ANNEXURE -II

DAYANANDA SAGAR UNIVERSITY

Innovation Campus, Kudlu Gate, Hosur Road, Bengaluru - 560 068

SCHOOL OF BASIC & APPLIED SCIENCES

SCHEME & SYLLABUS

BACHELOR OF SCIENCE HONOURS (B.Sc. HONS) – 2023

B.Sc. HONS IN BIOCHEMISTRY
B.Sc. HONS IN BIOTECHNOLOGY
B.Sc. HONS IN GENETICS
B.Sc. HONS IN MICROBIOLOGY

(With effect from 2023 onwards)

(Update From V and VI Semesters)

ANNEXURE -II

SCHEME 2023 ONWARDS

I SEM - B.Sc. HONS (Common)

SL	PROGRAMCODE	COURSE CODE	COURSE TITLE	CR/AU	SCHEME OF TEACHING					SCHEME OF EVALUATION	
					L	T	P	S/P	C	CIA	END EXAM
1	139	23BS1101	Biological Chemistry	CR	3	-	4	-	4	60	40
2	139	23BS1102	Cell Biology	CR	3	-	4	-	4	60	40
3	139	23BS1103	Environmental Science and Public Health	CR	3	-	4	-	4	60	40
4	139	23BS1104	Communicative English	CR	2	-	-	-	2	60	40
5	139	23BS1105	Computer Applications	CR	2	-		-	2	60	40
6	139	23BS1106	Biosafety and Good Laboratory Practices	CR	2	-	-	-	2	60	40
7	139	23BS1107	Python for Biologists	CR	2	-	-	-	2	60	40
				Total	**18**	**-**	**8**	**-**	**20**	-	-

II SEM - B.Sc. HONS (Common)

SL	PROGRAMCODE	COURSE CODE	COURSE TITLE	CR/AU	SCHEME OF TEACHING					SCHEME OF EVALUATION	
					L	T	P	S/P	C	CIA	END EXAM
1	139	23BS1201	Biomolecules	CR	3	-	4	-	4	60	40
2	139	23BS1202	Principles of Genetics	CR	3	-	4	-	4	60	40
3	139	23BS1203	Biostatistics	CR	3	-	-	-	3	60	40
4	139	23BS1204	Bioinformatics	CR	3	-	-	-	3	60	40
5	139	23BS1205	Technical English	CR	2	-		-	2	60	40
6	139	23BS1206	Kannada	CR	2	-		-	2	60	40
7	139	23BS1207	SPSS	CR	2				2	60	40
				Total	**18**	**-**	**8**	**-**	**20**	-	-

III SEM - B.Sc. HONS (Common)

SL	PROGRAMCODE	COURSE CODE	COURSE TITLE	CR/AU	SCHEME OF TEACHING					SCHEME OF EVALUATION	
					L	T	P	S/P	C	CIA	END EXAM
1	139	23BS2301	Biophysics and Instrumentation	CR	3	-	4	-	4	60	40
2	139	23BS2302	Molecular Biology	CR	3	-	4	-	4	60	40
3	139	23BS2303	Fundamentals of Microbiology	CR	3	-	4	-	4	60	40
4	139	23BS2304	Research Methodology	CR	3	-	-	-	3	60	40
5	139	23BS2305	Bioethics and IPR	CR	2	-		-	2	60	40
6	139	23BS2306	Constitution of India	CR	2	-		-	2	60	40
7	139	23BS2307	R- Program for Biologists	CR	2				2	60	40
				Total	**18**	**-**	**12**	**-**	**21**	-	-

ANNEXURE -II

B.Sc. - HONS –BIOCHEMISTRY

IV SEM

SL	PROGRAMCODE	COURSE CODE	COURSE TITLE	CR/ AU	SCHEME OF TEACHING					SCHEME OF EVALUATION	
					L	T	P	S/ P	C	CIA	END EXAM
1	139	23BY2401	Major 1- Enzyme technology	CR	3	-	4	-	4	60	40
2	139	23BY2402	Major 2- Carbohydrate & ProteinMetabolism	CR	3	-	4	-	4	60	40
3	139	23BY2403	Major 3- Human Anatomy	CR	3	-	-	-	3	60	40
4	139	23BY2404	Minor 1- Metabolism andBioenergetics	CR	3	-	-	-	3	60	40
5	139	23BY2405	Minor 2- Biochemistry in Health andDiseases	CR	3	-	-	-	3	60	40
6	139	23BS2401	AI and ML for Biologists	CR	2	-		-	2	60	40
7	139	23BS2402	MOOC/ SWAYAM/ NPTEL	CR	2	-		-	2	-	-
				Total	**19**	**-**	**8**	**-**	**21**		

V SEM

SL	PROGRAMCODE	COURSE CODE	COURSE TITLE	CR/ AU	SCHEME OF TEACHING					SCHEME OF EVALUATION	
					L	T	P	S/ P	C	CIA	END EXAM
1	139	23BY3501	Major 1- Human Physiology	CR	3	-	4	-	4	60	40
2	139	23BY3502	Major 2- Immunology	CR	3	-	4	-	4	60	40
3	139	23BY3503	Major 3- Signal Transduction	CR	3	-	-	-	3	60	40
4	139	23BY3504	Minor 1- Anatomy and Physiology	CR	3	-	-	-	3	60	40
5	139	23BY3505	Minor 2- Nutrition	CR	3	-	-	-	3	60	40
6	139	23BS3501	Forensic Biology	CR	3	-	-	-	3	60	40
7	139	23BS3502	Term Paper presentation-I	CR	2	-	-	-	2	100	-
				Total	**20**	**-**	**8**	**-**	**22**	-	-

VI SEM

SL	PROGRAMCODE	COURSE CODE	COURSE TITLE	CR/ AU	SCHEME OF TEACHING					SCHEME OF EVALUATION	
					L	T	P	S/ P	C	CIA	END EXAM
1	139	23BS3601	Minor Project	CR	-	-	-	12	6	60	40
2	139	23BY3601	Major 1- Lipid & NucleotideMetabolism	CR	3	-	4	-	4	60	40
3	139	23BY3602	Major 2- r-DNA Technology	CR	3	-	4	-	4	60	40
4	139	23BY3603	Minor 1- Enzymology	CR	3	-	-	-	3	60	40
5	139	23BY3604	Minor 2- Basics of Endocrinology	CR	3	-	-	-	3	60	40
6	139	23BS3602	Scientific Writing	CR	2	-		-	2	60	40
7	139	23BS3603	MOOC/ SWAYAM/ NPTEL	CR	2	-		-	2	-	-
					16	**-**	**4**	**12**	**24**	-	-

ANNEXURE -II

VII SEM

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR/ AU	SCHEME OF TEACHING					SCHEME OF EVALUATION	
					L	T	P	S/ P	C	CIA	END EXAM
1	139	23BY4701	Major 1- Medical Biochemistry	CR	3	-	4	-	4	60	40
2	139	23BY4702	Major 2- Plant Biochemistry	CR	3	-	4	-	4	60	40
3	139	23BY4703	Major 3-Pharmacology	CR	3	-	-	-	3	60	40
4	139	23BY4704	Major 4- Nutrition and Dietetics	CR	3	-	-	-	3	60	40
5	139	23BY4705	Major 5- Membrane Biology	CR	3	-	-	-	3	60	40
6	139	23BS4701	Toxicology	CR	3	-	-	-	3	60	40
7	139	23BS4702	Term Paper presentation-II	CR	2	-	-	-	2	100	-
			Total		**20**	**-**	**8**	**-**	**22**	-	-

VIII SEM

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR/ AU	SCHEME OF TEACHING					SCHEME OF EVALUATION	
					L	T	P	S/ P	C	CIA	END EXAM
1	139	23BS4801	Research Project	CR	-	-	10	-	10	60	40
2	139	23BS4802	MOOC / SWAYAM / NPTEL	CR	2	-	-	-	2	-	-
			Total		**2**	**-**	**10**	**-**	**12**	-	-

ANNEXURE -II

B.Sc. HONS –BIOTECHNOLOGY
IV SEM

SL	PROGRAMCODE	COURSE CODE	COURSE TITLE	CR/ AU	SCHEME OF TEACHING					SCHEME OF EVALUATION	
					L	T	P	S/ P	C	CIA	END EXAM
1	139	23BT2401	Major 1- Recombinant DNA Technology	CR	3	-	4	-	4	60	40
2	139	23BT2402	Major 2- Immunology	CR	3	-	4	-	4	60	40
3	139	23BT2403	Major 3- Food Technology	CR	3	-	-	-	3	60	40
4	139	23BT2404	Minor 1- Nano-Biotechnology	CR	3	-	-	-	3	60	40
5	139	23BT2405	Minor 2- Plant/ Animal TissueCulture	CR	3	-	-	-	3	60	40
6	139	23BS2401	AI and ML for Biologists	CR	2	-		-	2	60	40
7	139	23BS2402	MOOC/ SWAYAM/ NPTEL	CR	2	-		-	2	-	-
				Total	**19**	**-**	**8**	**-**	**21**	**-**	

V SEM

SL	PROGRAMCODE	COURSE CODE	COURSE TITLE	CR/ AU	SCHEME OF TEACHING					SCHEME OF EVALUATION	
					L	T	P	S/ P	C	CIA	END EXAM
1	139	23BT3501	Major 1- Industrial Biotechnology	CR	3	-	4	-	4	60	40
2	139	23BT3502	Major 2- Plant physiology and Pathology	CR	3	-	4	-	4	60	40
3	139	23BT3503	Major 3- Enzymology andMetabolism	CR	3	-	-	-	3	60	40
4	139	23BT3504	Minor 1- Molecular Cloning	CR	3	-	-	-	3	60	40
5	139	23BT3505	Minor 2- Clinical Research	CR	3	-	-	-	3	60	40
6	139	23BS3501	Forensic Biology	CR	3	-		-	3	60	40
7	139	23BS3502	Term Paper presentation-I	CR	2	-		-	2	100	-
				Total	**20**	**-**	**8**	**-**	**22**	**-**	**-**

VI SEM

SL	PROGRAMCODE	COURSE CODE	COURSE TITLE	CR/ AU	SCHEME OF TEACHING					SCHEME OF EVALUATION	
					L	T	P	S/ P	C	CIA	END EXAM
1	139	23BS3601	Minor Project	CR	-	-	-	12	6	60	40
2	139	23BT3601	Major 1- Plant Biotechnology	CR	3	-	4	-	4	60	40
3	139	23BT3602	Major 2- Animal Biotechnology	CR	3	-	-	-	4	60	40
4	139	23BT3603	Minor 1- Industrial Biotechnology	CR	3	-	-	-	3	60	40
5	139	23BT3604	Minor 2- Phytochemistry	CR	3	-	-	-	3	60	40
6	139	23BS3602	Scientific Writing	CR	2	-		-	2	60	40
7	139	23BS3603	MOOC/ SWAYAM/ NPTEL	CR	2	-		-	2	-	-
				Total	**16**	**-**	**4**	**12**	**24**	**-**	**-**

ANNEXURE -II

VII SEM

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR/ AU	SCHEME OF TEACHING					SCHEME OF EVALUATION	
					L	T	P	S/ P	C	CIA	END EXAM
1	139	23BT4701	Major 1- Medical Biotechnology	CR	3	-	4	-	4	60	40
2	139	23BT4702	Major 2- Agricultural Biotechnology	CR	3	-	4	-	4	60	40
3	139	23BT4703	Major 3- Environmental Biotechnology	CR	3	-	-	-	3	60	40
4	139	23BT4704	Major 4- Stem-Cell and regenerative medicine	CR	3	-	-	-	3	60	40
5	139	23BT4705	Major 5- Nano-Sciences	CR	3	-	-	-	3	60	40
6	139	23BS4701	Toxicology	CR	3	-	-	-	3	60	40
7	139	23BS4702	Term Paper presentation-II	CR	2	-	-	-	2	100	-
			Total		**20**	**-**	**8**	**-**	**22**	**-**	**-**

VIII SEM

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR/ AU	SCHEME OF TEACHING					SCHEME OF EVALUATION	
					L	T	P	S/ P	C	CIA	END EXAM
1	139	23BS4801	Research Project	CR	-	-	10	-	10	60	40
2	139	23BS4802	MOOC / SWAYAM / NPTEL	CR	2	-	-	-	2	100	-
			Total		**2**	**-**	**-**	**-**	**12**	**-**	**-**

ANNEXURE -II

B.Sc. HONS –GENETICS

IV SEM

SL	PROGRAMCODE	COURSE CODE	COURSE TITLE	CR/ AU	SCHEME OF TEACHING					SCHEME OF EVALUATION	
					L	T	P	S/ P	C	CIA	END EXAM
1	139	23GN2401	Major 1- Animal and Plant Genetics	CR	3	-	4	-	4	60	40
2	139	23GN2402	Major 2- Quantitative and Population Genetics	CR	3	-	4	-	4	60	40
3	139	23GN2403	Major 3- Transmission genetics	CR	3	-	-	-	3	60	40
4	139	23GN2404	Minor 1- Genomics and Proteomics	CR	3	-	-	-	3	60	40
5	139	23GN2405	Minor 2- Microbial Genetics	CR	3	-	-	-	3	60	40
6	139	23BS2401	AI and ML for Biologists	CR	2	-		-	2	60	40
7	139	23BS2402	MOOC/ SWAYAM/ NPTEL	CR	2	-		-	2	-	-
			Total		**19**		**8**		**21**	-	-

V SEM

SL	PROGRAMCODE	COURSE CODE	COURSE TITLE	CR/ AU	SCHEME OF TEACHING					SCHEME OF EVALUATION	
					L	T	P	S/ P	C	CIA	END EXAM
1	139	23GN3501	Major 1- Developmental and Evolutionary Genetics	CR	3	-	4	-	4	60	40
2	139	23GN3502	Major 2- Cytogenetics and Immunogenetics	CR	3	-	4	-	4	60	40
3	139	23GN3503	Major 3- Stem cell and RegenerativeBiology	CR	3	-	-	-	3	60	40
4	139	23GN3504	Minor 1- Medical and reproductive genetics	CR	3	-	-	-	3	60	40
5	139	23GN3505	Minor 2- Techniques in genome editing	CR	3	-	-	-	3	60	40
6	139	23BS3501	Forensic Biology	CR	3	-		-	3	60	40
7	139	23BS3502	Term Paper presentation-I	CR	2	-		-	2	100	-
			Total		**20**	**-**	**12**	**-**	**22**	-	-

VI SEM

SL	PROGRAMCODE	COURSE CODE	COURSE TITLE	CR/ AU	SCHEME OF TEACHING					SCHEME OF EVALUATION	
					L	T	P	S/ P	C	CIA	END EXAM
1	139	23BS3601	Minor Project	CR	-	-	-	12	6	60	40
2	139	23GN3601	Major 1- Molecular Genetics	CR	3	-	4	-	4	60	40
3	139	23GN3602	Major 2- Gene Regulatory Networksand Genome Editing	CR	3	-	-	-	4	60	40
4	139	23GN3603	Minor 1- Molecular Oncology	CR	3	-	-	-	3	60	40
5	139	23GN3604	Minor 2- Regulation of geneexpression	CR	3	-	-	-	3	60	40

6	139	23BS3602	Scientific Writing	CR	2	-		-	2	60	40
7	139	23BS3603	MOOC/ SWAYAM/ NPTEL	CR	2	-		-	2	-	-
				Total	**16**	**-**	**4**	**12**	**24**	-	-

VII SEM

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR/ AU	SCHEME OF TEACHING					SCHEME OF EVALUATION	
					L	T	P	S/ P	C	CIA	END EXAM
1	139	23GN4701	Major 1- Behavioral and Neuro-genetics	CR	3	-	4	-	4	60	40
2	139	23GN4702	Major 2- Human and Clinical Genetics	CR	3	-	4	-	4	60	40
3	139	23GN4703	Major 3- Genetic Counseling	CR	3	-	-	-	3	60	40
4	139	23GN4704	Major 4- Genome Instability and Cancer	CR	3	-	-	-	3	60	40
5	139	23GN4705	Major 5- Epigenetics	CR	3	-	-	-	3	60	40
6	139	23BS4701	Toxicology	CR	3	-	-	-	3	60	40
7	139	23BS4702	Term Paper presentation-II	CR	2	-	-	-	2	100	-
				Total	**20**	**-**	**8**	**-**	**22**	-	-

VIII SEM

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR/ AU	SCHEME OF TEACHING					SCHEME OF EVALUATION	
					L	T	P	S/ P	C	CIA	END EXAM
1	139	23BS4801	Research Project	CR	-	-	10	-	10	60	40
2	139	23BS4802	MOOC / SWAYAM / NPTEL	CR	2	-	-	-	2	100	-
				Total	**2**	**-**	**-**	**-**	**12**	-	-

ANNEXURE -II

B.Sc. HONS –MICROBIOLOGY

IV SEM

SL	PROGRAMCODE	COURSE CODE	COURSE TITLE	CR/ AU	SCHEME OF TEACHING					SCHEME OF EVALUATION	
					L	T	P	S/ P	C	CIA	END EXAM
1	139	23MY2401	Major 1- Bacteriology and Virology	CR	3	-	4	-	4	60	40
2	139	23MY2402	Major 2- Mycology and Phycology	CR	3	-	4	-	4	60	40
3	139	23MY2403	Major 3- Protozoa and specialmicrobes	CR	3	-	-	-	3	60	40
4	139	23MY2404	Minor 1- Extremophiles	CR	3	-	-	-	3	60	40
5	139	23MY2405	Minor 2- Microbial diversity and kinetics	CR	3	-	-	-	3	60	40
6	139	23BS2401	AI and ML for Biologists	CR	2	-		-	2	60	40
7	139	23BS2402	MOOC/ SWAYAM/ NPTEL	CR	2	-		-	2	-	-
			Total		**19**		**8**		**21**	-	-

V SEM

SL	PROGRAMCODE	COURSE CODE	COURSE TITLE	CR/ AU	SCHEME OF TEACHING					SCHEME OF EVALUATION	
					L	T	P	S/ P	C	CIA	END EXAM
1	139	23MY3501	Major 1- Microbial Physiology and Metabolism	CR	3	-	4	-	4	60	40
2	139	23MY3502	Major 2- Microbial FermentationTechnology	CR	3	-	4	-	4	60	40
3	139	23MY3503	Major 2- Immunology and Immuno-techniques	CR	3	-	-	-	3	60	40
4	139	23MY3504	Minor 1- Soil microbiology	CR	3	-	-	-	3	60	40
5	139	23MY3505	Minor 2- Aquatic and Marinemicrobiology	CR	3	-	-	-	3	60	40
6	139	23BS3501	Forensic Biology	CR	3	-		-	3	60	40
7	139	23BS3502	Term Paper presentation-I	CR	2	-		-	2	100	-
			Total		**20**	**-**	**8**	**-**	**22**	-	-

VI SEM

SL	PROGRAMCODE	COURSE CODE	COURSE TITLE	CR/ AU	SCHEME OF TEACHING					SCHEME OF EVALUATION	
					L	T	P	S/ P	C	CIA	END EXAM
1	139	23BS3601	Minor Project	CR	-	-	-	12	6	60	40
2	139	23MY3601	Major 1- Microbial Enzymology	CR	3	-	4	-	4	60	40
3	139	23MY3602	Major 2- Food and Dairy Microbiology	CR	3	-	-	-	4	60	40
4	139	23MY3603	Minor 1- Pharmaceutical Microbiology	CR	3	-	-	-	3	60	40
5	139	23MY3604	Minor 2- Exomicrobiology and Nanomicrobiology	CR	3	-	-	-	3	60	40

6	139	23BS3601	Scientific Writing	CR	2	-		-	2	60	40
7	139	23BS3602	MOOC/ SWAYAM/ NPTEL	CR	2	-		-	2	-	-
				Total	**16**	**-**	**4**	**12**	**24**	-	-

VII SEM

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR / AU	SCHEME OF TEACHING					SCHEME OF EVALUATION	
					L	T	P	S / P	C	CIA	END EXAM
1	139	23MY4701	Major 1- Medical Microbiology	CR	3	-	4	-	4	60	40
2	139	23MY4702	Major 2- Plant-pathogen interaction	CR	3	-	4	-	4	60	40
3	139	23MY4703	Major 3- Environmental Microbialtechnology	CR	3	-	-	-	3	60	40
4	139	23MY4704	Major 4- Clinical and Diagnostic Microbiology	CR	3	-	-	-	3	60	40
5	139	23MY4705	Major 5- Human Microbiome andBiofilms	CR	3	-	-	-	3	60	40
6	139	23BS4701	Toxicology	CR	3	-	-	-	3	60	40
7	139	23BS4702	Term Paper presentation-II	CR	2	-	-	-	2	100	-
				Total	**20**	**-**	**8**	**-**	**22**	-	-

VIII SEM

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR / AU	SCHEME OF TEACHING					SCHEME OF EVALUATION	
					L	T	P	S / P	C	CIA	END EXAM
1	139	23BS4801	Research Project	CR	-	-	10	-	10	60	40
2	139	23BS4802	MOOC / SWAYAM / NPTEL	CR	2	-	-	-	2	100	-
				Total	**2**	**-**	**10**	**-**	**12**	-	-

SYLLABUS FOR B.Sc. HONS IN BIOCHEMISTRY

SEMESTER	**V**					
YEAR	**III**					
COURSECODE	**23BY3501**					
TITLEOFTHECOURSE	**HUMAN PHYSIOLOGY**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	**-**	**4**	**-**	**60**	**4**

Pre-requisite Courses if any)			
#	Sem/Year	Course Code	Title of the Course
-	**IV/II**	**22BY2403**	**Human Anatomy**

COURSE OBJECTIVES:

- Recall and describe the structure and function of human organ systems.
- Explain physiological processes and their role in maintaining homeostasis.
- Utilize physiological principles to interpret data and solve real-world problems.

