Comes

- 6.After completing unit 1, the students will be able to identify the basic concept Research Methodology
- 7.After completing unit 2, the students will be able to know about the Bioinstrumentations
- 8.After completing unit 3, the students will be able to know about Bioethics
- 9.After completing unit 4, the students will be able to know about the Introduction to IPR
- 10.After completing unit 5, the students will be able to know about Bio safety

Matching Table (Put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	No	Yes ¹⁸	Yes	Yes	No
3	No	Yes	No	Yes	Yes	Yes
4	No	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

Units	Course Contents	Teaching hours
Unit I	Introduction, Defining Research Problem, Research Design, Sampling Design, Methods of Data Collection, Interpretation and report writing	18 hours
Unit-II	Centrifugation: Basic concept, Ultra Centrifugation, Density Gradient Centrifugation, Differential Centrifugation, Isopycnic Centrifugation Spectroscopy: Basic concept, UV/Visible Spectroscopy, Circular Dichroism (CD) & Optical Rotary Dispersion (ORD), Fluorescent Spectroscopy, Infra Red Spectroscopy, FTIR, Mass Spectroscopy, MALDI- TOF Radiography: Tracer Elements in Biology, Radio Active isotopes, Half Life of isotopes, Autoradiography, Pulse Chase experiment, Cerenkov radiation, Liquid Scintillation Counting, Phosphor Imaging	18 hours
Unit-III	Bioethics- History & Introduction; Social, Legal & Ethical Issues in biotechnology, ethical concerns of biotechnology research, Bioethics Committees Animal ethics- Norms in India-Licensing of animal house- Ethical clearance norms for conducting studies on human subjects, IAEC	18 hours
Unit-IV	Introduction to IPR, IPR in India, IPR in abroad, Types of IPR- Patent, Copyright, Trademark, Design & Trade Secret Biotechnology & IPR- Commercial potential of biotechnology inventions; Patenting Biotechnological Inventions- Objective, Concept of novelty, Concept of inventive step, Microorganism, Moral issues in patenting biotechnological inventions. Plant Varieties Protections- Objective, Justification, International position, Plant Variety Protection in India.	18 hours
Unit-V	Introduction a& development of Biosafety; Practices & Principles; General lab equipments; Definitions & Biosafety levels, 1, 2, 3, 4,.; Biological safety cabinets, centrifuge; Shipment of biological specimens; Biological waste management; Decontaminations, Biosafety manuals; Medical surveillance, Emergency response. Global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust, Wasteland reclamation: Case studies. Environment protection Acts: Air (Prevention and control of Pollution) Act. Water (Prevention and control of Pollution) Act Wildlife protection Act. Forest Conservation Act. Issues involved in enforcement of environmental legislation.	18 hours
Total Teaching hours		90hours

Internal Assessment Methods: (25 marks)

Distribution for internals	Test (CIA I + CIA II + CIA III)	Seminars	Assignment	Total marks
Marks	15	18	05	25

Reference Book:

1. Research Methodology- Methods & Techniques by C. R. Kothari
2. Principles & Techniques of Biochemistry & Molecular Biology by Wilson & Walker
3. Methods in Biostatistics by B. K. Mahajan
4. Fundamentals of Biostatistics by Khan & Khanum
5. Fundamentals of Biostatistics by U.B.Rastog
6. T. M. Murray & M. J. Mehlman, Encyclopedia of ethical, legal and policy issues in biotechnology, John Wiley & sons 2000.
7. Ethical Issues in Biotechnology by Richard Sherlock & John D. Morrey, Rowman & Littlefield Publishers
8. Agarwal, K.. 2001 Environmental Biology, Nidi Publ. Ltd. Bikane

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	2	3	3	3	2	3	3	3
CO2	3	3	2	3	3	3	2	3	2	2
CO3	3	3	2	3	3	3	2	2	2	2
CO4	3	3	2	3	3	3	2	3	2	3
CO5	3	3	2	3	3	3	2	2	3	3

Strong - 3, Medium – 2, Low - 1

Mapping with Programme Specific Outcomes

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	2	2	3
CO2	3	3	2	2	3
CO3	3	3	2	2	3
CO4	3	3	2	2	3
CO5	3	3	2	2	3
Weightage	15	15	10	10	15
Weighted percentage (rounded of) Course Contribution to POs	3	3	2	2	3

Strong - 3, Medium – 2, Low - 1
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SEMESTER III**ELECTIVE 2 : Industrial Biotechnology**

Paper code: Subject: **Industrial Biotechnology**

Hours/Week: 5

Aim: To enable the students to understand the basic concepts of aware of the overall industrial bio processes which requires for understanding the process and industrial demands.

Course Objectives

1. To learn the basic concept of Batch process, continuous process, recycled and non-recycled processes,
liquid & solid state of fermentation
2. To learn the concept of : Bio separation; filtration, membrane filtration, Centrifugation sedimentation,
3. To develop knowledge on Immobilized systems
4. To learn about the Concept of control, basic control theory, turbidostatic & chemo-static control.
5. To develop a piece of knowledge in Production of recombinant proteins

Course Out Comes

6. After completing unit 1, the students will be able to identify the basic concept Bioreactor Technology
7. After completing unit 2, the students will be able to know about the Down stream processing
8. After completing unit 3, the students will be able to know about Immobilized systems
9. After completing unit 4, the students will be able to know about the Scale up, unit processes
10. After completing unit 5, the students will be able to know about Production of recombinant proteins.