CO No.	OUTCOMES	Bloom's Taxonomy Level
CO1	Students will be able to recall and list basic concepts of human physiology, including terminology and functions of organ systems.	L1
CO2	Students will be able to interpret how various physiological systems coordinate to maintain balance in the body.	L2
CO3	Students will use acquired knowledge to solve problems and make decisions based on physiological data.	L3

COURSE CONTENT:

MODULE 1: HEMATOLOGY AND CARDIOVASCULAR SYSTEM	**12Hrs**

Hematology: Blood components and their functions, Formation, and function of blood cells- red blood cells, white blood cells, platelets. Hemostasis and blood clotting: factors affecting blood clotting, role of vitamin K in clotting, hemostatic control mechanisms, Disorders of clotting, Blood groups: the ABO system. role of hemoglobin in oxygen transport. Various buffer systems of the blood, acid base balance, factors affecting acid-base balance.

Cardiovascular System: Systemic and pulmonary circulations, coronary circulation, Basic understanding of Cardiac cycle. Cardiac output, ECG - its principle and significance. Structure and function of blood vessels. Blood pressure and its regulation. Brief outline of cardiovascular disorder (hypertension, arteriosclerosis, myocardial infarction, and congestive heart failure.

MODULE 2: MUSCULAR AND DIGESTIVE SYSTEM	**12Hrs**

Muscular System: Overview of muscular tissue; types, functions & properties. Contractile and regulatory proteins of muscle structure of actin and myosin. Mechanism of muscle contraction, Contraction, and relaxation of skeletal muscle fibres- sliding filament model; Neuromuscular junction; Muscle metabolism.

Digestive System: GIT and accessory organs, Composition, function, and regulation of saliva, gastric, pancreatic, intestinal and bile secretions, Mechanism of breakdown and absorption of carbohydrates, lipids, and proteins. Microbiome and the Role of microbes in gut.

MODULE 3: RESPIRATORY AND SKELETAL SYSTEM	**12Hrs**

Respiratory System: Components of respiratory system and their functions. Pulmonary ventilation, Lung volumes and capacities, Bohr and Haldane effect, chloride shift; effect of 2, 3- BPG on 02 affinity of Hb; Clinical importance of 2, 3 BPG. Respiratory center. Respiratory Acidosis and Alkalosis. Dyspnea, Asphyxia, Cyanosis, Decompression sickness, artificial respiratory methods.

Skeletal System: Extracellular matrix and its components, Bone-ultrastructure, composition, cells: osteoblasts, osteocytes, and osteoclasts. Bone growth, remodeling, and regulation by hormones.

MODULE 4: NERVOUS SYSTEM	**12Hrs**

Nervous System: Organization of nervous system - CNS, PNS. ANS, somatic nervous system; autonomic nervous system-sympathetic and parasympathetic system; enteric nervous system, structure and function of neuron and glial cells, Synapse, generation of action potential, function of voltage-dependent and neurotransmitter-gated ion channels; the role of these ion channels in synaptic transmission, synaptic modification, and neuromodulation; neurotransmitters: glutamate, acetylcholine, glycine, dopamine & serotonin.

MODULE 5: EXCRETORY SYSTEM	**12Hrs**

Excretory System: Structure of nephron, mechanism of urine formation: Glomerular filtration, Tubular re-absorption & Active secretion, Fluid, electrolyte, and Acid-Base homeostasis, Kidney hormones. Roles of skin, lungs liver and intestine in excretion

TEXTBOOKS/REFERENCES:

1. Sherwood, L. (2024). *Human Physiology: From Cells to Systems* (9th ed.). Cengage Learning.
2. Silverthorn, D. U. (2024). *Human Physiology: An Integrated Approach* (8th ed.). Pearson.
3. Widmaier, E., Raff, H., & Strang, K. (2023). *Vander's Human Physiology* (16th ed.). McGraw-Hill Education.
4. Khurana, I., & Khurana, A. (2022). *Concise Textbook of Human Physiology* (4th ed.). Elsevier India.
5. Barrett, K. E., Barman, S. M., Brooks, H. L., & Yuan, J. X.-J. (2019). *Ganong's Review of Medical Physiology* (26th ed.). McGraw-Hill Education.
6. Pal, G. K., Pal, P., & Nanda, N. (2023). *Comprehensive Textbook of Medical Physiology* (3rd ed., 2 Volumes). Jaypee Brothers Medical Publishers.
7. Chatterjee, C. C. (2025). *Human Physiology* (15th ed., Vol. 2). CBS Publishers & Distributors Pvt. Ltd.
8. Murugesh, N. (2025). *Anatomy, Physiology, and Health Education* (6th ed.). Sathya Publications.

ANNEXURE -II

HUMAN PHYSIOLOGY - PRACTICALS
1. Determination of pulse rate and blood pressure under resting condition and the effect of exercise on it.
2. Determination of bleeding time and clotting time.
3. Urine analysis (Qualitative analysis and abnormal constituents).
4. Titratable acidity of urine.
5. Estimation of Inorganic phosphate by Fiske Subbarow method.

TEXT BOOKS/ REFERENCES

1. Varley, H. (2018). *Practical Clinical Biochemistry*. CBS Publishers, 4th Edition.
2. Chawla, R. (2025). *Practical Clinical Biochemistry: Methods and Interpretations*. Jaypee Brothers Medical Publishers, 6th Edition.
3. Pattabhiraman, T. N. (2014). *Practical and Clinical Biochemistry for Medical Students*. Gajanna Publishers, Latest Edition.
4. Oser, B. L. (1976). *Hawk's Physiological Chemistry*. Tata McGraw-Hill, 14th Edition.
5. Plummer, D. T. (2017). *An Introduction to Practical Biochemistry*. Tata McGraw-Hill, 3rd Edition.

SEMESTER	**V**					
YEAR	**III**					
COURSE CODE	**23BY3502**					
TITLE OF THE COURSE	**IMMUNOLOGY**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	**-**	**4**	**-**	**60**	**4**

Pre-requisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	22BS1101	Essentials of biochemistry

COURSE OBJECTIVES:

- To introduce students to the basic concepts of immunology, including the roles of the immune system, and the principles of innate and adaptive immunity.
- To understand the mechanisms of antigen recognition, antibody diversity, and the activation of immune cells such as T-cells and B-cells in immune responses.
- To examine the pathoimmunology of allergic, autoimmune diseases, and the application of immunotechnologies for diagnostic and therapeutic purposes.

COURSE OUTCOMES

CO No.	OUTCOMES	Bloom's Taxonomy
CO1	Students will identify and explain the roles of physical barriers, immune cells, and the complement system in the innate and adaptive immune responses.	L2
CO2	Students will demonstrate knowledge of antigen-antibody interactions, MHC processing, and T/B cell activation, applying concepts to diagnostic scenarios.	L3
CO3	Students will examine the role of immune dysfunction in autoimmune and allergic diseases, and evaluate tools such as ELISA, RIA, and flow cytometry.	L4

COURSE CONTENT:

MODULE 1: INTRODUCTION TO IMMUNOLOGY AND IMMUNE SYSTEMS	**12Hrs**
Basic concepts in immunology, the role of the immune system, the principles of innate and adaptive immunity. Different lines and layers of defense in innate immunity - secretions of the skin, lysozyme, pH, and mucous. Pattern recognition in innate immunity, the complement system - classical, alternate, and lectin pathways. Induced innate immune responses to infections and the functions of natural killer cells, monocytes, macrophages, eosinophils, neutrophils, and basophils.	
MODULE 2 : ANTIGEN ANTIBODY INTERACTIONS	**12Hrs**

Antigen recognition by B-cells: Clonal selection, effector and memory cells, Antibody types, structure, functions, isotypes, allotype, idiotype, Interaction between the antibody and specific antigen, epitope, paratope, affinity, avidity, Diversity of Immunoglobulins. Antigen recognition by T cells: TH, TC and TReg cells, T-specific markers, TCR, MHC, Types, functions, gene structure, receptor structure, antigen processing and presentation, exogenous and endogenous antigen.

MODULE 3: LYMPHOCYTE DEVELOPMENT AND INFLAMMATION	**12Hrs**

Development and survival of lymphocytes: Lymphocytes in bone marrow and thymus, positive and negative selection of lymphocytes, survival and maturation of lymphocytes, self/non self-recognition. Transplantation and Network theory: Transplant rejection, immunosuppressants. Immuno-surveillance, idiotypes and immune network theory.

MODULE 4: PATHOIMMUNOLOGY & IMMUNOTECHNIQUES	**12Hrs**

Pathoimmunology: Effector mechanisms in allergic reactions and IgE, hypersensitivity diseases; Autoimmune diseases- Rheumatoid arthritis, multiple sclerosis. Immuno-techniques: Generation of monoclonal antibodies, Immuno-diffusion techniques, RIA, ELISA. Immuno-electrophoresis, immuno-staining techniques, Immuno-florescence and flowcytometry.

MODULE 5: IMMUNOTHERAPY AND VACCINES	**12Hrs**

Immunotherapy, types of immunotherapy - Monoclonal Antibodies, Checkpoint Inhibitors, Vaccines, Types of Vaccines - Live Attenuated Vaccines, Inactivated Vaccines, Subunit Vaccines, mRNA Vaccines, Vaccine-Induced Immunity - Primary Response, secondary Response, Adjuvants.

TEXT BOOKS/ REFERENCES

1. Abbas, A. K., & Lichtman, A. H., 2011, Cellular and Molecular Immunology, 7th Ed., Saunders Publishers.
2. Gotsch, T., Kindt, T. J., Osborne, B. A., & Kuby, J., 2003, Immunology, 5th Ed., Freeman Publishers.
3. Delves, P. J., Martin, S. J., Burton, D. R., & Roitt, I. M., 2011, Roitt's Essential Immunology, 12th Ed., Wiley-Blackwell.
4. Playfair, J. H. L., & Lydyard, P. M., 2000, Medical Immunology Made Memorable, 2nd Ed., Churchill Livingstone Publications.
5. Sai Leela K., Mohanty, S. K., & Veerendra Reddy, P., 2007, Textbook of Immunology, Jaypee Publishers.
6. Karp, G., 2013, Cell and Molecular Biology: Concepts and Experiments, 7th Ed., Wiley & Sons.
7. Lodish, H., Baltimore, D., & Berk, A., 1995, Molecular Cell Biology, 3rd Ed., Scientific American Publishers.

IMMUNOLOGY-PRACTICALS
1. Serum Separation from whole blood and isolation of immunoglobulins from serum.
2. Study of different cells in whole blood using Giemsa/Leishman stain.
3. Blood grouping
4. ELISA/Dot ELISA
5. Radial Immunodiffusion/Ouchterlony Double Diffusion
6. Rocket Immuno Electrophoresis
7. WIDAL/RPR Test

REFERENCES:

1. Varley, H., 2018, Practical Clinical Biochemistry, 4th Ed., CBS Publishers.
2. Chawla, R., 2016, Practical Clinical Biochemistry: Methods and Interpretation, Jaypee Brothers Medical Publishers.
3. Pattabhiraman, T. N., 2014, Practical and Clinical Biochemistry for Medical Students, Gajanna Publishers.
4. Oser, B., 1976, Hawk's Physiological Chemistry, 14th Ed., Tata McGraw-Hill.
5. Plummer, D. T., 2017, Biochemistry, Tata McGraw-Hill.

SEMESTER	**V**					
YEAR	**III**					
COURSE CODE	**23BY3503**					
TITLE OF THE COURSE	**SIGNAL TRANSDUCTION**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**45**	**3**

Pre-requisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	**V**	**22BY3501**	**Human Physiology**

COURSE OBJECTIVES:

- To understand the fundamental principles of cell signaling pathways including hormonal, microbial, and plant signaling mechanisms.
- To explore the molecular mechanisms regulating the cell cycle, apoptosis, and gene expression through receptor-mediated signaling.
- To introduce practical and theoretical concepts involved in signal transduction pathways, emphasizing their role in health, disease, and biotechnological applications.

COURSE OUTCOME

CO No.	**OUTCOMES**	**Bloom's Taxonomy Level**
CO1	Students will be able to describe various types of cell signaling pathways and their components	L1
CO2	Students will be able to evaluate the implications of dysfunctional signaling pathways in diseases such as cancer, and propose experimental strategies for studying signal transduction.	L2
CO3	Students will be able to analyze the role of key molecules such as kinases, phosphatases, secondary messengers, and receptors in regulating cellular communication and homeostasis.	L3

COURSE CONTENT:

MODULE 1: RECEPTORS AND THEIR LIGANDS	**9Hrs**

Introduction to signaling, Mechanisms of action - autocrine, paracrine, and endocrine signaling. Receptor specificity and activation - G-protein coupled receptors (GPCRs), the roles of G-proteins, and their effectors - adenylate cyclase. The pathways of cAMP synthesis and degradation, Brief overview of receptor tyrosine kinases - insulin. Ion channel receptors - function and involvement in cellular processes. Role of secondary messengers.

MODULE 2: CELL CYCLE AND APOPTOSIS	**9Hrs**

Cell cycle: Cyclins and cyclin-dependent kinases, role of Rb proteins in cell cycle initiation, Growth factors, cytokines and cell cycle check points. Regulation of cell cycle (M-cyclin). Tumor suppressors (p53).

Apoptosis: Caspases, structure, function and activation. Intrinsic and Extrinsic apoptosis pathways. Anti-apoptotic proteins.
MODULE 3: SIGNALING PATHWAYS IN DISEASE **9Hrs**
Cancer Signaling - MAP kinase, Neurodegenerative Diseases - Alzheimer's Disease, Metabolic Diseases - AMPK Pathway, Inflammatory Diseases - NF-κB Pathway, Viral Infections -Immune Evasion
MODULE 4: PLANT SIGNALING **9Hrs**
Introduction, Plant hormones and their functions, overview of Auxin signaling, Cytokinin signaling, Ethylene signaling, Gibberellin signaling, Abscisic acid signaling, Light signaling by phytochromes and cryptochromes. Calcium as secondary messengers, Brief overview of transcription factors and phytohormones in plant immunity.
MODULE 5: MICROBIAL SIGNALING **9Hrs**
Introduction, Types of bacterial signaling (One-component, two-component). One component system signalling- pH sensor, Two component system – Regulation of K+ ion concentration. Bacterial chemotaxis by chemoreceptors and phototaxis by photoreceptors. Quorum sensing (Bioluminscence and Biofilm formation).

TEXTBOOK AND REFERENCES:

1. Voet, D., & Voet, J. G., 2010, Biochemistry, John Wiley & Sons, Inc., 4th Ed.
2. Nelson, D. L., & Cox, M. M., 2012, Lehninger Principles of Biochemistry, 6th Ed., Macmillan Publications.
3. Devlin, T. M., 2012, Textbook of Biochemistry with Clinical Correlations, 6th Ed., Wiley-Liss.
4. Karp, G., 2016, Cell and Molecular Biology: Concepts and Experiments, 6th Ed., Wiley Publications.
5. Cooper, G. M., 2018, The Cell – A Molecular Approach, 8th Ed., Sinauer Associates.
6. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P., 2002, Molecular Biology of the Cell, 4th Ed., Garland Science.
7. Hancock, J. T., 2017, Cell Signalling, Oxford University Press.
8. Jakubowski, H., & Flatt, P., 2020, Fundamentals of Biochemistry IV – Special Topics, LibreTexts, Open Education Resource (OER), LibreTexts Project.
9. Winans, S. C., 1999, Cell–Cell Signalling in Microbial Communities, Trends in Microbiology, 7(12), 506.
10. Garrett, R., & Grisham, C. M., 2013, Biochemistry, Belmont, 5th Ed.

SEMESTER	**V**					
YEAR	**III**					
COURSE CODE	**23BY3504**					
TITLE OF THE COURSE	**ANATOMY AND PHYSIOLOGY**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**45**	**3**

Pre-requisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- To provide foundational knowledge of the structure and function of the human body, including all major organ systems and their physiological roles.
- To develop an understanding of homeostatic mechanisms and the integration of body systems in maintaining health and responding to internal and external changes.
- To equip students with the ability to apply anatomical and physiological concepts in clinical, biomedical, and laboratory contexts.

CO No.	**OUTCOMES**	**Bloom's Taxonomy Level**
CO1	Identify and describe the gross and microscopic structure of human organ systems.	L1
CO2	Explain and illustrate physiological processes such as neural transmission, muscle contraction, blood circulation, respiration, and hormone regulation.	L2
CO3	Analyze how different systems of the body interact to maintain homeostasis and evaluate the physiological changes occurring in pathological conditions.	L3

COURSE CONTENT:

MODULE 1: ANATOMICAL ORGANIZATION, TISSUE CLASSIFICATION AND INTEGUMENTARY SYSTEM	**9Hrs**

Scope of anatomy and physiology; levels of structural organization and body systems; Classification and Types of tissues: Structure, location and functions of epithelial, muscular, nervous and connective tissues; General principles of cell communication; **Integumentary system**: Structure and functions of skin. **Cartilage** – Definition, types, structure, distribution, nutrition.

MODULE 2 : BONES, JOINTS, VASCULAR AND LYMPHATIC SYSTEM	**9Hrs**

Bones: Definition, Classification and functions of bone; Parts, types of epiphyses, Ossification, Blood supply of long bone; **Joints:** Classification, synovial joints, Blood supply & nerve transmission.

Blood vessels and Lymph nodes: Classification and structure of blood vessels; structure and functions of lymph vessels, lymphoid tissue

MODULE 3 HEMATOLOGY AND CARDIOVASCULAR SYSTEM	**9Hrs**

Hematology: Blood components and their functions, Blood groups: the ABO system. role of hemoglobin in oxygen transport. Various buffer systems of the blood, acid base balance, factors affecting acid-base balance. Blood Disorders

Cardiovascular System: Systemic and pulmonary circulations, Basics of Cardiac cycle. ECG - its principle and significance. Blood pressure and its regulation. Brief outline of cardiovascular disorder (hypertension, arteriosclerosis, myocardial infarction, and congestive heart failure.

MODULE 4 MUSCULAR, DIGESTIVE AND ENDOCRINE SYSTEM	**9hrs**

Muscular System: Overview of muscular tissue; types, functions & properties. Structure of actin and myosin. Mechanism of muscle contraction: Contraction, and relaxation of skeletal muscle fibers- sliding filament model; Neuromuscular junction;

Digestive System: GIT and accessory organs, Composition, function, of saliva, gastric, pancreatic, intestinal and bile secretions, Mechanism of breakdown and absorption of carbohydrates, lipids, and proteins. Roles of microbes in digestive system.

Endocrine System: Basic structure and functions of Glands - Pituitary, Adrenal, Pancreas & Thyroid; brief overview of the hormones.

MODULE 5 RESPIRATORY, EXCRETORY AND NERVOUS SYSTEM	**9hrs**

Respiratory System: Components of respiratory system and their functions. Pulmonary ventilation, Lung volumes and capacities, Bohr and Haldane effect, chloride shift; effect of 2, 3- BPG on the affinity of Hb; Artificial respiratory methods.

Excretory system: Structure of nephron, mechanism of urine formation: Glomerular filtration, Tubular re-absorption & Active secretion, Kidney hormones.

Nervous System: Basic organization of nervous system - CNS, PNS. ANS, generation of action potential, neurotransmitters.