Matching Table (Put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	No	Yes	Yes	Yes	No
3	No	Yes	No	Yes	Yes	Yes
4	No	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

Units	Course Contents	Teaching hours
Unit I	Types of bioreactors: Plug flow reactors, continuously stirred tank flow reactors, loop reactors, air lift reactors, fed batch reactors, fluidized bed reactors, rotatory disc reactors. Concept of Batch process, continuous process, recycled and non-recycled processes, liquid & solid state of fermentations. Concept of bioreactor designing & process optimization, mass transfer, heat transfer, mixing rheology of fermentation fluids, mean residence time, substrate utilization rate, oxygenation, oxygen sag, yield coefficient.	18 hours
Unit-II	Down stream processing: Bioseparation; filtration, membrane filtration, centrifugation sedimentation, flocculation, purification, solvent extraction, counter current extraction, ion exchange, affinity techniques, concentration, crystallization, reverse osmosis, ultrafiltration, drying, storage and packaging.	18 hours
Unit-III	Absorption, covalent bonding, entrapment, encapsulation, cross linking, types of reactors, diffusion characteristics, effective factors, instability factors, deactivation rates, relative length of half life	18 hours
Unit-IV	. Concept of control, basic control theory, turbidostatic & chemostatic control. Basic principles of scale up, working parameters UNIT processes- production of enzymes, antibiotics Biosensor technology	18 hours
Unit-V	Production of recombinant proteins having therapeutic and diagnostic applications, vaccines. Bioprocess strategies in Plant Cell and Animal Cell culture	18 hours
Total Teaching hours		90hours

Internal Assessment Methods: (25 marks)

Distribution for internals	Test (CIA I + CIA II + CIA III)	Seminars	Assignment	Total marks
Marks	15	05	05	25

Reference Book:

1. H. Patel “ Industrial Microbiology” Macmillan
2. Prescott, S.C. and Cecil G. Dunn, “Industrial Microbiology”, Agrobios (India), 2005 .
3. Cruger, Wulf and Anneliese Crueger, “Biotechnology: A Textbook of Industrial Microbiology”, 2nd Edition, Panima Publishing, 2000.
4. C.F.A Bryce and EL.Mansi, Fermentation microbiology & Biotechnology, 1999.
5. K.G.Ramawat & Shaily Goyal, Comprehensive Biotechnology, 2009, S.Chand publications.
6. Bionanotechnology: Lesson from Nature, David S. Goodsell, Willey-Liss, First edition, 2004
7. Industrial microbiology: An introduction. Mike J. Waites, Neil Morgan, John Rackey, Gary Higton, John S. Rockey
8. Bioreactor recovery in bioprocess technology. Biotol Series
9. Principles of fermentation technology. P. F. Stanbury et al.

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	2	2	2	3	3	3
CO2	3	2	2	3	3	2	3	3	2	2
CO3	3	2	2	3	3	3	3	2	2	2
CO4	3	3	3	2	2	2	3	3	2	3
CO5	3	2	2	3	2	3	2	2	3	3

Strong - 3, Medium – 2, Low - 1

Mapping with Programme Specific Outcomes

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	3	3	3
CO2	3	2	3	3	3
CO3	3	2	3	3	3
CO4	3	2	3	3	3
CO5	3	2	3	3	3
Weightage	15	10	15	15	15
Weighted percentage (rounded of) Course Contribution to POs	18	3	2	3	3

Strong - 3, Medium – 2, Low - 1

SEMESTER III**ELECTIVE 3 : Developmental Biology and Human Physiology**

Paper code: Subject: Developmental Biology and Human Physiology

Hours/Week: 5

Aim: To enable the students to understand the basic concepts of understanding on objectives of statistics and computations

Course Objectives

- 1.To learn the basic concept of overview of developmental biology and its key concepts
- 2.To learn the concept of the actual pathway of physiological metabolism of major invertebrates and vertebrates including humans.
- 3.To develop knowledge on the mechanism behind functioning and maintenance of various living system
- 4.To learn about the Role of epigenetics in development.
- 5.To develop a piece of knowledge in Thermoregulation

Course Out Comes

- 6.After completing unit 1, the students will be able to identify the basic concept of the importance of embryology (historical review) and more recently developmental biology as an emerging discipline and science.
- 7.After completing unit 2, the students will be able to know about the developmental biology with respect to anatomy, physiology and evolution in selected Invertebrates and Vertebrates species.
- 8.After completing unit 3, the students will be able to know about early embryonic development (fertilization, early cleavage, blastula, gastrula, neurula) in Vertebrates including frog, chicken and mouse and Invertebrates.
- 9.After completing unit 4, the students will be able to know about the the molecular pathways controlling axis formation
- 10.After completing unit 5, the students will be able to know about Nervous system

Matching Table (Put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	No	Yes	Yes	Yes	No
3	No	Yes	No	Yes	Yes	Yes
4	No	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