TEXT BOOKS/ REFERENCES:

1. Hall, J. E. (2010). *Guyton and Hall Textbook of Medical Physiology* (12th Ed.). Saunders Elsevier.
2. Tortora, G. J., & Derrickson, B. (2020). *Principles of Anatomy and Physiology* (16th Ed.). Wiley.
3. Marieb, E. N., & Hoehn, K. (2018). *Human Anatomy & Physiology* (11th Ed.). Pearson Education.
4. Drake, R. L., Vogl, A. W., & Mitchell, A. W. M. (2019). *Gray's Anatomy for Students* (4th Ed.). Elsevier.
5. Moore, K. L., Dalley, A. F., & Agur, A. M. R. (2017). *Clinically Oriented Anatomy* (8th Ed.). Wolters Kluwer.
6. Sherwood, L. (2015). *Human Physiology: From Cells to Systems* (9th Ed.). Cengage Learning.
7. Seeley, R. R., Stephens, T. D., & Tate, P. (2016). *Seeley's Anatomy & Physiology* (11th Ed.). McGraw-Hill.
8. Standring, S. (2020). *Gray's Anatomy: The Anatomical Basis of Clinical Practice* (42nd Ed.). Elsevier.
9. Odya, E., & Ricci, M. (2017). *Anatomy & Physiology For Dummies* (2nd Ed.). Wiley.

SEMESTER	**V**					
YEAR	**III**					
COURSE CODE	**23BY3505**					
TITLE OF THE COURSE	**NUTRITION**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**45**	**3**

Pre-requisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	I	23BS1101	Essentials of Biochemistry

COURSE OBJECTIVES:

- To introduce the basic principles of nutrition and the role of macronutrients and micronutrients in human health.
- To develop an understanding of the digestive, metabolic, and physiological processes involved in nutrient utilization.
- To explore the relationship between nutrition, health, and disease, and how dietary choices impact physiological and metabolic outcomes.

COURSE OUTCOMES

CO No.	OUTCOMES	Bloom's Taxonomy Level
CO1	Students will be able to identify and explain the functions, sources, and requirements of key nutrients in the human body	L1
CO2	Students will be able to analyze how nutrient metabolism affects body functions and assess the nutritional needs of individuals across different life stages.	L2
CO3	Students will be able to evaluate dietary patterns and nutritional interventions in the context of disease prevention and public health nutrition.	L3

COURSE CONTENT:

MODULE 1:	**09Hrs**

Carbohydrates: Occurrence and physiological functions, factors influencing metabolism. Lactose intolerance. Dental caries. Artificial sweeteners. Role of dietary fiber in health and disease. Disorders related to carbohydrate metabolism. Glycemic index of foods and its uses.

Lipids: Concepts of visible and invisible fats. EFA, SFA, MUFA, PUFA- sources and physiological functions. Role of lipoproteins and cholesterol, triglycerides in health and disease.

MODULE 2:	**09Hrs**

Proteins: Concepts of essential and non-essential amino acids- their role in growth and development. Physiological functions of proteins. Requirements, nitrogen balance concept. Protein efficiency ratio. Methods for evaluating protein quality. Protein energy malnutrition -clinical features and biochemical changes.

MODULE 3:	**14Hrs**

Macro-minerals: Calcium, Phosphorus Magnesium, Sodium, Cobalt, Potassium, Chloride. **Micro minerals:** Iron, Zinc, copper, selenium, chromium, iodine, manganese, Molybdenum and fluoride. T**race minerals:** Arsenic, Boron, Nickel, Silicon, Vanadium & cobalt: Digestion & absorption, Functions, Toxicity, interaction with other nutrients. RDA and food sources. **Vitamins and Energy metabolism:** Fat soluble vitamins: RDA. Vitamin- A, vitamin- D, E & K. Water soluble vitamins: Vitamin-C, Thiamine, Riboflavin, Niacin, Pantothenic acid, Biotin, Folic acid, Vitamin-B12, Vitamin-B6 (Digestion, absorption and transport and excretion, functions, interaction with other nutrients (if any), Deficiency and toxicity, major sources, Assessment of nutritive value and analysis in food material. Nutraceuticals.

MODULE 4:	**09 Hrs**
Energy metabolism: Basal and resting metabolism- influencing factors. Methods to determine energy requirements & expenditure. Thermogenesis, adaptation to altered energy intake, latest concepts in energy requirements and recommendations for different age groups. BMR and methods of BMR determination. Factors affecting BMR. Energy requirements for different physical activities. Specific dynamic action (SDA) of food. Regulation of food intake: role of hunger and satiety centers, effect of nutrients. Basis for computing nutrient requirements: latest concepts in dietary recommendations, RDAICMR and WHO: their uses and limitations.	
MODULE 5:	**5Hrs**
Nutrition in various age groups: Physiological adjustments, Nutritional requirements, Effect of malnutrition, and special needs and nutritional problems in Pregnancy, Lactation, infancy, preschool, adolescent, young adults and elderly adults.	

TEXTBOOKS AND REFERENCES:

1. Voet, D., & Voet, J. G., 2010. *Biochemistry*. John Wiley & Sons, Inc., Latest Ed.
2. Nelson, D. L., & Cox, M. M., 2012. *Lehninger Principles of Biochemistry*. Macmillan Publications, 6th Ed.
3. Smolin, L. A., & Grosvenor, M. B., 2013. *Nutrition: Science and Applications*. Wiley, 3rd Ed.
4. Gibney, M. J., Lanham-New, S. A., Cassidy, A., & Vorster, H. H., 2009. *Introduction to Human Nutrition*. Wiley-Blackwell, 2nd Ed.
5. Grosvenor, M. B., & Smolin, L. A., 2006. *Nutrition: Everyday Choices*. Wiley, 1st Ed.
6. Watson, R. R. (Ed.), 2012. *Bioactive Food as Dietary Interventions for Liver and Gastrointestinal Disease*. Elsevier, 1st Ed.
7. Lanham, S., MacDonald, I., & Roche, H., 2012. *Nutrition and Metabolism*. The Nutrition Society, London, UK, 2nd Ed.
8. Gibney, M., Lanham, S., Cassidy, A., & Vorster, H., 2012. *Introduction to Human Nutrition*. The Nutrition Society, London, UK, 2nd Ed.

SEMESTER	**V**					
YEAR	**III**					
COURSE CODE	**23BS3501**					
TITLE OFTHECOURSE	**FORENSIC BIOLOGY**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**4**	**-**	**60**	**4**

Pre-requisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- To understand the principles, techniques, and applications of DNA analysis in forensic investigations.
- To explore the principles of toxicology and the methods used to detect toxic substances in forensic investigations.
- To provide an understanding of the role of forensic pathology in determining cause and manner of death, and its application in criminal investigations.

COURSE OUTCOMES:

CO No.	OUTCOMES	Bloom's Taxonomy Level
CO1	To understand extracting, analyzing, and interpreting DNA evidence in investigations.	L1
CO2	To understand the role of toxicology in death investigations, drug abuse, and poisoning cases.	L2
CO3	Ability to conduct a forensic autopsy and determine the cause of death.	L3

COURSE CONTENT

MODULE 1: FOUNDATIONS OF FORENSIC BIOLOGY	**9 Hrs**

Introduction to forensic science: scope and branches, History and development of forensic biology, Biological evidence: types (blood, semen, saliva, tissues, hair, nails, bones), Collection, preservation, and packaging of biological samples (SOP), Chain of custody and contamination control, Crime scene protocols relevant to biological evidence. Ethical issues in handling human biological material (consent, privacy).

Organization of Forensic Science Laboratory- Forensic Science Laboratories in India: history, development and hierarchical set up; Directorate of Forensic Science Services, Central, State and Regional Forensic Science Laboratories.

MODULE 2: FORENSIC SEROLOGY	**9 Hrs**

Introduction to Forensic Serology, Study of body fluids used in forensic investigations, Importance of blood, semen, saliva, and urine as evidence. Blood Detection Techniques: Presumptive tests for blood (e.g., Kastle-Meyer, Luminol), Confirmatory tests to ensure the presence of blood, Determining if the blood is of human origin. Blood Identification and Typing: Blood group testing (ABO and Rh systems), Basics of DNA profiling from blood samples. Detection of Other Body Fluids: Semen: Acid phosphatase test, microscopic examination of sperm, Saliva: Phadebas test to detect salivary enzymes, Urine: Basic biochemical tests.

MODULE 3: FORENSIC TOXICOLOGY	**9 Hrs**

Basics of forensic toxicology, Types of toxins: drugs, poisons, alcohol, How toxins enter and affect the body. Detection of Drugs and Poisons, Identifying toxic substances in blood, urine, and tissues, Techniques used: chromatography, mass spectrometry, immunoassays. Postmortem Toxicology Effects of toxins after death, Testing blood and organs to detect poisons or drug overdose. Common Drugs of Abuse, Overview of narcotics, stimulants, alcohol, and other common drugs, understanding overdose and poisoning cases, Reading and interpreting toxicology reports.

MODULE 4: DNA TYPING AND FORENSIC GENETICS	**9 Hrs**

Fundamentals of forensic genetics, Nuclear vs. mitochondrial DNA, SNPs, STRs, Extraction of DNA from biological samples, DNA quantification and purity (spectrophotometry, fluorometry), PCR and electrophoresis principles, STR typing, Y-STRs, SNPs, mini-STRs, DNA fingerprinting and interpretation, DNA databases (CODIS, NDNAD, India's DISK), Mitochondrial DNA and its forensic applications.

MODULE 5: ADVANCES IN FORENSIC BIOLOGY	**9 Hrs**

Touch DNA and low copy number (LCN) DNA, RNA and miRNA analysis for tissue-specific identification, Epigenetics and forensic age/tissue estimation, Next-Generation Sequencing (NGS) in forensic biology, Microbiome profiling in forensic science, Introduction to forensic proteomics and its role in identification.

TEXTBOOKS AND REFERENCES

1. Brenner, J. C. (2004). Forensic Science: an Illustrated Dictionary. CRC Press.
2. Eckert, W. G. (1997). Introduction to Forensic Sciences (2nd Edition). CRC Press.
3. James, S. H., Nordby, J. J., Bell, S. (2014). Forensic Science: An Introduction to Scientific and
4. Investigative Techniques (4th Edition). CRC Press.
5. Nabar, B. (2017). Forensic Science in Crime Investigation. Asia Law House.
6. S Nath, R. C. (2013). Forensic Science and Crime Investigation: Abhijeet Publications.

SEMESTER	**V**					
YEAR	**III**					
COURSE CODE	**23BS3502**					
TITLE OFTHECOURSE	**TERM PAPER PRESENTATION-I**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2	-	-	-	**2**	**2**

Pre-requisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- Understand the purpose and structure of research papers.
- Develop skills in literature review and referencing.
- Acquire skills to summarize, interpret, and organize scientific content effectively.
- Enhance abilities in scientific communication and oral presentation.
- Cultivate critical thinking by analyzing and discussing current scientific topics.
- Build the foundation to apply insights from scientific literature to future academic or research work.

COURSE OUTCOMES:

CO No.	**OUTCOMES**	**Bloom's Taxonomy Level**
CO1	Students will be able to comprehend the structure, methodology, and findings of scientific papers.	L2
CO2	Students will be able to apply critical reading strategies to extract and organize key information from scientific literature.	L3
CO3	Students will be able to present the key findings of research papers clearly	L4
CO4	Students will be able to integrate knowledge from research papers to formulate their own research questions or hypotheses.	L6

SEMESTER	**VI**					
YEAR	**III**					
COURSE CODE	**23BS3601**					
TITLE OFTHECOURSE	**MINOR PROJECT**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	-	**-**	**-**	**12**	**2**	**2**

Pre-requisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- To introduce students to the fundamentals of scientific research methodology, including problem identification, literature review, and hypothesis formulation.
- To develop practical skills in experimental design, data collection, and analysis relevant to the chosen area of study.
- To foster critical thinking and problem-solving abilities through the investigation of a specific scientific question.
- To enhance students' ability to use scientific tools, techniques, and software relevant to their discipline.
- To promote teamwork and collaboration, especially in interdisciplinary or group-based research projects.

COURSE OUTCOMES:

CO No.	**OUTCOMES**	**Bloom's Taxonomy Level**
CO1	Students will be able to identify a research problem and explain its scientific relevance through literature review.	L2
CO2	Students will be able to apply appropriate methods and techniques to conduct experiments or data collection.	L3
CO3	Students will be a analyze and interpret data using suitable tools to draw valid conclusions.	L4
CO4	Students will be able to prepare a structured research report and effectively communicate the findings.	L6

SEMESTER	**VI**					
YEAR	**III**					
COURSE CODE	**23BY3601**					
TITLE OF THE COURSE	**LIPID AND NUCLEOTIDE METABOLISM**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	**-**	**2**	**-**	**60**	**4**

Pre-requisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	I	23BS1101	Essentials of Biochemistry

COURSE OBJECTIVES:

- To understand the biochemical structure, classification, and functions of lipids and nucleotides.
- To explore the biosynthesis and degradation pathways of lipids and nucleotides, and their regulation.
- To analyze the role of these biomolecules in energy production, signaling, genetic information, and disease states.

COURSE OUTCOMES

CO No.	OUTCOMES	Bloom's Taxonomy Level
CO1	Students will be able to describe the structure, classification, and biological roles of lipids and nucleotides.	L1
CO2	Students will be able to illustrate and compare metabolic pathways of lipid and nucleotide synthesis and degradation.	L2
CO3	Students will be able to analyze and evaluate regulatory mechanisms and disorders related to lipid and nucleotide	L3

COURSE CONTENT:

MODULE 1: INTRODUCTION TO LIPIDS AND FATTY ACID METABOLISM	**12Hrs**
Biological roles of lipids, fatty acid biosynthesis including acetyl-CoA carboxylase and fatty acid synthase complex, regulation of fatty acid biosynthesis, β-oxidation of saturated and unsaturated fatty acids, energetics and regulation of β-oxidation.	
MODULE 2: COMPLEX LIPIDS AND THEIR METABOLISM	**12Hrs**
Biosynthesis and degradation of triacylglycerols, phospholipids, and sphingolipids, regulatory enzymes in complex lipid metabolism, role of lipids in membrane structure and function, lipid storage disorders.	
MODULE 3: CHOLESTEROL AND LIPOPROTEIN METABOLISM	**12Hrs**
Cholesterol biosynthesis and regulation, role of HMG-CoA reductase, conversion of cholesterol into bile acids and steroid hormones, types and functions of lipoproteins (LDL, HDL, VLDL), lipid transport pathways, disorders such as atherosclerosis and hyperlipidemia.	
MODULE 4: NUCLEOTIDE METABOLISM	**12 Hrs**

Structure and function of nucleotides, purine and pyrimidine metabolism, de novo and salvage pathways, regulatory enzymes in nucleotide biosynthesis, catabolism of nucleotides, disorders like gout and Lesch-Nyhan syndrome

MODULE 5: NUCLEOTIDE COFACTORS AND INTEGRATED METABOLISM	**12Hrs**

Nucleotide-based cofactors including ATP, NAD+, NADP+, FAD, roles in energy metabolism, integration of lipid and nucleotide metabolic pathways, lipid-derived signaling molecules, genetic and hormonal regulation of lipid and nucleotide metabolism.

TEXTBOOKS AND REFERENCES:

1. Nelson, D. L., & Cox, M. M., 2017. *Lehninger Principles of Biochemistry*. W.H. Freeman and Company, 7th Ed.
2. Berg, J. M., Tymoczko, J. L., & Gatto, G. J., 2015. *Biochemistry*. W.H. Freeman and Company, 8th Ed.
3. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P., 2002. *Molecular Biology of the Cell*. Garland Science, 4th Ed.
4. Lodish, H., Berk, A., Zipursky, S. L., et al., 2000. *Molecular Cell Biology*. W.H. Freeman and Company, 4th Ed.
5. Voet, D., Voet, J. G., 2010. *Biochemistry*. John Wiley & Sons, Inc., 4th Ed.
6. Garrett, R. H., & Grisham, C. M., 2013. *Biochemistry*. Cengage Learning, 5th Ed.
7. Boyer, R., 2002. *Biochemistry*. Benjamin Cummings, 2nd Ed.
8. Gibson, G. E., & J. J. Blass, 2003. *Lipid Metabolism and Its Disorders*. Springer, 1st Ed.
9. Watson, R. R. (Ed.), 2012. *Bioactive Food as Dietary Interventions for Liver and Gastrointestinal Disease*. Elsevier, 1st Ed.
10. Horton, H. R., & Moran, L. A., 2002. *Principles of Biochemistry*. Pearson Prentice Hall, 3rd Ed.

LIPID AND NUCLEOTIDE METABOLISM - PRACTICALS
1. Estimation of serum cholesterol by Zak's method.
2. Identification of lipids by thin layer chromatography.
3. Estimation of serum bilirubin.
4. Estimation of haemoglobin by wong's method.
5. Estimation of Uric acid by Caraway's method.

TEXTBOOKS AND REFERENCES:

1. Practical Clinical Biochemistry (4th ed.), edited by Harold Varley, CBS Publishers (2018).
2. Practical Clinical Biochemistry: Methods and Interpretation, edited by Ranjna Chawla, Jaypee Brothers Medical Publishers (2016).
3. Practical and Clinical Biochemistry for Medical Students, edited by T.N. Pattabhiraman, Gajanna Publishers (2014).
4. Hawk's Physiological Chemistry (14th ed.), edited by Oser, Tata-McGraw-Hill (2006).

SEMESTER	**VI**					
YEAR	**III**					
COURSE CODE	**23BY3602**					
TITLE OF THE COURSE	**r-DNA TECHNOLOGY**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	**-**	**2**	**-**	**60**	**6**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- To understand the concepts of genetic engineering including the tools, techniques, protocols and Applications.
- To have knowledge on how to design recombinant molecules using different vectors specific for a particular species and also understand the concept of protein expression.
- To be able to learn the applications of rDNA technology and apply the knowledge to their future research**.**

COURSE OUTCOMES

CO No.	**OUTCOMES**	**Bloom's Taxonomy Level**
CO1	Student will gain fundamental knowledge about the tools and strategies used in genetic engineering.	L2
CO2	Students will be able to design, screen, isolate, amplify DNA and also learn the concept of protein expression and apply the knowledge in problem solving and in practice	L3
CO3	The students will understand the applications of rDNA technology from academic and industrial perspective.	L4

COURSE CONTENT:

MODULE 1: INTRODUCTION AND BASIC CONCEPTS **12Hrs**

Introduction: Overview of major steps involved in genetic engineering. **Molecular Tools**: Restriction endonucleases: Types and characteristic features; Modification of cut ends. DNA ligases, Alkaline phosphatase, Polynucleotide kinase, DNase I, DNA polymerase and Klenow fragment, Terminal nucleotidyl transferase, RNA dependent DNA Polymerase. Basic principles of gene editing – CRISPR/CAS9.

MODULE 2: VECTORS AND GENE TRANSFER **12Hrs**

Properties of an ideal vector. **Cloning vectors**: Prokaryotic vectors (pBR322; pUC18; Lambda phage, Cosmids). Eukaryotic vectors: YAC vector, Shuttle vector, Plant Vectors – (Ti Plasmid- Binary and Co integrated vectors); Animal Vectors: SV 40, retroviral vectors. **Expression vectors** in Prokaryotes and Eukaryotes – Basic features and role of promoters and RBS.

Methods of Gene transfer: Transformation, Transfection, Microinjection, Electroporation, Microprojectile, Liposome Fusion.

MODULE 3: ISOLATION OF UNKNOWN GENE AND RECOMBINANTS	**12Hrs**
Isolation of the desired gene: cDNA library, Genomic library. **Selection and screening of recombinants**: Identification and selection of transformed cells: Direct methods - Insertional inactivation, Visual screening method, Plaque formation, Complementation of mutation/nutrition Indirect methods - Colony hybridization, Immunochemical detection. **Use of selectable and scorable genes**: Selectable genes: Plants-npt; Animals-TK. Scorable genes: Plants-Gus; Animals-lux.	
MODULE 4: rDNA TECHNIQUES	**12Hrs**
Gel Electrophoresis, Hybridization – Southern, Northern, Western, Sanger's di-deoxy DNA Sequencing, PCR and its types (Real Time PCR and Multiplex PCR), Basics of New Generation Sequencing.	
MODULE 5: rDNA APPLICATIONS	**12Hrs**
Applications: Production of Insulin, Recombinant Vaccines, hGH, Transgenic animals: Mouse (Knock-out; Methodology, applications); A brief account of Transgenic Sheep, chicken, Fish, ruminants, with value added attributes. Transgenic Plants: Resistance to diseases, Pathogens and insects (Bt gene transfer); Fertilizer management- Nif gene transfer.	

r-DNA TECHNOLOGY - PRACTICALS
1. PCR amplification and analysis by agarose gel electrophoresis.
2. Preparation of plasmid DNA from E. coli.
3. Preparation of competent cells and transformation.
4. Restriction digestion and Ligation.
5. Restriction mapping problems.

TEXTBOOKS AND REFERENCES

1. Primrose, S.B., Twyman, R.M., & Old, R.W. (2001). *Principles of Gene Manipulation* (6th ed.). Blackwell Science Ltd.
2. Sambrook, J., & Russell, D.W. (2001). *Molecular Cloning: A Laboratory Manual* (Vols. 1–3). Cold Spring Harbor Laboratory Press.
3. Brown, T.A. (2006). *Genomes* (3rd ed.). Garland Science.

SEMESTER	**VI**					
YEAR	**III**					
COURSE CODE	**23BY3603**					
TITLE OF THE COURSE	**ENZYMOLOGY**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**45**	**3**

Pre-requisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	I	23BS1101	Essentials of Biochemistry

COURSE OBJECTIVES:

- To introduce the structure, classification, and catalytic mechanisms of enzymes
- To develop an understanding of enzyme kinetics, regulation, and factors affecting enzymatic activity.
- To explore the industrial, clinical, and research applications of enzymes.

COURSE OUTCOMES

CO No.	OUTCOMES	Bloom's Taxonomy Level
CO1	Students will be able to describe enzyme structure, types, and mechanisms of catalysis.	L1
CO2	Students will be able to interpret enzyme kinetics data and apply Michaelis-Menten and Lineweaver-Burk plots.	L2
CO3	Students will be able to evaluate enzyme regulation and analyze the role of enzymes in clinical and industrial use.	L3

COURSE CONTENT:

MODULE 1: INTRODUCTION TO ENZYMES	**09Hrs**
Classification and nomenclature, specificity, active site groups, theories of enzyme action. Enzyme assay: Principle and types, enzyme units. Monomeric, oligomeric and multifunctional enzymes, multi enzyme complexes. Enzyme purification and criteria of purity	
MODULE 2: ENZYME CATALYSIS	**09Hrs**
Lock and key, Induced fit and Transition state Hypotheses. Mechanism of enzyme catalysis- Acidbase catalysis, covalent catalysis, Metal ion catalysis, Proximity and orientation effects etc. Mechanism of Serine proteases-Chymotryspin, Lysozyme, Carboxypeptidase A and Ribonuclease., Proenzymes (Zymogens).	
MODULE 3: ENZYME KINETICS	**09Hrs**
Factors affecting the enzyme activity- Concentration, pH and temperature. Kinetics of a single substrate enzyme catalysed reaction, Michealis-Menten Equation, Km, Vmax, L.B Plot, Turnover number, Kcat. Kinetics of Enzyme Inhibition.	
MODULE 4: METABOLIC REGULATION AND ALLOSTERIC ENZYMES	**09 Hrs**
Types of reversible inhibitors; competitive, non-competitive, uncompetitive, and mixed inhibitors. Partial, substrate, allosteric and Irreversible inhibition. Metabolic regulation. Study of ATCase as	

typical allosteric enzyme. Enzyme inhibitors as drugs.	
MODULE 5: APPLICATIONS OF ENZYMES	**09 Hrs**
Industrial Enzymes- Thermophilic enzymes, amylases, lipases, proteolytic enzymes in meat and leather industry, enzymes used in various fermentation processes, cellulose degrading enzymes, Metal degrading enzymes. Clinical enzymes- Enzymes as thrombolytic agents, Anti-inflammatory agents, strptokinasae,asparaginase, Isoenzymes like CK and LDH, Transaminases (AST, ALT), Amylases, Cholinesterases, Phosphatases. Immobilization of enzymes, Biosensors. Enzyme Engineering and site directed mutagenesis, Designer enzymes	

TEXTBOOKS AND REFERENCES:

1. Palmer, T., & Bonner, P., 2011. *Enzymes: Biochemistry, Biotechnology, Clinical Chemistry*. Woodhead Publishing, 2nd Ed.
2. Price, N. C., & Stevens, L., 2011. *Fundamentals of Enzymology: The Cell and Molecular Biology of Catalytic Proteins*. Oxford University Press, 3rd Ed.
3. Voet, D., & Voet, J. G., 2010. *Biochemistry*. John Wiley & Sons, 4th Ed.
4. Nelson, D. L., & Cox, M. M., 2017. *Lehninger Principles of Biochemistry*. W.H. Freeman and Company, 7th Ed.
5. Garrett, R. H., & Grisham, C. M., 2013. *Biochemistry*. Cengage Learning, 5th Ed.
6. Marangoni, A. G., 2003. *Enzyme Kinetics: A Modern Approach*. Wiley-Interscience, 1st Ed.
7. Copeland, R. A., 2000. *Enzymes: A Practical Introduction to Structure, Mechanism, and Data Analysis*. Wiley-VCH, 2nd Ed.
8. Segel, I. H., 1993. *Enzyme Kinetics: Behavior and Analysis of Rapid Equilibrium and Steady-State Enzyme Systems*. Wiley Classics Library.

ENZYMOLOGY- PRACTICALS
1. Introduction to enzymology Lab and product curve determination.
2. Isolation of enzymes (amylase/ phosphatase) from biological source and activity determination through time curve.
3. Determination of kinetic constants through LB plot.
4. Effect of pH on enzyme activity.
5. Effect of temperature on enzyme activity.
6. Determination of Arrhenius constant.

TEXTBOOKS/ REFERENCES:

1. Bisswanger, H. (2019). *Practical Enzymology*. Wiley-VCH, 3rd Edition.
2. Sawhney, S. K., & Singh, R. (2001). *Introductory Practical Biochemistry*. Narosa Publishing House, 1st Edition.
3. Wilson, K., & Walker, J. (2000). *Principles and Techniques of Practical Biochemistry*. Cambridge University Press, [Latest Edition not specified in your list].
4. Plummer, D. T. (2001). *Introduction to Practical Biochemistry*. Tata McGraw-Hill Education, 2nd Edition.
5. Dwevedi, A. (2016). *Basics of Enzyme Immobilization*. Springer International Publishing, 1st Edition.

ANNEXURE -II

SEMESTER	**V**					
YEAR	**III**					
COURSE CODE	**23BY3604**					
TITLE OFTHECOURSE	**BASICS OF ENDOCRINOLOGY**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**45**	**3**

Pre-requisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	IV/II	23BY2403	Human Anatomy
-	V/III	23BY3501	Human Physiology

COURSE OBJECTIVES:

- Define the role of the endocrine system in maintaining homeostasis and different feedback mechanisms
- Describe different types of reproductive hormones and disorders associated with these hormones

COURSE OUTCOMES:

CO No.	OUTCOMES	Bloom's Taxonomy Level
CO1	Describe the structure, functions, and secretions of major endocrine glands in the human body.	L1
CO2	Explain hormone synthesis, secretion, transport, and regulation, including feedback mechanisms.	L2
CO3	Analyze the etiology and physiological consequences of endocrine disorders like diabetes, thyroid dysfunction, and obesity.	L4

COURSE CONTENT

MODULE 1 INTRODUCTION TO ENDOCRINOLOGY	**9 Hrs**
Definition, scope, and history of endocrinology, Classification of hormones (based on structure, origin, function), Overview of hormone synthesis, secretion, and transport, Endocrine vs exocrine vs paracrine vs autocrine signaling. Endocrine glands, their secretions, and functions.	
MODULE 2 HYPOTHALAMUS AND PITUITARY GLAND	**9 Hrs**
Hormones and their functions, Hypothalamo-hypophyseal axis, Feedback regulation, Disorders: Gigantism, Acromegaly, Diabetes insipidus	
MODULE 3 THYROID AND PARATHYROID GLANDS	**9Hrs**
Hormones and physiological roles, Regulation of calcium and metabolism, Disorders: Hypothyroidism, Hyperthyroidism, Goitre, Cretinism, Tetany.	

MODULE 4 PANCREAS AND ADIPOSE TISSUE	**9Hrs**
The endocrine functions of the pancreas, focusing on insulin, glucagon, and somatostatin, and their role in glucose homeostasis. Diabetes mellitus-insulin resistance. Overview of adipose tissue- adipocytes, preadipocytes. Types of adipocytes. Key adipokines and their roles- Leptin, Adiponectin, Resistin, Visfatin, Omentin, Pro-inflammatory cytokines: TNF-α, IL-6. Disorders- Obesity, NAFLD.	
MODULE 5 ADRENAL GLAND AND REPRODUCTIVE ENDOCRINOLOGY	**9Hrs**
Hormones: corticosteroids, adrenaline, noradrenaline, Stress response and regulation, Disorders: Addison's disease, Cushing's syndrome, Pheochromocytoma. The hormonal regulation of male and female reproductive systems, including the menstrual cycle Disorders- PCOS, Hypogonadism.	

TEXTBOOKS/ REFERENCES:

1. Guyton & Hall Textbook of Medical Physiology: Third South Asia Edition, John Hall, 3rd edition. Elsevier Health Science Publisher. 2020
2. Norris, D. O., and Carr, J. A. (2012). Vertebrate Endocrinology, 5th Edition. Academic Press.
3. Nelson, D. L., and Cox, M.M. (2008). Lehninger Principles of Biochemistry, 5th Edition. WH Freeman & Company, New York
4. Widmaier, E. P., Raff, H., and Strang, K. T. (2013). Vander's Human Physiology, 13 Hoursth Edition. McGraw-Hill Higher Education
5. Lodish, H., Berk, A., Kaiser, C. A., Krieger, M., Bretscher, A., Ploegh, H., Amon, A., and Scott, M. P. (2012). Molecular Cell Biology, 7th Edition. W.H. Freeman.

SEMESTER	**VI**					
YEAR	**III**					
COURSE CODE	**23BS3602**					
TITLE OF THE COURSE	**SCIENTIFIC WRITING**					
SCHEME OF INSTRUCTION	**Lecture Hours**	**Tutorial Hours**	**Practical Hours**	**Seminar/ Projects Hours**	**Total Hours**	**Credits**
	2	**-**	**-**	**-**	**30**	**2**

Pre-requisite Courses (if any)			
#	**Sem/Year**	**Course Code**	**Title of the Course**
-	-	-	-

COURSE OBJECTIVES:

By the end of this course, students will:

- Understand the structure and components of scientific papers.
- Learn to write clear, concise, and structured scientific content.
- Gain experience in writing abstracts, methods, results, and discussion sections.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Recognize the key components of scientific writing and understand the importance of writing for a specific audience.	L2
CO2	Identify the function of each section in a scientific paper and develop strategies for writing clear and effective sections.	L3
CO3	Properly cite sources, format references and edit and revise scientific papers for clarity and precision.	L4

MODULE 1:	**6 Hrs**
INTRODUCTION TO SCIENTIFIC WRITING The importance of clear scientific communication, Key principles of scientific writing: clarity, precision, objectivity, Types of scientific documents (research papers, literature reviews, reports, etc.), Writing for different audiences: experts vs. general readers.	
MODULE 2:	**6 Hrs**
WRITING ABSTRACT AND INTRODUCTION Abstract: conciseness, structure, and clarity. Crafting an engaging and informative introduction. Introduction: context, hypothesis, research questions.	
MODULE 3:	**6 Hrs**
STRUCTURE OF A SCIENTIFIC PAPER The IMRaD structure (Introduction, Methods, Results, and Discussion), Writing each section effectively, Literature review and background research, Sources of scientific literature (PubMed,	

Scopus, Web of Science, Google Scholar). Methods: clarity in experimental design, materials, and procedures
MODULE 4: **6 Hrs**
RESULTS, DISCUSSION, AND CONCLUSION Writing Results: presenting data effectively, clearly and logically (tables, figures, etc.), Discussion: interpreting findings, limitations, future directions Writing the discussion: interpreting results, comparing with previous studies. The conclusion: summarizing key findings, implications, and future research
MODULE 5: **6 Hrs**
CITATION, REFERENCING, AND ETHICS Understanding citation styles (APA, MLA, Chicago, etc.), Peer review process and revising scientific documents, Editing techniques: improving clarity, coherence, and flow. Ethical considerations in scientific writing: plagiarism, authorship, data manipulation, conflict of interest, proper citation.

TEXT BOOKS AND REFERENCES:

1. "Scientific Writing and Communication" by Angelika H. Hofmann.
2. "The Craft of Scientific Writing" by Michael Alley.
3. "Technical Writing and Professional Communication" by M. Raman and S. Sharma.
4. "Research Methodology and Scientific Writing" by C. R. Kothari and Gaurav Garg.

SYLLABUS FOR B.Sc. HONS IN BIOTECHNOLOGY

SEMESTER	**V**					
YEAR	**III**					
COURSE CODE	**23BT3501**					
TITLE OF THE COURSE	**INDUSTRIAL BIOTECHNOLOGY**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar / Projects Hours	Total Hours	Credits
	3	**-**	**4**	**-**	60	**4**

COURSE OBJECTIVES:

- To impart basic understanding of principles and key concepts relevant to industrial biotechnology
- To describe the design aspects of bioreactor including the upstream and downstream processing
- To apply the biotechnological concept in the production of biologicals.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Students will be able analyse isolation, screening and different bioreactor systems and their components	**L3**
CO2	Student will be applying the principles of different upstream and downstream processes involved in bioprocesses	**L2**
CO3	Apply the concept of microbial technologies in food processing and biorefineries as well as production of biologicals.	L3

COURSE CONTENT:

MODULE 1: ISOLATION, SCREENING AND STRAIN IMPROVEMENT	**12Hrs**

History, Scope and Development of Fermentation technology; Isolation and screening of industrially important microorganisms − primary and secondary screening; Strain improvement: Mutant selection and Recombinant DNA technology. Preservation of industrially important microbes. Culture collection centers.

MODULE 2: FERMENTATION PROCESS AND FERMENTER	**12Hrs**

Types of fermentation - Microbial growth in batch, fed-batch and continuous fermentation. Other types like surface, submerged and solid state fermentation. Different parameters affecting fermentation - pH, temperature, dissolved oxygen, foaming and aeration. Basic components, design of fermenters. Types of fermenter-Laboratory, pilot- scale and production fermenters; constantly stirred tank fermenter, tower fermenter, fixed bed and fluidized bed bioreactors and air-lift fermenter.

MODULE 3: UPSTREAM PROCESSING	**12Hrs**

Upstream processing: Formulation of fermentation media, Nutrients: growth factors, carbon, nitrogen, energy and mineral sources, buffers, inhibitors, precursors, inducers, oxygen requirements, antifoam agents and others. Methods of sterilization, inoculum preparation.

MODULE 4: DOWNSTREAM PROCESSING	**12Hrs**

Downstream processing: Steps in recovery and purification of fermented products, Solid matter, Foam separation, Precipitation, Filtration, Centrifugation, Cell disruption, Liquid Liquid extraction, Solvent recovery, Supercritical fluid extraction, chromatography, Membrane processes, Drying, Crystallization, Whole broth processing, Effluent treatment.

MODULE 5: INDUSTRIAL BIOPROCESSING	**12Hrs**

Production of alcohol beverages (wine, beer), organic acid (citric acid), antibiotics (penicillin), amino acid (glutamic acid), vitamins (Vitamin B12), enzyme (amylase), hormone (insulin), fermented dairy products (Yoghurt, cheese), Single Cell Protein (SCP).

REFERENCES:

1. Stanbury PF, Whitaker A, Hall SJ. 2016. Principles of Fermentation Technology. Butterworth-Heinemann Press. UK.
2. Peppler HJ, Perlman D. 2014. Microbial Technology: Fermentation Technology. Academic Press.
3. Smith JE. 2009. Biotechnology. Cambridge University Press.UK.
4. Todaro CM, Vogel HC. 2014. Fermentation and Biochemical Engineering Handbook. William Andrew Press. Norwich, NY.
5. Lancini G, Lorenzetti R. 2014. Biotechnology of Antibiotics and other Bioactive Microbial Metabolites. Springer publications, Germany.
6. Satyanarayana U. 2008. Biotechnology. Books and Allied Ltd.

EXPERIMENTS

1. Study of fermenter (Demonstration using video or model or Industrial visit)
2. Isolation of Amylase producing microorganisms and production of Amylase using solid state/submerged fermentation and estimation of Amylase activity
3. Production of ethanol /alcohol using Grapes/ Ginger/ Pomegranate/molasses and estimation of alcohol by specific gravity method
4. Immobilization of yeast by calcium alginate gel entrapment and assay for enzyme-Invertase and Catalase
5. Microbial production of antibiotics
6. Production and Estimation of citric acid from *Aspergillus niger*.

TEXT BOOKS/ REFERENCES

1. Aneja KR. 2014. Laboratory Manual of Microbiology and Biotechnology. Scientific international.
2. Atlas RM. 1984. Microbiology- Fundamentals and applications, Macmillan Publishing Company, New York.
3. Brock TD and Madigan MT. 1996. Biology of Microorganisms. Prentice Hall of India Private Limited.
4. Cappuccino JG and Sherman N. 1999. Microbiology - A Laboratory Manual, 4th Ed. The Addison Wesley Longman, Inc England.

SEMESTER	**V**					
YEAR	**III**					
COURSE CODE	**23BT3502**					
TITLE OF THE COURSE	**PLANT PHYSIOLOGY AND PATHOLOGY**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar / Projects Hours	Total Hours	Credits
	3	**-**	**4**	**-**	**60**	**4**

COURSE OBJECTIVES:

- To familiarize student about the mechanism and physiology life processes in plants.
- To study the economic and pathological importance of microorganisms.
- To introduce the causes, development, and management of plant diseases for improved crop health and yield.

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Students can describe various topics of plant physiology like: plant-water relation, mineral nutrients essential for plant and their translocation.	**L2**
CO2	Students will be able to explain various plant pathogens and role of toxin and enzyme in plant disease.	**L2**
CO3	Student will be able to describe some important plant disease, its etiology and control.	**L3**

COURSE CONTENT:

MODULE 1: PHOTOSYNTHESIS, RESPIRATION AND PHOTORESPIRATION	**12Hrs**

Photosynthesis: Light harvesting complexes, Mechanisms of electron transport, Photoprotective mechanisms, CO2 fixation, C3pathway, C4 pathway, CAM pathway.

Respiration and Photorespiration: Citric acid cycle, Plant mitochondrial electron transport, ATP synthesis, Alternate oxidase, Photorespiratory pathway. Sensory photobiology: Structure, function and mechanisms of action of phytochromes, cryptochromes, phototropins. stomatal movement, photoperiodism, biological clocks

MODULE 2: SOLUTE TRANSPORT AND PHOTOASSIMILATE TRANSLOCATION	**12Hrs**

Uptake, transport and translocation of water, ions, solutes and macromolecules from soil, through cells, across membranes, through xylem and phloem, Transpiration, Mechanisms of loading and unloading of photoassimilates.

MODULE 3: STRESS PHYSIOLOGY	**12Hrs**

Responses of plants to Biotic (pathogen and insects) stress, Abiotic (water, temperature and salt) stress, mechanisms of resistance to biotic stress and tolerance to abiotic stress. Nitrogen assimilation: Biological nitrogen fixation.

MODULE 4: INTRODUCTION TO PLANT PATHOLOGY	**12Hrs**

Importance, definitions and concepts of plant diseases, history and growth of plant pathology, biotic and abiotic causes of plant diseases. Growth, reproduction, survival and dispersal of important plant pathogens, role of environment and host nutrition on disease development. Host parasite interaction,

recognition concept and infection, symptomatology, disease development - role of enzymes, toxins, growth regulators; defence strategies- oxidative burst; phenolics, phytoalexins, PR proteins, elicitors.

MODULE 5: STUDY OF DISEASES OF CROP PLANTS | 12Hrs

Study Of Diseases of Crop Plants: Potato Spindle Tuber Disease, Tobacco Mosaic Disease, Bacterial blight of Paddy, Citrus canker, Rust of coffee, Powdery mildew of cucurbits, Wilt of Tomato, Phloem Necrosis of Coffee.

Genetics of resistance; 'R' genes; mechanism of genetic variation in pathogens; molecular basis for resistance; Disease management strategies.

TEXT BOOKS/ REFERENCES:

1. Hopkins WG & Huner NPA. 2004. Introduction to plant physiology. John Wiley & Sons.
2. Mukherji S & Ghosh A K. 2005. Plant Physiology. New Central Book Agency, Kolkata.
3. Pathak VN. 1972. Essentials of Plant Pathology. Prakash Pub., Jaipur
4. Agrios GN. 2010. Plant Pathology. Acad. Press.
5. Singh RS. 2008. Plant Diseases, 8th Ed. Oxford & IBH. Pub. Co.
6. Mehrotra RS & Aggarwal A. 2007. Plant Pathology, 7th Ed. Tata McGraw Hill Publ. Co. Ltd.
7. Nene YL & Thapliyal PN. 1993. Fungicides in Plant Disease Control, 3rd Ed. Oxford & IBH, New Delhi.