Units	Course Contents	Teaching hours
Unit I	Defining developmental biology. Structure and function of reproductive system: Male reproductive system, Female reproductive system. Production of gametes: Spermatogenesis, Oogenesis. Cell surface molecules in sperm - egg recognition in animals; zygote formation, cleavage, blastula formation, gastrulation and formation of germ layers in animals. Early developmental events in vertebrates.	18 hours
Unit-II	Overview of homeotic genes, axis formation in sea urchin, C. elegans, D. melanogaster, amphibians and mammals; formation of vulva in C. elegans; Embryonic fields, potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; genomic equivalence and the cytoplasmic determinants; imprinting. Role of epigenetics in development. Postembryonic development: metamorphosis, regeneration and aging; Developmental constraints on evolution. Developmental defects and disorders.	18 hours
Unit-III	Homeostasis, nutrition, structure and functions of digestive system. Physiology of digestion. Blood corpuscles, haemopoiesis, plasma function, blood volume, haemostasis. Comparative anatomy of heart structure, myogenic heart, ECG its principle and significance, cardiac cycle, heart as a pump, blood pressure, neural and chemical regulation of all above.	18 hours
Unit-IV	Comparison of respiration in different species, anatomical considerations, transport of gases, exchange of gases, waste elimination, neural and chemical regulation of respiration. Comparative physiology of excretion, kidney, urine formation, urine concentration, waste elimination, micturition, regulation of water balance, electrolyte balance and acid-base balance.	18 hours
Unit-V	Neurons, action potential, gross neuroanatomy of the brain and spinal cord, central and peripheral nervous system. Types, structure and functions of muscles, Physiology of muscle contraction. Sense organs: vision, hearing and tactile response. Endocrine glands, basic mechanism of hormone action, hormone and diseases; Thermoregulation.	18 hours
Total Teaching hours		90hours

Internal Assessment Methods: (25 marks)

Distribution for internals	Test (CIA I + CIA II + CIA III)	Seminars	Assignment	Total marks
Marks	15	05	05	25

Reference Book:

1. Developmental biology, (2018), 11th edition by Michael J. F. Barresi, Scott F. Gilbert.
2. Human Embryology & Developmental Biology (2019), 6th edition by Bruce M. Carlson.
3. Principles of Development (2019), 6th edition by Cheryll Tickle; Lewis Wolpert; Alfonso Martinez Arias.
4. Essentials of Animal Physiology (2019) 4th edition by Rastogi.
5. Ganong's Review of Medical Physiology (2019), 26th edition by Kim E. Barrett, Susan M. Barman, Heddwen L. Brooks, Jason Yuan, Scott Boitano.

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	2	3	3	3	2	3	3	3
CO2	3	3	2	3	3	3	2	3	2	2
CO3	3	3	2	3	3	3	2	2	2	2
CO4	3	3	2	3	3	3	2	3	2	3
CO5	3	3	2	3	3	3	2	2	3	3

Strong - 3, Medium – 2, Low - 1

Mapping with Programme Specific Outcomes

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	2	2	3
CO2	3	3	2	2	3
CO3	3	3	2	2	3
CO4	3	3	2	2	3
CO5	3	3	2	2	3
Weightage	18	15	10	10	15
Weighted percentage (rounded of) Course Contribution to POs	3	3	2	2	3

Strong - 3, Medium – 2, Low - 1

SEMESTER III**OPEN ELECTIVE 1 : Seminar and Communication skills**

Paper code:

Subject: **Seminar and Communication skills****Hours/Week:****5****Credits: 2**

Aim: To enable the students to understand the basic concepts of Basic communication and presentation skills

Course Objectives

- 1.To learn the basic concept of To aid students with a good presentation skill.
- 2.To learn the concept of the To enable student's effective communication.
- 3.To develop knowledge on Oral Communication Skills
- 4.To learn about the Verbal Communication
- 5.To develop a piece of knowledge in Presentation Skills.

Course Out Comes

- 6.After completing unit 1, the students will be able to identify the basic concept of the Scope of the communication skills
- 7.After completing unit 2, the students will be able to know about Converse in the non-verbal communication
- 8.After completing unit 3, the students will be able to know about Command over the oral communication skills
- 9.After completing unit 4, the students will be able to know about Converse in the verbal communication
- 10.After completing unit 5, the students will be able to know about Command over the presentation skills

Matching Table (Put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	No	Yes	Yes	Yes	No
3	No	Yes	No	Yes	Yes	Yes
4	No	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

Units	Course Contents	Teaching hours
Unit I	Definition, Nature and Scope of Communication. Importance and Purpose of Communication. Process of Communication and types of Communication	18 hours
Unit-II	Personal Appearance, Gestures, Postures, Facial Expression, Eye Contacts, Body Language, Time language, Silence and Tips for Improving Non-Verbal Communication	18 hours
Unit-III	.Asking for and giving information, Offering and responding to offers, Requesting and responding to requests, congratulating people on their success, asking questions and responding politely, Apologizing and forgiving, giving instructions, Seeking and giving permission, expressing opinions (likes and dislikes), Agreeing and disagreeing, demanding explanations, asking for and giving advice and suggestions and Expressing sympathy	18 hours
Unit-IV	Elements of Effective Writing, The Sentence, Phrases and Clauses , Types of Sentences, Main Forms of Written Communication, Paragraph Writing (Linkage and Cohesion), Letter Writing (formal and informal), Essay writing and Notices	18 hours
Unit-V	Preparing a PowerPoint Presentation, Greeting and introducing, presenting a Paper, Group Discussions, preparing for and Facing a Job Interview	18 hours
Total Teaching hours		90hours

Internal Assessment Methods: (25 marks)

Distribution for internals	Test (CIA I + CIA II + CIA III)	Seminars	Assignment	Total marks
Marks	15	05	05	25

Reference Book:

1. Wren, P. C., & Martin, W. (2005). High school English grammar and composition. S Chand.
2. Usmanova, M., & Xaydarova, N. (2020). ENGLISH GRAMMAR BASICS. Inter Conf.
3. McCorry, L. K., & Mason, J. (2020). Communication skills for the healthcare professional. JONES & BARTLETT PUB Incorporated.
4. MacDonald-Wicks, L., & Levett-Jones, T. (2018). Effective teaching of communication to health professional undergraduate and postgraduate students: A Systematic Review. JBI Database of Systematic Reviews and Implementation Reports, 10(28), 1-18.