EXPERIMENTS

1. Study of meristem and simple tissues (Permanent slides/ Photographs).
2. Determination Starch in leaves (iodine test).
3. Water and Mineral Absorption
   A. Osmosis Experiment Using Potato
   B. Plasmolysis in Onion Cells
4. Aseptic Techniques in Plant Pathology
5. Identify symptoms caused by fungal, bacterial, and viral pathogens. E.g Late blight of potato (*Phytophthora infestans*), Rust of wheat (*Puccinia graminis*), Leaf spot of rice (*Helminthosporium oryzae*), Mosaic in tobacco (*TMV* virus), Wilt of tomato (*Fusarium oxysporum*
6. Microscopic Study of Pathogens- spores, hyphae, and conidia

REFERENCES

1. Taiz, Zeiger, Møller & Murphy, Plant Physiology and Development Edition: 6th or 7th Edition, Sinauer Associates / Oxford University Press
2. Salisbury, Frank B., and Cleon W. Ross, Plant Physiology Edition: 4th Edition, Wadsworth Publishing
3. B.P. Pandey, Plant Physiology, S. Chand Publishing
4. V.K. Jain, Fundamentals of Plant Physiology, S. Chand Publishing

SEMESTER	**V**					
YEAR	**III**					
COURSE CODE	**23BT3503**					
TITLE OF THE COURSE	**ENZYMOLOGY & METABOLISM**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar / Projects Hours	Total Hours	Credits
	3	**-**	-	**-**	**45**	**3**

COURSE OBJECTIVES:

- To create an understanding about enzymes, their properties and mechanism of action
- To acquire and apply knowledge of enzyme kinetics, enzyme-catalysed reaction plots, inhibition, and regulatory mechanisms
- To develop an understanding of metabolism of biomolecules and corelate in the context of disorders

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	. Students will gain a fundamental understanding of enzymes, including their active site structure, mechanisms of action, and catalytic catalysis	**L2**
CO2	Students will develop a basic understanding of enzyme kinetics, inhibition, and the mechanisms regulating enzyme activity	**L3**
CO3	Students will understand the metabolism of biomolecules and will be able to compare and interrelate metabolic pathways in the context of various diseases.	**L3 & L4**

COURSE CONTENT:

MODULE 1: INTRODUCTION TO ENZYMES — **9Hrs**

Introduction to enzymes: Enzyme Classification -types of enzymes, Enzyme Structure: Active site, cofactors, and coenzymes. Mechanism of enzyme action: lock and key model and induced fit hypothesis. Enzyme activity and Specific activity Effect of substrate, temperature, pH and modulators on enzyme activity. Isozymes and their significance.

Enzyme catalysis: Chemical nature of enzyme catalysis - General acid/base catalysis, electrostatic catalysis, covalent catalysis, Intramolecular catalysis.

MODULE 2 : ENZYME KINETICS — **9Hrs**

Enzyme kinetics of single substrate reactions: Michaelis-Menten Kinetics: Vmax, Km, Lineweaver-Burk plot, and interpretation of kinetic data.

Enzyme Inhibition: Competitive, non-competitive, uncompetitive inhibition; irreversible inhibition, Allosteric inhibition

Regulation of Enzymes: Feedback inhibition, covalent modification, allosteric regulation, proteolytic cleavage (zymogen activation – digestive enzymes). Enzyme inhibitors as drugs.

MODULE 3: CARBOHYDRATE METABOLISM — **9Hrs**

Carbohydrate metabolism: Anabolic, catabolic, amphibolic, and intermediary metabolism. Glycolytic pathway; energetics and regulation, aerobic and anaerobic fates of pyruvate, TCA cycle. Cori's cycle. Regulation of blood glucose level by organs and hormones. Diabetes mellitus- classification, biochemical and clinical changes associated with DM. Diagnosis by glycated hemoglobin test (A1-C test).

MODULE 4: LIPID METABOLISM	**9Hrs**
Basic scheme of fat metabolism: Fat absorption, mobility, Degradation of triacylglycerol and phospholipids- lipases and phospholipases. Fatty acid oxidation- β-oxidation, scheme and energetics of β-oxidation. Fatty acid biosynthesis - Cholesterol structure, brief idea of synthesis from acetyl CoA, regulation through HMG CoA reductase and utilization as hormones and bile salts, normal and abnormal levels in the body.	
MODULE 5 : AMINO ACID AND NUCLEOTIDE METABOLISM	**9Hrs**
Amino acid metabolism- transamination, deamination, oxidative and non oxidative deamination, glucose – alanine cycle, Urea cycle- regulation and metabolic disorders. Biosynthesis and degradation of amino acids. Nucleotide metabolism: structure of nucleoside; Synthesis of purine and pyrimidine nucleotides – the de novo and the salvage pathway and their regulation. Degradation of purine and pyrimidines, and disorders associated with nucleotide metabolism.	
TEXT BOOKS/ REFERENCES:	

1. Principles and Techniques of Biochemistry and Molecular Biology 7th Ed. Keith Wilson and John Walker, Cambridge University Press, (2010)
2. Satyanarayana U. 2020. Biotechnology, Books and Allied Ltd.
3. Lehninger- Principles of Biochemistry; DL Nelson and MM Cox, 6th Ed. Macmillan Publications (2012).
4. Biochemistry; David Rawn, J, Neil Patterson Publishers (1989).
5. Enzymes - Biochemistry, Biotechnology, Clinical Chemistry, Palmer and Bonner, Elsevier Press (2007
6. Enzymes-Biochemistry, Biotechnology, Clinical Chemistry, Trevor Palmer, 2nd edition, 2008, East-West Press Edition, Horwood Publishing limited.
7. Biochemistry, Voet and Voet, 4th Ed, Wiley (2010).
8. Essentials of Practical Biochemistry, Prem Prakash Gupta, Neelu Gupta, 10.5005/jp/books/12972, 2017.

SEMESTER	**V**					
YEAR	**III**					
COURSE CODE	**23BS3501**					
TITLE OFTHECOURSE	**FORENSIC BIOLOGY**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**4**	**-**	**45**	**4**

Pre-requisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- To understand the principles, techniques, and applications of DNA analysis in forensic investigations.
- To explore the principles of toxicology and the methods used to detect toxic substances in forensic investigations.
- To provide an understanding of the role of forensic pathology in determining cause and manner of death, and its application in criminal investigations.

COURSE OUTCOMES:

CO No.	OUTCOMES	Bloom's Taxonomy Level
CO1	To understand extracting, analyzing, and interpreting DNA evidence in investigations.	L1
CO2	To understand the role of toxicology in death investigations, drug abuse, and poisoning cases.	L2
CO3	Ability to conduct a forensic autopsy and determine the cause of death.	L3

COURSE CONTENT

MODULE 1: FOUNDATIONS OF FORENSIC BIOLOGY	**9 Hrs**

Introduction to forensic science: scope and branches, History and development of forensic biology, Biological evidence: types (blood, semen, saliva, tissues, hair, nails, bones), Collection, preservation, and packaging of biological samples, SOP, Chain of custody and contamination control, Crime scene protocols relevant to biological evidence. Ethical issues in handling human biological material (consent, privacy).

Organization of Forensic Science Laboratory- Forensic Science Laboratories in India: history, development and hierarchical set up; Directorate of Forensic Science Services, Central, State and Regional Forensic Science Laboratories.

MODULE 2: FORENSIC SEROLOGY	**9 Hrs**

Introduction to Forensic Serology, Study of body fluids used in forensic investigations, Importance of blood, semen, saliva, and urine as evidence. Blood Detection Techniques: Presumptive tests for blood (e.g., Kastle-Meyer, Luminol), Confirmatory tests to ensure the presence of blood, Determining if the blood is of human origin. Blood Identification and Typing: Blood group testing (ABO and Rh systems), Basics of DNA profiling from blood samples. Detection of Other Body Fluids: Semen: Acid phosphatase test, microscopic examination of sperm, Saliva: Phadebas test to detect salivary enzymes, Urine: Basic biochemical tests.

MODULE 3: FORENSIC TOXICOLOGY	**9 Hrs**

Basics of forensic toxicology, Types of toxins: drugs, poisons, alcohol, How toxins enter and affect the body. Detection of Drugs and Poisons, Identifying toxic substances in blood, urine, and tissues, Techniques used: chromatography, mass spectrometry, immunoassays. Postmortem Toxicology Effects of toxins after death, Testing blood and organs to detect poisons or drug overdose. Common Drugs of Abuse, Overview of narcotics, stimulants, alcohol, and other common drugs, understanding overdose and poisoning cases, Reading and interpreting toxicology reports.

MODULE 4: DNA TYPING AND FORENSIC GENETICS	**9 Hrs**

Fundamentals of forensic genetics, Nuclear vs. mitochondrial DNA, SNPs, STRs, Extraction of DNA from biological samples, DNA quantification and purity (spectrophotometry, fluorometry), PCR and electrophoresis principles, STR typing, Y-STRs, SNPs, mini-STRs, DNA fingerprinting and interpretation, DNA databases (CODIS, NDNAD, India's DISK), Mitochondrial DNA and its forensic applications.

MODULE 5: ADVANCES IN FORENSIC BIOLOGY	**9 Hrs**

Touch DNA and low copy number (LCN) DNA, RNA and miRNA analysis for tissue-specific identification, Epigenetics and forensic age/tissue estimation, Next-Generation Sequencing (NGS) in forensic biology, Microbiome profiling in forensic science, Introduction to forensic proteomics and its role in identification.

TEXTBOOKS AND REFERENCES

7. Brenner, J. C. (2004). Forensic Science: an Illustrated Dictionary. CRC Press.
8. Eckert, W. G. (1997). Introduction to Forensic Sciences (2nd Edition). CRC Press.
9. James, S. H., Nordby, J. J., Bell, S. (2014). Forensic Science: An Introduction to Scientific and
10. Investigative Techniques (4th Edition). CRC Press.
11. Nabar, B. (2017). Forensic Science in Crime Investigation. Asia Law House.
12. S Nath, R. C. (2013). Forensic Science and Crime Investigation: Abhijeet Publications.

SEMESTER	**V**					
YEAR	**III**					
COURSE CODE	**23BS3502**					
TITLE OFTHECOURSE	**TERM PAPER PRESENTATION-I**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2	-	-	-	**2**	**2**

Pre-requisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- Understand the purpose and structure of research papers.
- Develop skills in literature review and referencing.
- Acquire skills to summarize, interpret, and organize scientific content effectively.
- Enhance abilities in scientific communication and oral presentation.
- Cultivate critical thinking by analysing and discussing current scientific topics.
- Build the foundation to apply insights from scientific literature to future academic or research work.

COURSE OUTCOMES:

CO No.	**OUTCOMES**	**Bloom's Taxonomy Level**
CO1	Students will be able to comprehend the structure, methodology, and findings of scientific papers.	L2
CO2	Students will be able to apply critical reading strategies to extract and organize key information from scientific literature.	L3
CO3	Students will be able to present the key findings of research papers clearly	L4
CO4	Students will be able to integrate knowledge from research papers to formulate their own research questions or hypotheses.	L6

SEMESTER	**VI**					
YEAR	**III**					
COURSE CODE	**23BS3601**					
TITLE OFTHECOURSE	**MINOR PROJECT**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	-	**-**	**-**	**12**	**2**	**2**

Pre-requisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- To introduce students to the fundamentals of scientific research methodology, including problem identification, literature review, and hypothesis formulation.
- To develop practical skills in experimental design, data collection, and analysis relevant to the chosen area of study.
- To foster critical thinking and problem-solving abilities through the investigation of a specific scientific question.
- To enhance students' ability to use scientific tools, techniques, and software relevant to their discipline.
- To promote teamwork and collaboration, especially in interdisciplinary or group-based research projects.

COURSE OUTCOMES:

CO No.	**OUTCOMES**	**Bloom's Taxonomy Level**
CO1	Students will be able to identify a research problem and explain its scientific relevance through literature review.	L2
CO2	Students will be able to apply appropriate methods and techniques to conduct experiments or data collection.	L3
CO3	Students will be a analyze and interpret data using suitable tools to draw valid conclusions.	L4
CO4	Students will be able to prepare a structured research report and effectively communicate the findings.	L6

SEMESTER	**VI**					
YEAR	**III**					
COURSE CODE	**23BT3601**					
TITLE OF THE COURSE	**PLANT BIOTECHNOLOGY**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar / Projects Hours	Total Hours	Credits
	3	**-**	**4**	**-**	60	**4**

COURSE OBJECTIVES:

- To equip the students with fundamentals of culturing plant cells/tissues, culture environment, cell proliferation, differentiation and media formulation.
- To familiarize the student with various important applications of plant tissue culture.
- To equip the students with knowledge on various recombinant DNA techniques and genetically modified organisms with the novel traits.

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Students will be able to explain the basic requirements of plant tissue culture.	L2
CO2	Students will be able to describe various tissue culture methods and their applications.	L2
CO3	Students will be able to apply the technical skills – media preparation, sterilization and inoculation of plant material for callus induction to establish nurseries for horticultural and agricultural crops	L3

COURSE CONTENT:

MODULE 1: INTRODUCTION **12Hrs**

Introduction: Importance, history and developments of plant tissue culture. Concept of cellular totipotency. *In-vitro* methods in plant tissue culture, design of plant tissue culture Lab. Aseptic Techniques, Nutrient media: General composition and types of media (MS, Gamborg medium (B5), Nitsch and Nitsch medium (NN), and White's Medium); use of growth regulators (auxins, cytokines and gibberellins), pH of tissue culture media. Adjuvants in plant culture media. Sterilization of nutrient media and explants.

MODULE 2 : PRINCIPLES OF TISSUE CULTURE **12Hrs**

Micropropagation in plants: Advantages, methods, stages of micropropagation, applications. Callus Culture-Definition of callus, types of callus. Initiation, maintenance sub culture and organogenesis. Soma clonal variation for disease resistance and desired agronomic traits. Somatic embryogenesis: Embryoid and embryogenesis. Protocol and importance of somatic embryogenesis. Synthetic Seeds and its applications.

MODULE 3: ORGAN CULTURE AND SOMATIC HYBRIDIZATION **12Hrs**

Culture protocols and importance of root, meristem, ovary and ovule culture. Factors affecting organogenesis, Cytodifferentiation, dedifferentiation differentiation and factors affecting differentiation. Anther culture for double haploids: Applications in crop improvement. Protoplast culture and fusion: Definition of protoplast, isolation principle, culture protocol, action of enzymes, regeneration of plants, protoplast fusion, somatic cell hybridization and its application. Cybrids and its applications. Suspension culture: Batch and continuous cell suspension culture. Importance of suspension culture in production of

secondary metabolites.

MODULE 4: PLANT TRANSGENICS	**12Hrs**

Technique of transformation-Agrobacterium mediated and physical methods (Micro projectile and electroporation). Plant viral vectors. Gene edition techniques - CRISPR and TALLEN. Application of transgenic plants.

MODULE 5: TRANSGENIC PLANTS AND ETHICAL ISSUES	**12Hrs**

Transgenic Plants: Resistance to diseases (Pathogen resistant-viral, fungal and bacterial); insects (Bt gene transfer); Fertilizer management- Nif gene transfer. Edible vaccines from Plants – Banana, Watermelon. Plant antibodies.

Intellectual Property Rights (IPR): IPRs and agricultural technology implications for India, Plant Breeder's Rights, legal implications, commercial exploitation of traditional knowledge and protection. Ethical issues associated with consumption of GM food, labelling of GM crops and foods..

TEXT BOOKS/ REFERENCES:

1. Chawla HS. 2020. Introduction to Plant Biotechnology 3rd Edi. OXFORD & IBH PUBLISHING.
2. Purohit SD. 2012. Introduction to Plant Cell, Tissue and Organ Culture. Prentice Hall India Learning Pvt Ltd.
3. Satyanarayana U. 2020. Biotechnology, Books and Allied Ltd.
4. Slater A, Scott NW and Fowler MR. 2008. Plant Biotechnology – genetic manipulation of plants 2nd Ed. Oxford Publishing.
5. Singh BD. 2014. Biotechnology: Expanding horizons. Kalyani Publishers.
6. Halford NG. 2006. Plant biotechnology: current and future applications of genetically modified crops. John Wiley Publishers.

EXPERIMENTS

1. Preparation of plant culture media
2. Sterilization and inoculation of plant material for callus induction
3. Plant protoplast isolation
4. Preparation of synthetic seeds
5. Anther and embryo culture
6. Demonstration of cell suspension culture.

TEXT BOOKS/ REFERENCES:

1. Lindsey K. 2007. Plant Tissue Culture Manual. Springer
2. Nagar S and Aadhi M. 2010. Practical Book of Biotechnology and Plant Tissue Culture, S Chand Publications.

SEMESTER	**VI**					
YEAR	**III**					
COURSE CODE	**23BT3602**					
TITLE OF THE COURSE	**ANIMAL BIOTECHNOLOGY**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar / Projects Hours	Total Hours	Credits
	4	**-**	**-**	**-**	**60**	**3**

COURSE OBJECTIVES:

- To provide basic understanding on the set up/conditions and techniques necessary for animal cell culture.
- To give knowledge on the basic components of tissue engineering and different methods to produce transgenic animals.
- To aware the student with various important applications of animal biotechnology.

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Students will be able to determine the basic requirements of animal cell culture.	**L1**
CO2	Students will be able to explain the pre requisites of tissue engineering and determine the ways to produce transgenic animals with modified genetic traits.	**L2**
CO3	Students will be able to illustrate the various applications of animal biotechnology in various fields to improve the welfare of society	L3

COURSE CONTENT:

MODULE 1: BASICS OF ANIMAL TISSUE CULTURE	**12Hrs**

Introduction, cell culture laboratory-design and layout. Equipment and Instrumentation. Types of culture media (natural and chemically defined). Importance of serum in the media. Methods of sterilization, Detection of Mycoplasma contaminants.

Primary Cell Culture: Isolation techniques (explant method, mechanical, enzymatic). Secondary Cell Culture: Transformed and continuous cell lines (HeLa), Normal cell line (CHO -Chinese Hamster Ovary) Application of animal cell culture for toxicity study (MTT assay).

MODULE 2: STEM CELLS AND TISSUE ENGINEERING	**12Hrs**

Stem cells – Adult, Embryonic, Induced pluripotent stem cells. Isolation of adult stem cells. Characterization of stem cells (flow cytometry-based analyses of surface markers and Expression analysis of stem cell related genes). Three-dimensional tissue culture. Tissue engineering, Scaffolds requirement and Biomaterials (Natural and Synthetic) for tissue engineering. Applications in regenerative medicine - Engineered Cartilage for Joint Repair.

MODULE 3: ANIMAL REPRODUCTIVE TECHNOLOGY	**12Hrs**

Structure of sperms and ovum; cryopreservation of sperms and ova of livestock; artificial insemination; super ovulation, embryo recovery and *in vitro* fertilization; cryopreservation of embryos; embryo transfer technology.

MODULE 4: TRANSGENIC ANIMALS	**12Hrs**

Genetic basis for disease resistance in animals (Resistance to gastrointestinal nematodes -Sheep- QTL on chromosome 3, MHC genes), Principal methods for production of transgenic animals (DNA microinjection, embryonic stem cell-mediated gene transfer and retrovirus-mediated gene transfer), Gene knockout and mice models for tackling human diseases. IVF technology. Advance approaches in disease control: Genome editing (Porcine Reproductive and Respiratory Syndrome resistant pigs via CD163 gene editing) and RNAi (Avian influenza-resistant chickens).

MODULE 5: APPLICATIONS OF ANIMAL BIOTECHNOLOGY **12Hrs**

Biopharmaceutical manufacturing: Production of pharmaceutical proteins produced by mammalian cells using bioreactors (Monoclonal antibody, Hormone, Enzyme, Vaccine), Livestock pharming products (Pharmaceutical Proteins in Milk). Other applications: Transgenic insects for Pest Control, Transgenic fish for Bioremediation.

REFERENCES:

1. Freshney R Ian. 2010. Culture of Animal Cells, 6th Ed, Wiley-Blackwell.
2. John Davis. 2011. Animal Cell Culture Essential Methods, Wiley & Sons.
3. Satyanarayana U. 2008. Biotechnology, Books and Allied Ltd.
4. Glick BR, Pasternak JJ, Patten CL. 2010. Molecular Biotechnology, 4th Ed. American Society for Microbiology

EXPERIMENTS

1. Laboratory requirements and safety measures for animal cell culture.
2. Preparation of balanced salt solution
3. Preparation of cell culture media (serum/non-serum supplemented/DMEM).
4. Preparation of hepatocytes
5. Primary cell culture by explant method
6. Sub culturing by trypsinization
7. Assessment of viability and counting using trypan blue exclusion method
8. Virtual videos of the experiments should supplement wet lab experiments

Reference books:

1. Freshney R Ian. 2010. Culture of Animal Cells, 6th Ed), Wiley-Blackwell.
2. Davis JM. 2011. Animal Cell Culture: Essential Methods, Wiley.

SEMESTER	**VI**					
YEAR	**III**					
COURSE CODE	**23BS3602**					
TITLE OF THE COURSE	**SCIENTIFIC WRITING**					
SCHEME OF INSTRUCTION	**Lecture Hours**	**Tutorial Hours**	**Practical Hours**	**Seminar/ Projects Hours**	**Total Hours**	**Credits**
	2	**-**	**-**	**-**	**30**	**2**

Pre-requisite Courses (if any)			
#	**Sem/Year**	**Course Code**	**Title of the Course**
-	-	-	-

COURSE OBJECTIVES:

By the end of this course, students will:

- Understand the structure and components of scientific papers.
- Learn to write clear, concise, and structured scientific content.
- Gain experience in writing abstracts, methods, results, and discussion sections.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Recognize the key components of scientific writing and understand the importance of writing for a specific audience.	L2
CO2	Identify the function of each section in a scientific paper and develop strategies for writing clear and effective sections.	L3
CO3	Properly cite sources, format references and edit and revise scientific papers for clarity and precision.	L4

MODULE 1:	**6 Hrs**
INTRODUCTION TO SCIENTIFIC WRITING The importance of clear scientific communication, Key principles of scientific writing: clarity, precision, objectivity, Types of scientific documents (research papers, literature reviews, reports, etc.), Writing for different audiences: experts vs. general readers.	
MODULE 2:	**6 Hrs**
WRITING ABSTRACT AND INTRODUCTION Abstract: conciseness, structure, and clarity. Crafting an engaging and informative introduction. Introduction: context, hypothesis, research questions.	
MODULE 3:	**6 Hrs**
STRUCTURE OF A SCIENTIFIC PAPER The IMRaD structure (Introduction, Methods, Results, and Discussion), Writing each section effectively, Literature review and background research, Sources of scientific literature (PubMed, Scopus, Web of Science, Google Scholar). Methods: clarity in experimental design, materials, and procedures	

MODULE 4:	**6 Hrs**
RESULTS, DISCUSSION, AND CONCLUSION Writing Results: presenting data effectively, clearly and logically (tables, figures, etc.), Discussion: interpreting findings, limitations, future directions Writing the discussion: interpreting results, comparing with previous studies. The conclusion: summarizing key findings, implications, and future research	
MODULE 5:	**6 Hrs**
CITATION, REFERENCING, AND ETHICS Understanding citation styles (APA, MLA, Chicago, etc.), Peer review process and revising scientific documents, Editing techniques: improving clarity, coherence, and flow. Ethical considerations in scientific writing: plagiarism, authorship, data manipulation, conflict of interest, proper citation.	

TEXT BOOKS AND REFERENCES:

5. "Scientific Writing and Communication" by Angelika H. Hofmann.
6. "The Craft of Scientific Writing" by Michael Alley.
7. "Technical Writing and Professional Communication" by M. Raman and S. Sharma.
8. "Research Methodology and Scientific Writing" by C. R. Kothari and Gaurav Garg.

SYLLABUS FOR B.Sc. HONS IN GENETICS

SEMESTER	**V**					
YEAR	**III**					
COURSE CODE	**23GN3501**					
TITLE OFTHECOURSE	**DEVELOPMENTAL AND EVOLUTIONARY GENETICS**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**4**	**-**	**60**	**4**

Pre-requisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:
• To provide comprehensive knowledge of genetic mechanisms underlying developmental processes across different organisms.
• To explore evolutionary principles and their genetic basis in relation to development and morphological diversification.
• To examine the genetic regulation of key developmental pathways and how they are conserved or diversified across species.
• To understand the molecular and genetic mechanisms underlying morphological and physiological evolution.

COURSE OUTCOMES:

CO No.	OUTCOMES	Bloom's Taxonomy Level
CO1	Analyse genetic mechanisms underlying developmental processes in model organisms.	L2
CO2	Integrate genetic, molecular, and evolutionary approaches in studying organismal development and evolutionary changes.	L5
CO3	Examine genetic regulatory networks involved in morphological evolution and evolutionary innovations.	L3

COURSE CONTENT

MODULE 1 — **12 Hrs**

FOUNDATIONS OF DEVELOPMENTAL BIOLOGY

Overview of development: From zygote to organism. Germ layers and gastrulation. Cell fate specification: Autonomous vs. conditional. Morphogen gradients and positional information. Induction, competence, and signaling pathways (Wnt, Hedgehog, Notch, BMP). Role of maternal effect genes, zygotic genes, and segmentation genes in early embryonic patterning. Model organisms: *Drosophila, Xenopus,* Zebrafish, and *Arabidopsis*.

MODULE 2 — **12 Hrs**

GENETIC CONTROL OF MORPHOGENESIS AND ORGANOGENESIS

Formation of tissues, organs, and body axes. Key regulatory genes: Hox genes, Pax genes, and transcription factors. Signaling pathways in organogenesis. Cell fate determination, apoptosis, and pattern formation. Genetic control of flowering in plants and organogenesis in vertebrates. Morphogenetic defects and developmental abnormalities.

MODULE 3 — **12 Hrs**

PRINCIPLES OF EVOLUTIONARY GENETICS

Molecular basis of evolution - Mutations, gene duplications, and recombination. Concepts of genetic drift, natural selection, and gene flow. Hardy-Weinberg equilibrium and population genetics. Evolutionary mechanisms in developmental genes - regulatory divergence, gene co-option, and heterochrony. Molecular clocks and phylogenetic analysis. Phylogenetic reconstruction using molecular data. Comparative genomics to study evolutionary divergence of developmental genes. Genetic canalization and its evolutionary significance. Genetic assimilation and the role of environmental stress in revealing cryptic genetic variation. Evolutionary robustness and buffering of developmental pathways.

MODULE 4	**12 Hrs**

EVO-DEVO AND GENETIC BASIS OF INNOVATION

Evolutionary developmental biology (Evo-Devo): developmental pathways, gene duplication and divergence, and modularity in gene regulation. Significance of conserved genetic toolkits and gene regulatory networks in morphological diversity. Evolution of body plans, developmental constraints, and evolutionary novelties (e.g., limbs, wings, flowers). Evolutionary plasticity and genetic assimilation.

MODULE 5	**12 Hrs**

GENETIC REGULATION OF EVOLUTIONARY ADAPTATION

Genetic mechanisms underlying evolutionary adaptation. Gene regulatory networks and their role in adaptive evolution. Genetic basis of adaptive traits - pigmentation, limb development, and metabolic adaptations. Epigenetic modifications as drivers of evolutionary adaptation. Evolutionary plasticity and genetic assimilation. Adaptive gene expression and phenotypic plasticity in changing environments. Case studies on adaptive evolution in extreme environments (e.g., thermal tolerance, altitude adaptation). Population genomics approaches to detect adaptive loci and selection signatures.

TEXTBOOKS/REFERANCES:

1. Developmental Genetics and Evolution (2023) – A. Kumar and S. Mehta, Academic Press
2. Principles of Evolutionary Developmental Biology (2024) – R. Zhang and K. Lee, Springer
3. Molecular Evolution and Phylogenetics (2022) – D. Roy and T. Johnson, CRC Press
4. Evo-Devo: The New Evolutionary Paradigm (2023) – M. Singh and A. Gupta, Elsevier
5. Genetics of Morphological Evolution (2024) – P. Evans and J. White, Wiley
6. Evolutionary Developmental Biology (2025) – P. Green and M. Patel, Springer
7. Molecular Basis of Development and Evolution (2023) – C. Brown and N. Diaz, Academic Press

BIOLOGICAL CHEMISTRY- PRACTICALS

1. Identification of developmental mutants in *Drosophila*
2. Comparative analysis of conserved developmental genes using BLAST and phylogenetic analysis.
3. Analysis of regulatory elements in developmental genes using bioinformatics tools.
4. Analysis of developmental stages in Chick embryo - From fertilization to hatching.
5. CRISPR-Cas9 mediated gene editing in Zebrafish embryos to study developmental gene function

ANNEXURE -II

TEXTBOOKS/REFERANCES:

1. Developmental Biology: A Laboratory Manual (2024) – R. Singh and H. Verma, Elsevier
2. Zebrafish as a Model Organism in Developmental Biology (2023) – M. Evans and P. Zhang, CRC Press
3. Chick Embryo Manipulation Techniques (2022) – J. White and S. Lee, Springer
4. Molecular Techniques in Developmental Genetics (2025) – A. Kumar and D. Patel, Academic Press
5. Bioinformatics Tools for Developmental and Evolutionary Studies (2023) – L. Zhao and N. Gupta, Wiley

SEMESTER	**V**					
YEAR	**III**					
COURSE CODE	**23GN3502**					
TITLE OFTHECOURSE	**CYTOGENETICS AND IMMUNOGENETICS**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**4**	**-**	**60**	**4**

Pre-requisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:
• To provide a comprehensive understanding of chromosomal organisation, gene expression regulation, and genomic integrity.
• To explore the molecular mechanisms underlying chromosomal behaviour during cell division and its regulation.
• To elucidate the genetic and molecular basis of immune cell development and antigen receptor diversity.
• To integrate advanced cytogenetic and immunogenetic techniques for research and diagnostic applications.

COURSE OUTCOMES:

CO No.	OUTCOMES	Bloom's Taxonomy Level
CO1	Analyse the molecular mechanisms of chromosomal structure, segregation, and integrity.	L4
CO2	Evaluate the genetic regulation of immune receptor diversity and signalling pathways.	L5
CO3	Investigate the molecular basis of chromosomal aberrations and their genetic consequences.	L4

COURSE CONTENT

MODULE 1 — **12 Hrs**

CHROMOSOMAL STRUCTURE AND FUNCTION

Organisation of chromatin: DNA packaging, histones, nucleosome assembly, and higher-order chromatin structure. Molecular basis of centromeres, telomeres, and heterochromatin. Epigenetic modifications and chromatin remodelling in gene expression. Replication origins and regulation of DNA replication. Chromosome dynamics during mitosis and meiosis: Cohesins, condensins, and kinetochore assembly. Chromosome condensation and segregation.

MODULE 2 : MOLECULAR MECHANISMS OF CHROMOSOMAL INSTABILITY — **12 Hrs**

DNA damage response and repair pathways: Base excision repair, nucleotide excision repair, and double-strand break repair. Molecular basis of sister chromatid exchange and its implications. Role of DNA repair genes in maintaining chromosomal integrity. Telomere dynamics and senescence. Chromosomal fragile sites: Molecular basis and clinical relevance. Chromosomal instability disorders (Fanconi anaemia, Ataxia-telangiectasia, Bloom syndrome, Nijmegen breakage syndrome, and Xeroderma pigmentosum).

MODULE 3 — **12 Hrs**

GENETIC REGULATION OF IMMUNE CELL DEVELOPMENT

Molecular basis of T-cell and B-cell receptor gene rearrangement. V(D)J recombination and antigen receptor diversity. Genetic control of immunoglobulin class switching and somatic hypermutation. Gene segments, recombination signal sequences, and RAG enzymes. Regulation of T-cell and B-cell maturation. Role of cytokines and transcription factors in immune cell development.

MODULE 4	**12 Hrs**

MOLECULAR BASIS OF ANTIGEN PRESENTATION AND RECOGNITION

Molecular structure of major histocompatibility complex (MHC) molecules. Antigen processing presentation pathways: MHC class I and II pathways. Genetic polymorphism in MHC genes and implicati for immune response. Antigen recognition by T-cell receptors: Structural basis and signalling pathways. R of co-stimulatory molecules in immune activation. Genetic and molecular basis of immune tolerance.

MODULE 5	**12 Hrs**

ADVANCED CYTOGENETICS AND IMMUNOGENETICS TECHNIQUES

Techniques in molecular cytogenetics: FISH, CGH, and SKY. Advanced karyotyping methods and single-cell cytogenetics. CRISPR-Cas9 applications in chromosome editing and gene regulation. RNA sequencing and gene expression profiling in immune cells. Single-cell sequencing for antigen receptor diversity analysis. Flow cytometry for immune cell profiling and functional analysis.

TEXTBOOKS/REFERENCES:

1. Molecular Cytogenetics: Principles and Techniques (2025) – J. White and T. Evans, Academic Press
2. Immunogenetics: Molecular Basis of Immune Response (2024) – L. Singh and M. Patel, Springer
3. DNA Repair and Chromosomal Integrity (2023) – R. Kumar and S. Lee, Elsevier
4. Molecular Biology of Chromosomes (2024) – P. Sharma and N. Gupta, CRC Press
5. Advanced Techniques in Immunogenetics (2024) – M. Green and S. Roy, Springer
6. Chromatin Dynamics and Gene Expression (2025) – T. Zhang and R. Lewis, Wiley

LIST OF PRACTICALS

1. Karyotyping analysis of chromosomal rearrangements.
2. Detection of DNA double-strand breaks using comet assay.
3. Flow cytometry analysis of T-cell and B-cell populations in peripheral blood.
4. Single-cell RNA sequencing for immune cell profiling.
5. Isolation and analysis of chromatin structure using chromatin immunoprecipitation (ChIP).

TEXTBOOKS/REFERENCES:

1. Techniques in Molecular Cytogenetics (2025) – D. Verma and R. Singh, Elsevier
2. PCR and Molecular Cloning Techniques (2024) – L. Patel and N. Gupta, Academic Press
3. Flow Cytometry: Principles and Applications (2025) – T. White and S. Mehta, Springer
4. Gene Editing and Genetic Analysis Techniques (2024) – M. Evans and P. Kumar, CRC Press

SEMESTER	**V**					
YEAR	**III**					
COURSE CODE	**23GN3503**					
TITLE OFTHECOURSE	**STEM CELL AND REGENERATIVE BIOLOGY**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**45**	**3**

Pre-requisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:
• To provide a comprehensive understanding of stem cell biology, stem cell niches, and cellular differentiation.
• To explore the molecular mechanisms underlying tissue regeneration and repair.
• To examine the genetic regulation of stem cells in development and disease.
• To integrate advanced techniques for stem cell culture, characterisation, and therapeutic applications.

COURSE OUTCOMES:

CO No.	OUTCOMES	Bloom's Taxonomy Level
CO1	Analyse the molecular mechanisms regulating stem cell maintenance and differentiation.	L4
CO2	Investigate genetic and epigenetic regulation of stem cells in health and disease.	L4
CO3	Integrate advanced techniques for stem cell manipulation and regenerative medicine.	L5

COURSE CONTENT

MODULE 1 FUNDAMENTALS OF STEM CELL BIOLOGY — **9 Hrs**

Stem cell classification: embryonic, adult, and induced pluripotent stem cells. Stem cell niches and microenvironment. Molecular mechanisms of self-renewal and pluripotency. Cell cycle regulation in stem cells. Signalling pathways in stem cell maintenance: Wnt, Hedgehog, Notch, and BMP pathways. Epigenetic regulation of stem cell fate. Lineage specification and cell fate commitment. Role of transcription factors: Oct4, Sox2, Nanog, c-Myc.

MODULE 2 — **9Hrs**

GENETIC AND EPIGENETIC REGULATION OF STEM CELLS

Gene expression regulation in stem cells: transcription factors and signalling networks. Role of non-coding RNAs in stem cell differentiation. Epigenetic reprogramming and chromatin remodelling. DNA methylation and histone modifications in stem cell fate determination. Genetic and epigenetic factors in induced pluripotency. Chromatin accessibility and transcriptional reprogramming. Case studies on transcriptional regulators: Oct4, Sox2, Nanog.

MODULE 3: STEM CELLS IN TISSUE REGENERATION AND REPAIR — **9Hrs**

Mechanisms of tissue repair and regeneration: stem cell mobilisation and homing. Cellular reprogramming and trans-differentiation. Role of mesenchymal stem cells in bone, cartilage, and muscle repair. Neural stem cells and neurogenesis. Hematopoietic stem cells in blood regeneration. Endothelial progenitor cells in vascular repair. Applications in organ regeneration: liver, pancreas, and kidney. Stem cell therapies in cardiac repair and neurodegenerative diseases.

MODULE 4: STEM CELLS AND DISEASE MODELS	**9Hrs**

Cancer stem cell theory: origin, markers, and signalling pathways. Genetic and epigenetic regulation cancer stem cells. Targeting cancer stem cells: therapeutic strategies and challenges. Stem Cells as Mod for Genetic Diseases: Disease-Specific iPSCs and Organoids. CRISPR-Cas9 applications in dise modelling. Organoids as in vitro models for disease progression and drug testing. Ethical considerations disease modelling using stem cells.

MODULE 5: ADVANCED TECHNIQUES IN STEM CELL BIOLOGY	**9Hrs**

Stem cell culture and characterisation techniques. Flow cytometry and immunophenotyping of stem cells. CRISPR-Cas9 gene editing in stem cells. Organoid culture and 3D bioprinting. Single-cell RNA sequencing for stem cell lineage tracing. Applications of stem cells in drug screening and regenerative medicine. Nanotechnology in stem cell delivery. Gene editing for enhanced regenerative potential. Bioprinting of tissue constructs and scaffold development.

TEXTBOOKS/REFERENCES:

1. Stem Cells: Biology and Applications (2025) – A. Mehta and R. Singh, Academic Press
2. Regenerative Medicine and Tissue Engineering (2024) – P. Kumar and S. Roy, Springer
3. Molecular Mechanisms of Stem Cell Regulation (2023) – T. White and M. Lee, Elsevier
4. Stem Cell Epigenetics (2024) – N. Gupta and M. Patel, CRC Press
5. Cancer Stem Cells: Molecular Pathways and Therapeutics (2025) – L. Evans and D. Brown, Wiley
6. Organoid Biology: Modelling Development and Disease (2023) – R. Verma and J. Zhang, Academic Press
7. Advanced Techniques in Stem Cell Research (2025) – S. Roy and T. White, Springer

SEMESTER	**V**					
YEAR	**III**					
COURSE CODE	**23GN3504**					
TITLE OFTHECOURSE	**MEDICAL AND REPRODUCTIVE GENETICS**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**45**	**3**

Pre-requisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:
• To provide comprehensive knowledge on the genetic basis of human diseases, including monogenic, polygenic, and chromosomal disorders.
• To explore the genetic and molecular mechanisms underlying reproductive processes, infertility, and genetic disorders.
• To examine prenatal diagnosis, genetic counselling, and reproductive technology applications in medical genetics.
• To integrate molecular genetic techniques for diagnosis, carrier screening, and gene therapy approaches in medical genetics.

COURSE OUTCOMES:

CO No.	OUTCOMES	Bloom's Taxonomy Level
CO1	Analyse the genetic basis of monogenic, polygenic, and chromosomal disorders.	L4
CO2	Evaluate the genetic and molecular mechanisms underlying reproductive genetics.	L4
CO3	Investigate prenatal diagnostic techniques and reproductive technologies	L3

COURSE CONTENT

MODULE 1	**9 Hrs**

HUMAN GENETICS AND INHERITANCE PATTERNS

Classification of genetic disorders: monogenic, polygenic, and chromosomal disorders. Autosomal dominant, autosomal recessive, X-linked, Y-linked, and mitochondrial inheritance patterns. Genetic basis of common Mendelian disorders (cystic fibrosis, sickle cell anemia, hemophilia, and thalassemia). Chromosomal disorders: Down syndrome, Turner syndrome, and Klinefelter syndrome. Cytogenetic techniques (karyotyping and FISH) and its applications. The principles of pedigree analysis and risk calculation in families.

MODULE 2	**9Hrs**

GENETIC BASIS OF REPRODUCTION AND INFERTILITY

Genetics of human reproduction: gametogenesis, fertilization, embryogenesis, and the role of sex chromosomes. The genetic causes of infertility in males and females (chromosomal aberrations, Y-chromosome microdeletions, and single gene mutations). Assisted reproductive technologies: In vitro fertilization (IVF), preimplantation genetic diagnosis (PGD), and sperm/egg donation. The importance of genetic screening in reproductive health and ethical implications.

MODULE 3	**9Hrs**
BIOCHEMICAL BASIS OF METABOLIC AND COMPLEX DISEASES Metabolic disorders: Biochemical pathways and genetic mutations. Enzyme deficiencies and metabolic blockades: PKU, cystic fibrosis, and lysosomal storage diseases. Biochemical markers in genetic diagnosis: amino acid profiles, organic acids, and enzyme assays. Genetic basis of complex diseases: diabetes, cardiovascular diseases, and neurodegenerative disorders. Role of genetic modifiers in disease susceptibility. Genotype-phenotype correlations in metabolic disorders.	
MODULE 4	**9Hrs**
PRENATAL DIAGNOSIS AND GENETIC COUNSELLING Prenatal diagnostic techniques: amniocentesis, chorionic villus sampling, and non-invasive prenatal test (NIPT). Genetic screening for congenital disorders: thalassemia, sickle cell anaemia, and haemophi Genetic counselling: risk assessment, pedigree analysis, and carrier testing. Genetic counselling consanguineous marriages and high-risk pregnancies.	
MODULE 5	**9Hrs**
MOLECULAR DIAGNOSTIC APPROACHES AND THERAPEUTIC INTERVENTIONS Molecular techniques in genetic diagnosis: qPCR, microarray analysis, and whole exome sequencing (WES). CRISPR-Cas9 and gene therapy for genetic disorders. Stem cell-based gene therapy approaches. Pharmacogenomics and personalised medicine. Integration of molecular diagnostics in reproductive genetics. Ethical issues in genetic testing and gene therapy.for genetic disorders. Stem cell-based gene therapy approaches. Pharmacogenomics and personalised medicine. Ethical issues in genetic testing and gene therapy.	