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	2	2	2	3	3	3
CO2	3	2	2	3	3	2	3	3	2	2
CO3	3	2	2	3	3	3	3	2	2	2
CO4	3	3	3	2	2	2	3	3	2	3
CO5	3	2	2	3	2	3	2	2	3	3

Strong - 3, Medium – 2, Low - 1

Mapping with Programme Specific Outcomes

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	3	3	3
CO2	3	2	3	3	3
CO3	3	2	3	3	3
CO4	3	2	3	3	3
CO5	3	2	3	3	3
Weightage	15	10	15	15	15
Weighted percentage (rounded of) Course Contribution to POs	3	2	3	3	3

Strong - 3, Medium – 2, Low - 1

SEMESTER III**OPEN ELECTIVE 2 : Plant Molecular Pharming**

Paper code:

Subject: **Plant Molecular Pharming****Hours/Week: 5****Aim: To enable the students to understand the basic understanding of plant systems****Course Objectives**

- 1.To learn the basic concept of To gain basic knowledge on Plant Molecular Farming.
- 2.To learn the concept of the To understand the basic techniques in molecular pharming, limitations, and advantages of using plant systems for recombinant protein production, challenges, bio-safety, and public acceptance towards molecular pharming.
- 3.To develop knowledge on Methods of gene delivery into plant cells
- 4.To learn about the Production of plant-derived recombinant proteins
- 5.To develop a piece of knowledge in Pharmaceuticals.

Course Out Comes

- 6.After completing unit 1, the students will be able to explains the use of whole plants or in vitro cultured plant cells for the synthesis of desirable recombinant proteins
- 7.After completing unit 2, the students will be able to use of plant viral vectors for stable and transient gene expression
- 8.After completing unit 3, the students will be able Briefly explains about rapid production of biopharmaceuticals and edible vaccines in transgenic plants
- 9.After completing unit 4, the students will be able Provides a clear vision of the diverse host system and downstream processing strategies
- 10.After completing unit 5, the students will be able to describes biosafety issues governing plant-derived products

Matching Table (Put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	No	Yes	Yes	Yes	No
3	No	Yes	No	19 Yes	Yes	Yes
4	No	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

Units	Course Contents	Teaching hours
Unit I	Efficient and reliable production of pharmaceuticals in alfalfa; Foreign protein expression using plant cell suspension and cultures; Novel sprouting technology for recombinant protein production, monocot expression systems for molecular farming	18 hours
Unit-II	Plant viral vectors: history and new developments; Stable and transient expression system; Agroinfiltration technique and its advantages	18 hours
Unit-III	Production of pharmaceutical proteins in plants and plant cell suspension cultures; chloroplast expression system, biopharmaceuticals, and edible vaccines; production of secretory IgA in transgenic plants	18 hours
Unit-IV	Host plants, systems and expression strategies for molecular farming; Downstream processing of plant-derived recombinant therapeutic proteins.	18 hours
Unit-V	Biosafety aspects of molecular farming in plants.	18 hours
Total Teaching hours		90hours

Internal Assessment Methods: (25 marks)

Distribution for internals	Test (CIA I + CIA II + CIA III)	Seminars	Assignment	Total marks
Marks	15	05	05	25

Reference Book:

1. Kimmo, K. (2004) Novel Sprouting Technology for Recombinant Protein Production. Wiley.
2. Abrahamian, P., Hammond, R. W., & Hammond, J. (2020). Plant Virus–Derived Vectors: Applications in Agricultural and Medical Biotechnology. Annual Review of Virology, 7.
3. Reng, Q., Gang, T., & Qike, L. (2009). Transient gene expression mediated by agroinfiltration and its application. Molecular Plant Breeding.
4. Fischer, R., Vaquero-Martin, C., Sack, M., Drossard, J., Emans, N., & Commandeur, U. (1999). Towards molecular farming in the future: transient protein expression in plants. Biotechnology and applied biochemistry, 30(2), 113- 116.
5. Schiermeyer, A., Dorfmueller, S., & Schinkel, H. (2004). Production of pharmaceutical proteins in plants and plant cell suspension cultures. Molecular Farming.
6. Yagi, Y., & Shiina, T. (2014). Recent advances in the study of chloroplast gene expression and its evolution. Frontiers in Plant Science, 5, 61. 19
7. Chargelegue, D., Drake, P. M., Obregon, P., & Ma, J. K. C. (2004). Production of secretory IgA in transgenic plants. Molecular Farming. Plant-Made Pharmaceuticals and Technical Proteins, 159-169.