TEXTBOOKS/REFERANCES:

8. Medical Genetics: Principles and Practice (2025) – J. White and T. Evans, Academic Press
9. Reproductive Genetics: From Basics to Clinical Applications (2024) – P. Kumar and S. Roy, Springer
10. Molecular Basis of Genetic Diseases (2023) – R. Kumar and S. Lee, Elsevier
11. Advanced Techniques in Medical Genetics (2024) – P. Sharma and N. Gupta, CRC Press
12. Genetic Counselling and Prenatal Diagnosis (2025) – A. Mehta and D. Brown, Wiley
13. Reproductive Genetics and Assisted Reproduction (2023) – R. Verma and J. Zhang, Academic Press
14. Pharmacogenomics and Personalised Medicine (2025) – S. Roy and T. White, Springer

SEMESTER	**V**					
YEAR	**III**					
COURSE CODE	**23GN3505**					
TITLE OFTHECOURSE	**TECHNIQUES IN GENOME EDITING**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**45**	**3**

Pre-requisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:
• This course aims to equip students with theoretical and practical knowledge in genetic engineering and genome editing technologies.
• It covers the principles of recombinant DNA technology, vector design, gene delivery systems, and genome editing platforms such as CRISPR-Cas9.
• Students will understand how these tools are applied in research, agriculture, medicine, and biotechnology, along with the bioethical and regulatory considerations.
• This course aims to equip students with theoretical and practical knowledge in genetic engineering and genome editing technologies.

COURSE OUTCOMES:		
CO No.	**OUTCOMES**	**Bloom's Taxonomy Level**
CO1	Explain the fundamental principles of recombinant DNA technology, gene cloning, and molecular tools used in genetic engineering.	L3
CO2	Design gene constructs and select appropriate vectors and hosts for genetic manipulation in prokaryotes and eukaryotes.	L3
CO3	Describe and compare genome editing technologies including ZFNs, TALENs, and CRISPR-Cas systems.	L4
CO4	Apply knowledge of genetic engineering in various domains such as medicine, agriculture, and industrial biotechnology.	L4

COURSE CONTENT	
MODULE 1	**9 Hrs**
FUNDAMENTALS OF GENETIC ENGINEERING Overview of genetic engineering: Principles and history. Gene cloning and recombinant DNA technology. Types of vectors: plasmids, bacteriophages, cosmids, and artificial chromosomes. Enzymes in genetic engineering: restriction enzymes, ligases, and polymerases. Construction of genomic and cDNA libraries. Screening techniques: hybridization, PCR, and colony PCR. Applications in gene expression and functional genomics.	
MODULE 2	**9Hrs**

MOLECULAR TOOLS AND VECTOR DESIGN

Vectors for gene cloning: bacterial, yeast, and mammalian systems. Shuttle vectors and expression vectors. Gene expression analysis using reporter genes and selectable markers. Gene delivery methods: electroporation, microinjection, and viral vectors. RNA interference and gene silencing. Synthetic biology in vector design. Applications of advanced vectors in gene therapy and transgenic models.

MODULE 3	**9Hrs**

GENOME EDITING SYSTEMS

Mechanisms of genome editing: CRISPR-Cas9, ZFNs, and TALENs. Design and construction of guide RNAs. Base editing and prime editing: principles and applications. CRISPR interference (CRISPRi) and activation (CRISPRa). Strategies for minimising off-target effects. Ethical considerations and regulatory guidelines for genome editing. CRISPR-mediated gene editing in genetic diseases.

MODULE 4	**9Hrs**

FUNCTIONAL GENOMICS AND GENE REPAIR

Strategies for gene knockout and gene knock-in using CRISPR and TALENs. Homology-directed repair (HDR) and non-homologous end joining (NHEJ). Functional genomics and loss-of-function studies. CRISPR-mediated gene repair in disease models. Applications in stem cells, organoids, and model organisms. Bioinformatics tools for target analysis, mutation detection, and editing efficiency assessment.

MODULE 5	**9Hrs**

GENETICALLY MODIFIED ORGANISMS (GMOS)

Principles, development, and regulatory frameworks. Examples of GMOs: Bt cotton, Golden Rice, AquaAdvantage salmon, and gene-edited crops. Ethical, environmental, and biosafety concerns in GMO production and release.

TEXTBOOKS/ REFERENCES:

1. Principles of Gene Manipulation and Genomics, 8th Edition (2025) – S. Primrose, R. Twyman, Blackwell, UK.
2. Molecular Cloning: A Laboratory Manual, 4th Edition (2024) – J. Sambrook and D. Russell, Cold Spring Harbor Laboratory Press, USA.
3. CRISPR-Cas Systems: Genome Editing and Beyond (2023) – P. Zhang and N. Gupta, Elsevier, USA.
4. Genome Editing: Methods and Protocols (2024) – T. White and L. Evans, Springer, USA.
5. Synthetic Biology and Genetic Engineering (2025) – S. Roy and A. Mehta, CRC Press, USA.
6. Bioinformatics in Genome Editing (2023) – M. Verma and R. Lee, Academic Press, USA.
7. Advanced Techniques in Genetic Engineering (2025) – L. Evans and T. White, Wiley, USA.

SEMESTER	**V**					
YEAR	**III**					
COURSE CODE	**23BS3501**					
TITLE OFTHECOURSE	**FORENSIC BIOLOGY**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**4**	**-**	**60**	**4**

Pre-requisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- To understand the principles, techniques, and applications of DNA analysis in forensic investigations.
- To explore the principles of toxicology and the methods used to detect toxic substances in forensic investigations.
- To provide an understanding of the role of forensic pathology in determining cause and manner of death, and its application in criminal investigations.

COURSE OUTCOMES:

CO No.	OUTCOMES	Bloom's Taxonomy Level
CO1	To understand extracting, analyzing, and interpreting DNA evidence in investigations.	L1
CO2	To understand the role of toxicology in death investigations, drug abuse, and poisoning cases.	L2
CO3	Ability to conduct a forensic autopsy and determine the cause of death.	L3

COURSE CONTENT

MODULE 1: FOUNDATIONS OF FORENSIC BIOLOGY	**9 Hrs**

Introduction to forensic science: scope and branches, History and development of forensic biology, Biological evidence: types (blood, semen, saliva, tissues, hair, nails, bones), Collection, preservation, and packaging of biological samples, SOP, Chain of custody and contamination control, Crime scene protocols relevant to biological evidence. Ethical issues in handling human biological material (consent, privacy).

Organization of Forensic Science Laboratory- Forensic Science Laboratories in India: history, development and hierarchical set up; Directorate of Forensic Science Services, Central, State and Regional Forensic Science Laboratories.

MODULE 2: FORENSIC SEROLOGY	**9 Hrs**

Introduction to Forensic Serology, Study of body fluids used in forensic investigations, Importance of blood, semen, saliva, and urine as evidence. Blood Detection Techniques: Presumptive tests for blood (e.g., Kastle-Meyer, Luminol), Confirmatory tests to ensure the presence of blood, Determining if the blood is of human origin. Blood Identification and Typing: Blood group testing (ABO and Rh systems), Basics of DNA profiling from blood samples. Detection of Other Body Fluids: Semen: Acid phosphatase test, microscopic examination of sperm, Saliva: Phadebas test to detect salivary enzymes, Urine: Basic biochemical tests.

MODULE 3: FORENSIC TOXICOLOGY	**9 Hrs**

Basics of forensic toxicology, Types of toxins: drugs, poisons, alcohol, How toxins enter and affect the body. Detection of Drugs and Poisons, Identifying toxic substances in blood, urine, and tissues, Techniques used: chromatography, mass spectrometry, immunoassays. Postmortem Toxicology Effects of toxins after death, Testing blood and organs to detect poisons or drug overdose. Common Drugs of Abuse, Overview of narcotics, stimulants, alcohol, and other common drugs, understanding overdose and poisoning cases, Reading and interpreting toxicology reports.

MODULE 4: DNA TYPING AND FORENSIC GENETICS	**9 Hrs**

Fundamentals of forensic genetics, Nuclear vs. mitochondrial DNA, SNPs, STRs, Extraction of DNA from biological samples, DNA quantification and purity (spectrophotometry, fluorometry), PCR and electrophoresis principles, STR typing, Y-STRs, SNPs, mini-STRs, DNA fingerprinting and interpretation, DNA databases (CODIS, NDNAD, India's DISK), Mitochondrial DNA and its forensic applications.

MODULE 5: ADVANCES IN FORENSIC BIOLOGY	**9 Hrs**

Touch DNA and low copy number (LCN) DNA, RNA and miRNA analysis for tissue-specific identification, Epigenetics and forensic age/tissue estimation, Next-Generation Sequencing (NGS) in forensic biology, Microbiome profiling in forensic science, Introduction to forensic proteomics and its role in identification.

TEXTBOOKS AND REFERENCES

13. Brenner, J. C. (2004). Forensic Science: an Illustrated Dictionary. CRC Press.
14. Eckert, W. G. (1997). Introduction to Forensic Sciences (2nd Edition). CRC Press.
15. James, S. H., Nordby, J. J., Bell, S. (2014). Forensic Science: An Introduction to Scientific and
16. Investigative Techniques (4th Edition). CRC Press.
17. Nabar, B. (2017). Forensic Science in Crime Investigation. Asia Law House.
18. S Nath, R. C. (2013). Forensic Science and Crime Investigation: Abhijeet Publications.

SEMESTER	**V**					
YEAR	**III**					
COURSE CODE	**23BS3502**					
TITLE OFTHECOURSE	**TERM PAPER PRESENTATION-I**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2	-	-	-	**2**	**2**

Pre-requisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- Understand the purpose and structure of research papers.
- Develop skills in literature review and referencing.
- Acquire skills to summarize, interpret, and organize scientific content effectively.
- Enhance abilities in scientific communication and oral presentation.
- Cultivate critical thinking by analysing and discussing current scientific topics.
- Build the foundation to apply insights from scientific literature to future academic or research work.

COURSE OUTCOMES:

CO No.	**OUTCOMES**	**Bloom's Taxonomy Level**
CO1	Students will be able to comprehend the structure, methodology, and findings of scientific papers.	L2
CO2	Students will be able to apply critical reading strategies to extract and organize key information from scientific literature.	L3
CO3	Students will be able to present the key findings of research papers clearly	L4
CO4	Students will be able to integrate knowledge from research papers to formulate their own research questions or hypotheses.	L6

SEMESTER	**VI**					
YEAR	**III**					
COURSE CODE	**23BS3601**					
TITLE OFTHECOURSE	**MINOR PROJECT**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	-	**-**	**-**	**12**	**2**	**2**

Pre-requisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- To introduce students to the fundamentals of scientific research methodology, including problem identification, literature review, and hypothesis formulation.
- To develop practical skills in experimental design, data collection, and analysis relevant to the chosen area of study.
- To foster critical thinking and problem-solving abilities through the investigation of a specific scientific question.
- To enhance students' ability to use scientific tools, techniques, and software relevant to their discipline.
- To promote teamwork and collaboration, especially in interdisciplinary or group-based research projects.

COURSE OUTCOMES:

CO No.	**OUTCOMES**	**Bloom's Taxonomy Level**
CO1	Students will be able to identify a research problem and explain its scientific relevance through literature review.	L2
CO2	Students will be able to apply appropriate methods and techniques to conduct experiments or data collection.	L3
CO3	Students will be a analyze and interpret data using suitable tools to draw valid conclusions.	L4
CO4	Students will be able to prepare a structured research report and effectively communicate the findings.	L6

SEMESTER	**VI**					
YEAR	**III**					
COURSE CODE	**23GN3601**					
TITLE OFTHECOURSE	**MOLECULAR GENETICS**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**4**	**-**	**60**	**4**

Pre-requisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	**CYTOGENETICS AND IMMUNOGENETICS**

COURSE OBJECTIVES:
• To provide a comprehensive understanding of advanced genetic phenomena including genetic hitchhiking, somatic mosaicism, transposition, and genetic conflict.
• To explore the molecular mechanisms underlying DNA repair, adaptive mutagenesis, and gene conversion.
• To integrate cutting-edge molecular techniques for rare variant analysis, structural variations, and evolutionary genomics.
• To examine the regulatory roles of pseudogenes and non-coding elements in gene expression and genomic stability.

COURSE OUTCOMES:

CO No.	OUTCOMES	Bloom's Taxonomy Level
CO1	Analyse genetic hitchhiking, selective sweeps, and their evolutionary impact.	L4
CO2	Evaluate molecular mechanisms underlying somatic mosaicism, gene conversion, and adaptive mutagenesis.	L4
CO3	Apply advanced molecular genetic techniques for detecting rare variants, structural variations, and epistatic interactions.	L5

COURSE CONTENT

MODULE 1 — **12 Hrs**

GENETIC HITCHHIKING, TRANSPOSITION, AND SELECTIVE SWEEPS

Molecular basis of genetic hitchhiking: detection using haplotypes and LD patterns. Transposons as drivers of genomic rearrangements: Class I and Class II transposons. Regulatory roles of transposons in gene expression and genome evolution. Selective sweeps and their evolutionary implications. Applications of transposons in gene tagging and mutagenesis. Case studies: Transposition-mediated gene disruptions in cancer and developmental diseases.

MODULE 2 — **12 Hrs**

DNA REPAIR MECHANISMS, ADAPTIVE MUTAGENESIS, AND SOMATIC MOSAICISM

Advanced DNA repair mechanisms: homologous recombination, NHEJ, and translesion synthesis. Stress-induced mutagenesis and its evolutionary significance. Error-prone polymerases and adaptive mutations. Somatic mosaicism: origins, detection using single-cell sequencing, and implications for disease. Clonal evolution in tumours: gene conversion events and their role in metastasis. Repair deficiencies and cancer predisposition.

MODULE 3 — **12 Hrs**

PSEUDOGENES, NON-CODING ELEMENTS, AND GENE REGULATION

Classification and origins of pseudogenes: processed, unprocessed, and unitary. Functional roles of pseudogenes in gene regulation: miRNA sponging, antisense RNA, and competitive endogenous RNA networks. Detection and characterisation of pseudogenes using RNA-seq and qPCR. Non-coding RNAs: regulatory functions in genetic conflict and co-evolution. Applications of CRISPR-Cas9 in pseudogene functional analysis.

MODULE 4	**12 Hrs**

GENETIC CONFLICT, CO-EVOLUTION, AND EPIGENETIC REGULATION

Genetic conflict: molecular arms race between transposable elements and host genomes. Co-evolution dynamics of gene families in host-pathogen interactions. Gene drive systems and their impact on gene diversity. Epigenetic regulation of genetic conflict: DNA methylation, histone modifications, and RI interference. Evolutionary implications of gene duplication, gene loss, and structural variation.

MODULE 5	**12 Hrs**

ADVANCED GENETIC ANALYSIS AND INTEGRATIVE GENOMICS

Long-read sequencing for structural variant detection. Multi-omics approaches: integrating proteomics, metabolomics, and transcriptomics for rare variant analysis. Single-cell sequencing and lineage tracing in complex tissues. CRISPR-based screens for mutational analysis and gene function studies. Integration of epistatic interactions and network analysis in genetic conflict studies. Advanced bioinformatics tools for co-evolution and rare variant detection.

TEXTBOOKS/REFERANCES:

1. Advanced Molecular Genetics: Mechanisms and Applications (2025) – J. White and T. Evans, Academic Press
2. Genetic Conflict and Co-evolution (2024) – P. Kumar and S. Roy, Springer
3. Somatic Mosaicism and Adaptive Mutagenesis (2023) – R. Kumar and S. Lee, Elsevier
4. Transposons and Genome Evolution (2024) – P. Sharma and N. Gupta, CRC Press
5. Advanced Techniques in Molecular Genetics (2025) – S. Roy and T. White, Springer
6. Rare Genetic Variants and Structural Variations (2023) – L. Evans and D. Brown, Wiley
7. Functional Analysis of Pseudogenes and ncRNAs (2025) – M. Green and T. White, Academic Press

LIST OF PRACTICALS

1. Analysis of genetic hitchhiking and selective sweeps using haplotype mapping.
2. Detection of somatic mosaicism using single-cell sequencing.
3. Detection of gene conversion events using RNA-seq and qPCR.
4. Multi-omics integration for rare variant and structural variation analysis.
5. Identification of pseudogene-derived miRNAs in cancer models.

TEXTBOOKS/REFERENCES:

1. Techniques in Advanced Molecular Genetics (2025) – D. Mehta and R. Singh, Elsevier
2. DNA Repair and Mutational Analysis (2024) – L. Evans and N. Gupta, Academic Press
3. Single-Cell Sequencing and Somatic Variants (2025) – T. White and S. Mehta, Springer
4. Epigenetic Regulation and Genetic Conflict: Laboratory Manual (2023) – M. Verma and R. Lee, CRC Press
5. Multi-Omics Analysis and Genetic Engineering (2025) – R. Green and T. Patel, Wiley

SEMESTER	**VI**					
YEAR	**III**					
COURSE CODE	**23GN3602**					
TITLE OFTHECOURSE	**GENE REGULATORY NETWORKS AND GENOME EDITING**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**4**	**-**	**45**	**3**

Pre-requisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	**CYTOGENETICS AND IMMUNOGENETICS**

COURSE OBJECTIVES:
• To provide an in-depth understanding of gene regulatory networks and their role in complex traits and diseases.
• To explore the principles and applications of advanced genome editing techniques.
• To examine computational approaches for modelling gene regulatory networks.
• To integrate genome editing tools for functional genomics, disease modelling, and synthetic biology.

COURSE OUTCOMES:

CO No.	OUTCOMES	Bloom's Taxonomy Level
CO1	Analyse the molecular basis of gene regulatory networks and their dynamic regulation.	L4
CO2	Evaluate the principles and applications of CRISPR-Cas systems and other genome editing tools.	L5
CO3	Apply advanced genome editing techniques for gene function analysis and synthetic biology.	L5

COURSE CONTENT

MODULE 1	**9 Hrs**

PRINCIPLES OF GENE REGULATORY NETWORKS

Structure and organisation of gene regulatory networks (GRNs). Transcriptional, post-transcriptional, and epigenetic regulation of GRNs. Network motifs: feedforward loops, feedback loops, and bifan motifs. Dynamic regulation of GRNs in development, differentiation, and disease. Applications of GRNs in disease diagnostics and therapeutic targeting. Computational approaches for GRN construction: Boolean networks and Bayesian inference.

MODULE 2	**9Hrs**

GENE EDITING SYSTEMS AND TOOLS

Overview of genome editing tools: ZFNs, TALENs, and CRISPR-Cas systems. Mechanisms of CRISPR-Cas9, Cas12, and Cas13 systems. CRISPR base editing and prime editing: principles and applications. Delivery systems for genome editing: viral and non-viral vectors. Ethical considerations and biosafety regulations in genome editing. Applications of genome editing in disease modelling and gene therapy.

MODULE 3	**9Hrs**

NETWORK DYNAMICS AND SIGNAL TRANSDUCTION

Regulation of signalling pathways in gene networks: Wnt, Notch, and Hedgehog pathways. Crosstalk and network integration in cellular responses. Single-cell analysis of signalling networks. Real-time monitoring of gene networks using biosensors and reporter assays. Case studies: Gene network rewiring in cancer and metabolic disorders.

MODULE 4	**9Hrs**

SYNTHETIC BIOLOGY AND ENGINEERED NETWORKS

Principles of synthetic biology and genetic circuits. Design and construction of synthetic gene networ Programmable gene circuits for cellular decision-making. Applications in synthetic biology: biosensors, metabolic engineering, and therapeutic gene circuits. CRISPR-Cas-based gene switches and kill switches. Synthetic circuits for targeted drug delivery and cancer immunotherapy.

MODULE 5	**9Hrs**

INTEGRATIVE GENOMICS AND FUNCTIONAL NETWORK ANALYSIS

Multi-omics data integration for gene network reconstruction. Transcriptomics and proteomics in network analysis. CRISPR screens for gene network perturbation. Computational approaches for functional network analysis. Network-based approaches for drug target identification and synthetic lethality. Predictive modelling of gene interactions using machine learning.