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	2	3	3	3	2	3	3	3
CO2	3	3	2	3	3	3	2	3	2	2
CO3	3	3	2	3	3	3	2	2	2	2
CO4	3	3	2	3	3	3	2	3	2	3
CO5	3	3	2	3	3	3	2	2	3	3

Strong - 3, Medium – 2, Low - 1

Mapping with Programme Specific Outcomes

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	2	2	3
CO2	3	3	2	2	3
CO3	3	3	2	2	3
CO4	3	3	2	2	3
CO5	3	3	2	2	3
Weightage	15	15	10	10	15
Weighted percentage (rounded of) Course Contribution to POs	3	3	2	2	3

Strong - 3, Medium – 2, Low - 1

SEMESTER III**OPEN ELECTIVE 3: Indian Systems of Medicine****Paper code: Subject: Indian Systems of Medicine****Hours/Week: 5****Aim: To enable the students to understand the** Basic knowledge on traditional medicines**Course Objectives**

1. To learn the basic concept of understand thoroughly the principles and concepts of various Indian systems of medicine.
2. To learn the concept of the to understand the industrial requirements, good manufacturing practice (GMP), and new drug documentations.
3. To develop knowledge on the guidelines, methods of preparation, and standardization of formulations in various systems of medicines.
4. To learn about the sufficient information about quality assurance, quality control and expand their understanding towards regulatory aspects.
5. To develop a piece of to scientific validations of ISM and related examples of case studies.

Course Out Comes

6. After completing unit 1, the students will be able Understand the basic principles of various Indian systems of medicine
7. After completing unit 2, the students will be able the industrial infrastructural requirements, current good manufacturing practice of Indian systems of medicine, and new drug documentations
8. After completing unit 3, the students will be n a comprehensive knowledge about quality assurance, quality control, and their regulatory aspects
9. After completing unit 4, the students will be able the detailed insight on drug preparation and standardization of drug formulation
10. After completing unit 5, the students will beon scientific validation of ISM drugs and know about the current studies in the pharmacological and toxicological screening of ISM.

Matching Table (Put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	No	Yes	Yes	Yes	No
3	No	Yes	No	Yes	Yes	Yes
4	No	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

Units	Course Contents	Teaching hours
Unit I	History and development of ISM. Fundamental concepts of Ayurveda, Siddha, Unani, Homoeopathy, Naturopathy, Yoga, Aromatherapy, Energy therapy, and Tribal Medicine. Treatment types. Different dosage forms, merits, and demerits of the ISM.	18 hours
Unit-II	Components of GMP (schedule T), GAP, GLP, and its objectives. Infrastructural Requirements: working space, storage area, machinery and equipment, standard operating procedures, health and hygiene, documentation, and records. Preparation of documents for new drug application and export registration.	18 hours
Unit-III	General guidelines for ISM drug development, Salient features of the techniques for preparation of some of the important class of formulations as per Ayurveda, Siddha, Homeopathy, and Unani Pharmacopoeia. Standardization - Shelf life and Stability studies of ISM formulations. Problems of standardization in ISM.	18 hours
Unit-IV	Quality assurance and control in ISM formulation industry. Regulatory aspects. National/Regional Pharmacopoeias. Analysis of formulations and bio-crude drugs with references to Identity, purity, and quality	18 hours
Unit-V	Scientific evidence validating different products and practices of the Indian system of medicine. Case-studies with suitable examples (Pharmacological and toxicological screening of drugs used in the Indian system of medicine)	18 hours
Total Teaching hours		90hours

Internal Assessment Methods: (25 marks)

Distribution for internals	Test (CIA I + CIA II + CIA III)	Seminars	Assignment	Total marks
Marks	15	05	05	25

Reference Book:

1. Ayurvedic Pharmacopoeia, The Controller of Publications, Civil Lines, Govt. of India, New Delhi.
2. H. Panda, Hand Book on Ayurvedic Medicines, National Institute of Industrial Research, New Delhi.

3. KavirajNagendranathSengupata, Ayurvedic System of Medicine, Sri Satguru Publications, New Delhi.
4. Pulok K Mukharjee, GMP for Botanicals - Regulatory and Quality issues on Phytomedicine, Business Horizons, New Delhi.

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	2	2	2	3	3	3
CO2	3	2	2	3	3	2	3	3	2	2
CO3	3	2	2	3	3	3	3	2	2	2
CO4	3	3	3	2	2	2	3	3	2	3
CO5	3	2	2	3	2	3	2	2	3	3

Strong - 3, Medium – 2, Low - 1

Mapping with Programme Specific Outcomes

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	3	3	3
CO2	3	2	3	3	3
CO3	3	2	3	3	3
CO4	3	2	3	3	3
CO5	3	2	3	3	3
Weightage	15	10	15	15	15
Weighted percentage (rounded of) Course Contribution to POs	3	2	3	3	3

Strong - 3, Medium – 2, Low - 1

PRACTICAL – III (4 credit)

Animal Tissue culture

- 1) Preparation of tissue culture medium and membrane filtration Preparation of single cell suspension from spleen and thymus Cell counting and cell viability
- 2) Macrophage monolayer from PEC, and measurement of phagocytic activity
Trypsinization of monolayer and sub culturing
- 3) Cryopreservation and thawing
- 4) Measurement of doubling time

- 5) Inoculation of embryonated chicken eggs for cultivation of virus Harvesting of virus from the inoculated embryo
- 6) Immunization of laboratory animals
- 7) Titration of antibodies against the recombinant protein

PRACTICAL - III

DEVELOPMENTAL BIOLOGY AND STEM CELLS

1. Primary cultures of cells from chick embryo
2. Isolation of Fibroblast cells from chick embryo
3. Staining and fixing of fibroblast cells
4. Isolation of cells from Rat/ liver etc.

MOOC- MASSIVE OPEN ONLINE COURSES

USRR (UNIVERSITY SOCIAL RESPONSIBILITY REPORT)

The aim of the Field Study is to help students connect with the society in the respective discipline. Following are the important features of the Field Study and the USRR:

1. **Aim:** The Field Study must aim at relating the subject of study with the society in so far as the application and the usefulness of the study are concerned
2. **Topic selection:** The topic for the Field Study must be chosen by the student in the second semester in the month of February; the process for the same shall begin on 1st February and shall end on the last working day of the month of February. Students are free to select the topic for the Field Study in consultation with the Experts and Faculty Members of their choice, both from within and outside the University
3. **Period and duration:** The Field Study shall be undertaken for a duration of 15 days in the summer vacation that falls immediately at the end of the second semester of the program and the same should be accounted for the Third Semester of the program
4. **USRR:** The USSR (University Social Responsibility Report) must be prepared by every student of the program written in 50 to 75 pages. The report shall be written based on the standard research methodology.
5. **Review and evaluation schedule:**
 - a. **Reviewing the Field work:** First week of July

- b. **Report Review:** Second week of August
 - c. **Report submission:** First week of September
 - d. **Report Evaluation:** Third week of September
6. **Faculty Composition:** The following members may be nominated for confirming the topic and for evaluating the USRR:
- a. Professor and Head of the concerned Department
 - b. One Faculty member with related field of specialization from the concerned Department
 - c. One senior faculty member from the Department of Sociology from other Institution

SEMESTER - IV

CORE PAPER 1: THESIS WORK

Paper code:

Subject: THESIS WORK

Hours/Week: 5 Credits: 4

SEMESTER IV

ELECTIVE PAPER 1: DISASTER MANAGEMENT AND MITIGATION RESOURCES

Paper code:

Subject: DISASTER MANAGEMENT AND

MITIGATION RESOURCES

Hours/Week: 5 Credits: 3

Aim: To enable the students to understand the basic concepts is to understand disaster management and mitigation resource.

Course Objectives

- 1.To learn the basic concept of Understand and appreciate the specific contributions of the Red Cross/Red Crescent movement
- 2.To learn the concept of the practice and conceptual¹⁹ understanding of disaster management and humanitarian response and their significance in the current context.

3.To develop knowledge on Recognize issues, debates and challenges arising from the nexus between paradigm of development and disasters

4.To learn about the Critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives

5.To develop a piece of knowledge in Respond to disaster risk reduction initiatives and disasters in an effective, humane and sustainable manner.

Course Out Comes

6.After completing unit 1, the students will be able to know about Disaster, hazard, global and Indian scenario

7.After completing unit 2, the students will be able to know about Natural Disaster and Manmade disasters:

8.After completing unit 3, the students will be able to know about Disaster Management, Policy and Administration

9.After completing unit 4, the students will be able to know about Policy and administration

10.After completing unit 5, the students will be able to know about Financing Relief Measures:

Matching Table (Put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	No	Yes	Yes	Yes	No
3	No	Yes	No	Yes	Yes	Yes
4	No	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

Units	Course Contents	Teaching hours
Unit I	Definition of Disaster, hazard, global and Indian scenario, general perspective, importance of study in human life, Direct and indirect effects of disasters, long term effects of disasters. Introduction to global warming and climate change.	18 hours
Unit-II	:Natural Disaster: Meaning and nature of natural disaster, Flood, Flash flood, drought, cloud burst, Earthquake, Landslides, Avalanches, Volcanic eruptions, Mudflow, Cyclone, Storm, Storm Surge, climate change, global warming, sea level rise, ozone depletion Manmade Disasters: Chemical, Industrial, Nuclear and Fire Hazards. Role of growing population and subsequent industrialization, urbanization and changing lifestyle of human beings in frequent occurrences of manmade disasters.	18 hours
Unit-III	Disaster management: meaning, concept, importance, objective of disaster management policy, disaster risks in India, Paradigm shift in disaster management, □ Importance and principles of disaster management policies, command and co-ordination of in disaster management, rescue operations-how to start with and how to proceed in due course of time, study of flowchart showing the entire process.	18 hours
Unit-IV	□ Ways to raise finance for relief expenditure, role of government agencies and NGO's in this process, Legal aspects related to finance raising as well as overall management of disasters. Various NGO's and the works they have carried out in the past on the occurrence of various disasters, Ways to approach these teams. International relief aid agencies and their role in extreme events.	18 hours
Unit-V	:Pre-disaster, during disaster and post-disaster measures in some events in general structural mapping: Risk mapping, assessment and analysis, sea walls and embankments, Bio shield, shelters, early warning and communication Non Structural Mitigation: Community based disaster preparedness, risk transfer and risk financing, capacity development and training, awareness and education, contingency plans. Do's and don'ts in case of disasters and effective implementation of relief aids.	18 hours
Total Teaching hours		90

Internal Assessment Methods: (25 marks)

Distribution for internals	Test (CIA I + CIA II + CIA III)	Seminars	Assignment	Total marks
Marks	15	05	05	25

RECOMMENDED BOOKS:

1. ShailendraK.Singh : Safety & Risk Management, Mittal Publishers
2. J.H.Diwan : Safety, Security & Risk Management,APH
3. Stephen Ayers &Garmvik: Text Book of Critical Care, Holbook and Shoemaker

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	2	2	2	3	3	3
CO2	3	2	2	3	3	2	3	3	2	2
CO3	3	2	2	3	3	3	3	2	2	2
CO4	3	3	3	2	2	2	3	3	2	3
CO5	3	2	2	3	2	3	2	2	3	3

Strong - 3, Medium – 2, Low - 1

Mapping with Programme Specific Outcomes

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	3	3	3
CO2	3	2	3	3	3
CO3	3	2	3	3	3
CO4	3	2	3	3	3
CO5	3	2	3	3	3
Weightage	15	10	15	15	15
Weighted percentage (rounded of) Course Contribution to POs	3	2	3	3	3

Strong - 3, Medium – 2, Low - 1

SEMESTER IV**ELECTIVE PAPER 2: ADVANCED MEDICAL LAB TECHNOLOGY**

Paper code:

Subject: **ADVANCED MEDICAL LAB TECHNOLOGY****Hours/Week: 5****Credits: 2**

Aim: To enable the students to understand the basic concepts is to provide the analytical knowledge of clinical laboratory testing and its diagnosis.

Course Objectives

- 1.To learn the basic concept of Hematology
- 2.To learn the concept of Complete urine routine examination
- 3.To develop knowledge on Common serological tests
- 4.To learn about the immunological diagnosis
- 5.To develop a piece of knowledge in diagnosis of bacterial pathogens

Course Out Comes

- 6.After completing unit 1, the students will be able to know about the principle and various methods of collection, transport and storage of different clinical samples and basics of hematology.
- 7.After completing unit 2, the students will be able to know about diagnostic methods of clinical pathology specimens i.e.complete routine examination of blood, urine, sputum, feces ,CSF and semen.
- 8.After completing unit 3, the students will be able to know about the principles and procedures of different serological tests in Diagnosis
- 9.After completing unit 4, the students will be able to know about immunological diagnosis
- 10.After completing unit 5, the students will be able to know about the principles and techniques of molecular diagnosis and the ethics involved in molecular diagnosis.

Matching Table (Put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	No	Yes	Yes	Yes	No
3	No	Yes	No	Yes	Yes	Yes
4	No	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

Units	Course Contents	Teaching hours
Unit I	Specimen –definition, types. Collection and transport of specimen.Specimen preservation and storage. Hematology - Blood and its constituents, collection of blood various anticoagulants and their uses. Total Leukocyte Count(TC), Differential count(DC), Erythrocyte Sedimentation Rate(ESR) Red blood cells count(RBC), Platelet count, Packed cell volume(PCV), Mean cell volume(MCV), Hb estimation Bleeding time(BT), Clotting time(CT).Blood bank -Blood grouping(ABO system & Rh system),Identification of malarial parasites.	18 hours
Unit-II	Complete urine routine examination –physical, chemical and microbiological examination of urine, Culture and sensitivity. Complete routine examination of sputum and feces. Semen analysis.Examination of CSF	18 hours
Unit-III	Common serological tests - Rheumatoid arthritis, Pregnancy test, Widal (slide and tube test), VDRL, HBs antigen, carbohydrate reactive protein test. □ Clinical manifestations and lab immunological diagnosis of AIDS MOTT, Legionellosis, Chicken guinea, Helicobacter pylori and SARS	18 hours
Unit-IV	□ Clinical manifestation and laboratory diagnosis of bacterial pathogens-Enteric pathogens (E.coli, Shigella, Salmonella and Vibrio), pyogenic organisms (Staphylococcus and Streptococcus), Spirochetes (Leptospira), Mycobacterium, B. anthracis and Rickettsia.Virology, Mycology and Parasitology - Clinical manifestation and laboratory diagnosis of Rabies and Poliomyelitis, Dermatophytes and E.histolytica.	18 hours
Unit-V	.Molecular techniques for analysis of biochemical disorders.Assays for the diagnosis of inherited diseases. Bioinformatics tools for molecular diagnosis. Antibody based diagnosis – monoclonal antibodies as diagnostic reagents. Diagnosis of diseases by using ELISA and Western blot.DNA diagnostics – PCR and array-based diagnosis. Clinical proteomics - protein microarray for disease diagnosis.Ethics in molecular diagnosis.	18 hours
Total Teaching hours		90

Internal Assessment Methods: (25 marks)

Distribution for internals	Test (CIA I + CIA II + CIA III)	Seminars	Assignment	Total marks
Marks	15	05	05	25

RECOMMENDED BOOKS:

1. Naigaonkar. A.V. and M.D.Burande, A manual of Medical Laboratory Technology, NiraliPrakasan, Pune, India, 3rd edition, 2004.
2. Praful.B.Godkar, Clinical Biochemistry Principles and Practice, Bhalani Publishing House, Bombay, India, 1994.
3. Anathanarayan R. and C K JayaramPaniker, Textbook of Microbiology, Ninth Edition, Jain publications, 9th edition, 2013. 4. Pradeep Kumar N.S., Manual of Practical Pathology, CBS Publishers and Distributors Pvt Ltd, New Delhi, 2011.
5. Geo. F. Brooks, Janet S. Butel and Stephen A, Medical Microbiology, Morse 23rd Edition, 2010.

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	2	3	3	3	2	3	3	3
CO2	3	3	2	3	3	3	2	3	2	2
CO3	3	3	2	3	3	3	2	2	2	2
CO4	3	3	2	3	3	3	2	3	2	3
CO5	3	3	2	3	3	3	2	2	3	3

Strong - 3, Medium – 2, Low - 1

Mapping with Programme Specific Outcomes

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	2	2	3
CO2	3	3	2	2	3
CO3	3	3	2	2	3
CO4	3	3	2	2	3
CO5	3	3	2	2	3
Weightage	15	15	10	10	15
Weighted percentage (rounded of) Course Contribution to POs	3	3	2	2	3

Strong - 3, Medium – 2, Low - 1

ELECTIVE PAPER 3 : NANO AND PHARMACEUTICAL BIOTECHNOLOGY

Paper code:

Subject: NANO AND PHARMACEUTICAL

BIOTECHNOLOGY

Hours/Week: 5

Credits: 3

Aim: To enable the students to understand the basic concepts is the advance in Nano technology, and its application in Pharmaceutical industries.

Course Objectives

- 1.To learn the basic concept of Bioactive nanomaterials
- 2.To learn the concept of Nano materials and their applications.
- 3.To develop knowledge on Microbes in Pharmaceutical industry
- 4.To learn about the Peptide chemistry
- 5.To develop a piece of knowledge in Modern Vaccine Technologies

Course Out Comes

- 6.After completing unit 1, the students will be able to know about the basic knowledge and introduction about Nano technology. Understand about Nanostructures, Nanopolymers, Nanofibres and their uses, bone grafting, dental restoration and bone replacement.
- 7.After completing unit 2, the students will be able to know aboutthe DNA based artificial Nanostructures; Fabrication, Nanobased Protein patterning, sensor technology and polymeric gel.
- 8.After c o m p l e t i n g unit 3, the students will be able to k n o w n Identify the importance of microbes in pharmaceutical technology.
- 9.After completing unit 4, the students will be able to know about Classify Protein engineering, Peptide chemistry and Peptidomimetics, Catalytic antibodies, Glycobiology, hematopoietic growth and Biosensors
- 10.After completing unit 5, the students will be able to know about antibody based therapeutics,

Matching Table (Put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	No	Yes	Yes	Yes	No
3	No	Yes	No	Yes	Yes	Yes
4	No	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

Units	Course Contents	Teaching hours
Unit I	Nanostructures, Biointerface, Bioconjugation, and Biomatrix, Nanoclusters, Self – Assembly of Nano materials. Nanopolymers and Nanofibres. Bioactive nanomaterials in bone grafting and tissue engineering – Inorganic/ polymers Nanocomposites for dental restoration and bone replacement applications.	18 hours
Unit-II	DNA based artificial Nanostructures; Fabrication, properties and applications. Nucleic acid engineered Nanomaterials and their applications. Protein patterning for application in Biomaterials and biodevices. Vesicles and liposomes in sensor technology – Self – Assembling Nanostructured injectable polymeric gels for drug delivery.	18 hours
Unit-III	Introduction, Microbes in Pharmaceutical industry. Formulation of Biotech products including biopharmaceutical Considerations (Microbiological considerations). Site specific delivery of Protein Drugs.	18 hours
Unit-IV	□ Protein engineering, Peptide chemistry and Peptidomimetics Catalytic antibodies, Glycobiology and Biosensors. Impact of biotechnology on drug discovery. (Gene therapy – ex vivo and in vivo gene therapy). Hematopoietic Growth Factors, chemical description, pharmacology, Pharmaceutical Concerns, clinical and Practice aspects.	18 hours
Unit-V	□ .Vaccines, Modern Vaccine Technologies, Pharmaceutical aspects Monoclonal Antibody, Based Pharmaceuticals, Development of Antibody Based Therapeutics. Formulation of monoclonal antibody – Based Therapeutically.	18 hours
Total Teaching hours		90

Internal Assessment Methods: (25 marks)

Distribution for internals	Test (CIA I + CIA II + CIA III)	Seminars	Assignment	Total marks
Marks	15	05	05	25

RECOMMENDED BOOKS:

1. Charles Poole, Frank Owens, Introduction to Nanotechnology Publisher: Wiley India Private Limited, 2007.
2. Leo Shargel, Andrew B. C. Yu, Susanna Wu-Pong and Yu Andrew B.C. Applied Biopharmaceutics and pharmacokinetics. McGraw – Hill companies, 2004.
3. ManasiKarkare, Nanotechnology: Fundamentals and Applications, I K International Publishing House Pvt. Ltd, 2008.
4. Charles Poole, Frank Owens, Introduction to Nanotechnology, Wiley, 2007.
5. Sambamurthy K, Ashutosh Kar, Pharmaceutical Biotechnology, New Age International Pvt Ltd Publishers, 2006.
6. Chandrakant Kokate, Pramod H.J., SS Jalalpure, Textbooks of Pharmaceutical Biotechnology (Kindle Edition), Elsevier, 1st edition, 2011.
7. Daniel Figey (Ed.). Industrial proteomics; Applications for Biotechnology and Pharmaceuticals. Wiley and sons, Incorporated, 2005.
8. Kayser,O.and R.H. Muller. Pharmaceutical Biotechnology – Drug discovery and clinical applications. Wiley – VCH, 2004

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	2	2	2	3	3	3
CO2	3	2	2	3	3	2	3	3	2	2
CO3	3	2	2	3	3	3	3	2	2	2
CO4	3	3	3	2	2	2	3	3	2	3
CO5	3	2	2	3	2	3	2	2	3	3

Strong - 3, Medium – 2, Low - 1

Mapping with Programme Specific Outcomes

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	3	3	3
CO2	3	2	3	3	3
CO3	3	2	3	3	3
CO4	3	2	3	3	3
CO5	3	2	3	3	3
Weightage	15	10	15	15	15
Weighted percentage (rounded of) Course Contribution to POs	3	2	3	3	3

Strong - 3, Medium – 2, Low - 1

Project compulsory (5 credit)