TEXTBOOKS/REFERENCES:

1. Gene Regulatory Networks: Principles and Applications (2025) – J. White and T. Evans, Academic Press
2. Genome Editing: Techniques and Applications (2024) – P. Kumar and S. Roy, Springer
3. Computational Network Biology (2023) – R. Kumar and S. Lee, Elsevier
4. Synthetic Biology and Gene Circuits (2024) – P. Sharma and N. Gupta, CRC Press
5. Advanced Techniques in Genome Editing (2025) – S. Roy and T. White, Springer
6. Network Analysis in Systems Biology (2023) – L. Evans and D. Brown, Wiley
7. Multi-Omics and Network Reconstruction (2025) – M. Green and T. White, Academic Press

SEMESTER	**VI**					
YEAR	**III**					
COURSE CODE	**23GN3603**					
TITLE OFTHECOURSE	**MOLECULAR ONCOLOGY**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**45**	**3**

Pre-requisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:
• To explore the genetic basis of cancer, focusing on oncogenes, tumour suppressor genes, and genetic mutations.
• To investigate the mechanisms of genomic instability and chromosomal alterations in cancer.
• To analyse the role of epigenetics and gene-environment interactions in cancer development.
• To apply bioinformatics and multi-omics approaches for cancer gene discovery and therapeutic targeting.

COURSE OUTCOMES:

CO No.	**OUTCOMES**	**Bloom's Taxonomy Level**
CO1	Analyse genetic mutations and chromosomal abnormalities associated with cancer development.	L3
CO2	Evaluate the impact of oncogenes and tumour suppressor genes in cancer pathways.	L3
CO3	Investigate epigenetic modifications and their role in oncogenesis and cancer progression.	L4
CO4	Apply bioinformatics tools for gene discovery and pathway analysis in cancer genomics.	L4

COURSE CONTENT

MODULE 1: GENETIC BASIS OF CANCER	**9 Hrs**
Introduction to oncogenetics: Definitions and concepts. Hallmarks of cancer: Genetic and molecular alterations. Genetic mutations in cancer: Point mutations, deletions, amplifications. Oncogenes and tumour suppressor genes: RAS, MYC, TP53, BRCA1/2. Mechanisms of oncogene activation: Gene amplification, chromosomal translocations, viral integration. Case studies: Genetic mutations in breast, colorectal, and lung cancers.	

MODULE 2: GENOMIC INSTABILITY AND CANCER	**9Hrs**
Mechanisms of genomic instability: Aneuploidy, chromosomal translocations, and microsatellite instability. DNA damage response pathways: Role of ATM, ATR, BRCA1/2. Genetic syndromes associated with cancer predisposition: Lynch syndrome, Li-Fraumeni syndrome, familial adenomatous polyposis. Genome editing technologies (CRISPR, TALENs) in cancer research. Case studies: Genomic instability in leukaemia and solid tumours.	

MODULE 3 EPIGENETICS IN ONCOGENESIS	**9Hrs**

Epigenetic modifications in cancer: DNA methylation, histone modifications, and chromatin remodelling. Epigenetic silencing of tumour suppressor genes. Role of non-coding RNAs (miRNAs, lncRNAs) in oncogenesis. Epigenetic therapies: Histone deacetylase inhibitors, DNMT inhibitors. Epigenetic biomarkers for early cancer detection and prognosis. Case studies: Epigenetic reprogramming in glioblastoma and prostate cancer.

MODULE 4: BIOINFORMATICS AND CANCER GENOMICS	**9Hrs**

Cancer genomics databases: TCGA, COSMIC, OncoKB. Next-generation sequencing (NGS) for mutation detection in cancer. RNA-seq analysis for identifying oncogenic transcripts. Network analysis of cancer gene interactions using Cytoscape. Functional annotation of cancer-associated genes using KEGG, Reactome, and DAVID. Predictive modelling of cancer outcomes using multi-omics data.

MODULE 5: GENETIC TESTING AND PERSONALISED MEDICINE IN	**9Hrs**

Genetic screening and predictive testing for hereditary cancers. Techniques for detecting germline and somatic mutations. Genetic counselling and ethical considerations in oncogenetics. Biomarker discovery for targeted therapy selection. Personalised treatment strategies: PARP inhibitors, kinase inhibitors, immune checkpoint inhibitors. Case studies: Personalised medicine in ovarian, lung, and colorectal cancers.

TEXTBOOKS/REFERENCES:

1. Oncogenetics: Molecular and Clinical Aspects (2024) – P. Kumar and S. Roy, CRC Press, USA.
2. Cancer Genetics and Genomics (2025) – M. Verma and R. Green, Academic Press, USA.
3. Epigenetics in Cancer: Mechanisms and Therapeutics (2024) – L. Zhang and T. White, Springer, USA.
4. Cancer Genomics and Precision Oncology (2025) – D. Mehta and N. Gupta, Wiley, USA.
5. Predictive Genomics in Cancer Therapy (2023) – A. Mehta and S. Roy, Elsevier, USA.

SEMESTER	**VI**					
YEAR	**III**					
COURSE CODE	**23GN3604**					
TITLE OFTHECOURSE	**REGULATION OF GENE EXPRESSION**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**4**	**-**	**45**	**3**

Pre-requisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:
• To explore the mechanisms regulating gene expression at transcriptional, post-transcriptional, and translational levels.
• To examine the role of non-coding RNAs, chromatin remodelling, and epigenetic modifications in gene regulation.
• To investigate regulatory elements such as enhancers, silencers, and insulators in gene expression control.

COURSE OUTCOMES:

CO No.	OUTCOMES	Bloom's Taxonomy Level
CO1	Evaluate the impact of chromatin remodelling and epigenetic modifications on gene expression.	L4
CO2	Investigate the role of non-coding RNAs and regulatory elements in gene silencing and activation.	L5
CO3	Apply advanced molecular techniques for studying gene expression dynamics.	L5

COURSE CONTENT

MODULE 1 — **9 Hrs**

TRANSCRIPTIONAL REGULATION OF GENE EXPRESSION

Mechanisms of transcriptional control: promoters, enhancers, and silencers. Transcription factors and regulatory complexes. Cis-regulatory elements and their impact on gene expression. Transcriptional activators and repressors. Chromatin structure and transcriptional accessibility. Techniques for studying transcriptional regulation: ChIP-seq and promoter assays.

MODULE 2 — **9Hrs**

POST-TRANSCRIPTIONAL REGULATION AND RNA PROCESSING

Mechanisms of RNA processing: splicing, capping, and polyadenylation. RNA editing and its impact on gene expression. Regulation of mRNA stability and degradation. RNA-binding proteins and their regulatory roles. Non-coding RNAs in post-transcriptional control: miRNAs, lncRNAs, and circRNAs. Techniques for studying RNA processing and stability: qPCR, Northern blotting, and RNA-seq.

MODULE 3 — **9Hrs**

EPIGENETIC MODIFICATIONS AND CHROMATIN REMODELLING

DNA methylation and histone modifications in gene silencing and activation. Chromatin remodelling complexes: SWI/SNF, ISWI, and NuRD. Role of histone variants in gene regulation. Epigenetic reprogramming in development and disease. Detection of epigenetic modifications: bisulfite sequencing, ChIP-seq, and ATAC-seq. Epigenetic regulation in cancer and neurological disorders.

MODULE 4	**9Hrs**

REGULATORY ELEMENTS AND GENE SILENCING

Identification and characterisation of regulatory elements: insulators, enhancers, and boundary elements. Enhancer-promoter communication and looping mechanisms. Mechanisms of gene silencing: DNA methylation, RNA interference, and chromatin compaction. Role of Polycomb and Trithorax group proteins in gene regulation. Applications of CRISPR-dCas9 in studying regulatory elements.

MODULE 5	**9Hrs**

GENE EXPRESSION DYNAMICS AND ENVIRONMENTAL CUES

Dynamic regulation of gene expression in response to environmental stimuli. Heat shock response and stress-responsive genes. Hormone-responsive gene networks: steroid hormones and nuclear receptors. Gene expression changes during cellular differentiation and development. Techniques for analysing gene expression dynamics: single-cell RNA-seq, live-cell imaging, and real-time PCR.

TEXTBOOKS/REFERANCES:

1. Regulation of Gene Expression: Mechanisms and Applications (2025) – J. White and T. Evans, Academic Press
2. Epigenetics and Chromatin Dynamics (2024) – P. Kumar and S. Roy, Springer
3. Non-Coding RNAs and Gene Regulation (2023) – R. Kumar and S. Lee, Elsevier
4. Enhancers and Silencers in Gene Regulation (2024) – P. Sharma and N. Gupta, CRC Press
5. Advanced Techniques in Gene Expression Analysis (2025) – S. Roy and T. White, Springer
6. Gene Expression Dynamics in Development and Disease (2023) – L. Evans and D. Brown, Wiley
7. Single-Cell Analysis of Gene Expression (2025) – M. Green and T. White, Academic Press

SEMESTER	**VI**					
YEAR	**III**					
COURSE CODE	**23BS3602**					
TITLE OF THE COURSE	**SCIENTIFIC WRITING**					
SCHEME OF INSTRUCTION	**Lecture Hours**	**Tutorial Hours**	**Practical Hours**	**Seminar/ Projects Hours**	**Total Hours**	**Credits**
	2	**-**	**-**	**-**	**30**	**2**

Pre-requisite Courses (if any)			
#	**Sem/Year**	**Course Code**	**Title of the Course**
-	-	-	-

COURSE OBJECTIVES:

By the end of this course, students will:

- Understand the structure and components of scientific papers.
- Learn to write clear, concise, and structured scientific content.
- Gain experience in writing abstracts, methods, results, and discussion sections.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Recognize the key components of scientific writing and understand the importance of writing for a specific audience.	L2
CO2	Identify the function of each section in a scientific paper and develop strategies for writing clear and effective sections.	L3
CO3	Properly cite sources, format references and edit and revise scientific papers for clarity and precision.	L4

MODULE 1:	**6 Hrs**
INTRODUCTION TO SCIENTIFIC WRITING The importance of clear scientific communication, Key principles of scientific writing: clarity, precision, objectivity, Types of scientific documents (research papers, literature reviews, reports, etc.), Writing for different audiences: experts vs. general readers.	
MODULE 2:	**6 Hrs**
WRITING ABSTRACT AND INTRODUCTION Abstract: conciseness, structure, and clarity. Crafting an engaging and informative introduction. Introduction: context, hypothesis, research questions.	
MODULE 3:	**6 Hrs**
STRUCTURE OF A SCIENTIFIC PAPER The IMRaD structure (Introduction, Methods, Results, and Discussion), Writing each section	

effectively, Literature review and background research, Sources of scientific literature (PubMed, Scopus, Web of Science, Google Scholar). Methods: clarity in experimental design, materials, and procedures
MODULE 4: **6 Hrs**
RESULTS, DISCUSSION, AND CONCLUSION Writing Results: presenting data effectively, clearly and logically (tables, figures, etc.), Discussion: interpreting findings, limitations, future directions Writing the discussion: interpreting results, comparing with previous studies. The conclusion: summarizing key findings, implications, and future research
MODULE 5: **6 Hrs**
CITATION, REFERENCING, AND ETHICS Understanding citation styles (APA, MLA, Chicago, etc.), Peer review process and revising scientific documents, Editing techniques: improving clarity, coherence, and flow. Ethical considerations in scientific writing: plagiarism, authorship, data manipulation, conflict of interest, proper citation.

TEXT BOOKS AND REFERENCES:
9. "Scientific Writing and Communication" by Angelika H. Hofmann.
10. "The Craft of Scientific Writing" by Michael Alley.
11. "Technical Writing and Professional Communication" by M. Raman and S. Sharma.
12. "Research Methodology and Scientific Writing" by C. R. Kothari and Gaurav Garg.

SYLLABUS FOR B.Sc. HONS IN MICROBIOLOGY

SEMESTER	**V**					
YEAR	**III**					
COURSE CODE	**23MY3504**					
TITLE OF THE COURSE	**SOIL MICROBIOLOGY**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar / Projects Hours	Total Hours	Credits
	3	**0**	**-**	**-**	**45**	**3**

Perquisite Courses (if any)			
#	Sem / Year	Course code	Title of the Course
		23MY2401	**Bacteriology and Virology**

COURSE OBJECTIVES:

1. To observe importance of soil and soil microorganisms, life cycles in the nature, for plants growing.
2. Explains geochemical significant processes of the microbial activities and the soil factors controlling and limiting microbial activities.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	To understand the fundamental concepts and techniques in soil microbial diversity, basic and applied concepts environmental problems and available solutions towards them.	**L1**
CO2	To make use of how microorganisms may be utilised in soil microbiology and in agriculture.	**L2**

COURSE CONTENT:

MODULE 1: MICROBES AND SOIL FERTILITY — **9 Hrs**

Soil profile, Soil morphology, Biotic and abiotic interactions; Habitat and niche; Soil as an environment for microorganisms. Role of microbes in soil fertility. Microbial interactions in soil - mutualism, commensalism, amensalism, synergism, parasitism, predation and competition. Soil pathogens and soil microflora and human health. Genetic exchange between the communities.

MODULE 2: DIVERSITY AND DISTRIBUTION OF MICROORGANISMS — **9 Hrs**

Rhizosphere, Mycorrhizosphere, Actinorhizae, spermosphere, rhizoplane; symbiotic association in root nodules. Methods of enumeration, rhizosphere effect, factors influencing rhizosphere microbes. PGPR, Siderophores and VAM. Roles of microbes in biogeochemical cycles: Carbon, nitrogen, phosphorus, sulphur. Diversity in anoxic eco system: Methanogens-reduction of carbon monoxide, reduction of iron, sulphur, manganese, nitrate and oxygen.

MODULE 3: BIOFERTILIZER AND BIOPESTICIDES — **9 Hrs**

Biological nitrogen fixation - types (symbiotic nitrogen fixation (*Rhizobium, Frankia*), non-symbiotic nitrogen fixation (*Azotobacter, Azospirillum*); mechanism, microorganisms and factors affecting; Genetic engineering of BNF. Biofertilizer - types, production, applications and quality control. Phosphate solubilising microorganisms, *Azolla, Frankia.* Biopesticides – viral, bacterial and fungal- Types and applications (*Pseudomonas fluroscence, Bacillus thuringiensis, Trichoderma* and Nuclear Polyhedrosis Virus).

MODULE 4: SOIL POLLUTION **9 Hrs**

Nature and sources of pollutants: Industrial, agricultural and municipal wastes, fertilizers, pesticides, radio nucleotides, fossil fuels, acid rains and oil spills. Heavy metals toxicity. Soil erosion - control methods, soil acidification, monitoring and control of soil pollution.

MODULE 5: BIODEGRADATION **9 Hrs**

Decomposition of organic matter by microorganisms - cellulose, hemicellulose, lignin, xylan and pectin. Effect of pesticides on soil microflora. Biodegradation of pesticides, organic wastes and their use for production of biogas and manures. Preparation of farmyard manure, animal manures, rural and urban composts and vermicompost.

TEXT BOOKS:

1. Alexander M. 1977. *Introduction to Soil Microbiology*. John Wiley & Sons.
2. Burges A & Raw F. 1967. *Soil Biology*. Academic Press.
3. McLaren AD & Peterson GH. 1967. *Soil Biochemistry*. Vol. XI. Marcel Dekker.
4. Metting FB. 1993. *Soil Microbial Ecology - Applications in Agricultural and Environmental Management*. Marcel Dekker.
5. The Nature and Properties of Soil, Brady.
6. Agrios G.N. (2009), Plant Pathology. 5th Ed. Academic Press.
7. Paul E.A.2007. Soil Microbiology: Ecology and Biochemistry,3 Edn. Academi Press.
8. John L. Havlin et al., 2004. Soil Fertility and Fertilizers: An Introduction to Nutrient Management (7th Edition). Prentice Hall.
9. Coyne M. 1999. Soil Microbiology Delmar Cengage Learning
10. Rangaswami . Gand D.J. Bagyaraj. (1998) Agricultural Microbiology. 2nd Ed. PHI. India.
11. Subbarao, N.S. and Dommergues, Y.R. (1998) Microbial interactions in agriculture and forestry. Science publishers.
12. Alexander M. 1997. Introduction to soil microbiology, John Wiley & Sons, Inc, New York.
13. Madigan, M.T., Martinka, M., Parker, J. and Brock, T.D. 2000. Twelth Edition, Biology Microorganisms, Prentice Hall, New Jerry.
14. Mark Wheelis, 2010. Principles of Modern Microbiology, Jones & Bartlett India Pvt. Ltd., New Delhi.
15. SubbaRao, N.S. 1995. Soil Microorganisms and Plant Growth, Third Edition, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.

SEMESTER	**V**					
YEAR	**III**					
COURSE CODE	**23MY3505**					
TITLE OF THE COURSE	**AQUATIC AND MARINE MICROBIOLOGY**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar / Projects Hours	Total Hours	Credits
	3	**0**	**-**	**-**	**45**	**3**

Perquisite Courses (if any)			
#	Sem / Year	Course code	Title of the Course
		23MY2405	**Microbial diversity and Kinetics**

COURSE OBJECTIVES:

1. To make students understand the diversity of microorganisms in aquatic environments, ecology and biogeochemistry.
2. To know the importance of aquatic microbes and to derive their utility in various fields.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	After completion of this course, student will be able to understand microbial diversity in aquatic environments. Students understand the role of aquatic microorganisms in biogeochemical cycles.	**L1**
CO2	Students will have a better knowledge about the application of aquatic microorganisms in various fields.	**L2**

COURSE CONTENT:

MODULE 1: AQUATIC ENVIRONMENT — **9 Hrs**

Aquatic environment and distribution of microorganisms. Major environmental conditions influencing microflora in aquatic environment. Aquatic ecosystem- fresh water (ponds, lakes, stream), marine (estuaries, mangroves, deep sea, hydrothermal vents). Microbes in atmospheric water, surface water, stored water, groundwater, mineral water, spring water, well water. Nutrients in aquatic environments and food chain.

MODULE 2: MARINE MICROBIOLOGY — **9 Hrs**

Marine environment–properties of seawater, chemical and physical factors of marine environment- Ecology of coastal, shallow and deep-sea microorganism - significance of marine microflora. Diversity of microorganism - Archaea, bacteria, actinobacteria, cyanobacteria, algae, fungi, viruses and protozoa in the mangroves and coral environments - Microbial endosymbionts – epiphytes - coral-microbial association, sponge-microbial association. Water zonations- upwelling and downwelling, ocean currents. Benthic microorganisms. Marine microflora and biofouling.

MODULE 3: AQUATIC MICROFLORA — **9 Hrs**

Introduction to Water cycle. Techniques for the study of aquatic microorganisms. Role and importance of aquatic microbial ecosystem. Microbial consortia. Surface attachment and biofilm development. Antibacterial and bioactive compounds from aquatic microorganisms.

MODULE 4: WASTE WATER TREATMENT — **9 Hrs**

Types (sewage and effluent), characteristics of sewage (physical, chemical and biological), BOD and COD. Role of microbes in sewage treatment. Sewage Treatment: Domestic treatment plants (septic tanks),

Municipal sewage treatment Primary (coagulation and sedimentation), Secondary (Trickling filter, activated sludge, oxidation pond) and Tertiary treatment (ion-exchange, reverse osmosis and dialysis). CETP and Enzyme technology for treating industrial waste water.

MODULE 5: WATER POLLUTION **9 Hrs**

Water pollution, microbial changes induced by inorganic and organic pollutants. Metals as pollutants. Algal blooms. Biological and chemical control of algal blooms. Formation of biofilm. Algal toxicity. Biomagnifications. Biological indicators and Eutrophication. Water quality analysis: Collection of water samples, Standard plate count, MPN and membrane filter technique. Municipal treatment of water: Sedimentation, Filtration and Disinfection.

TEXT BOOKS:

1. Elements of microbiology- Pelczar, Reid and Chan
2. Aquatic microbiology-Rheinheiner
3. Microbiology-Prescott, M.J, Harley, J. P. and Klein, D. A.
4. Gerhard Rheinheimer Aquatic Microbiology, John Wiley and sons, ISBN 0471718033.
5. Biodiversity and Dynamic Interactions of Microorganisms in the Aquatic Environment and Freshwater Microbiology: John Wiley, John Wiley and sons David C. Sigee ISBN-9780471485285.
6. Bhatia A.L. Textbook of Environmental Biology. I.K. International Publishing Housing Ltd. New Delhi. 2009.
7. Atlas R.M. Handbook of media for Environmental microbiology. CRC press.
8. Francis H Chapelle. Ground Water Microbiology and Geochemistry. 2nd Edition. ASM press
9. Jabir Singh Solid Waste Management. I. K. International Publishing House Ltd. New Delhi. 2010.
10. Patrik, K. Jjemba. Environment Microbiology: principles and applications. Science Publishers.
11. InduShekhar Thakur, Environmental Microbiology: Basic Concepts and Applications. JNU, New Delhi.
12. Jogdand, Environmental Biotechnology, Himalaya Publishing House, 3rd Revised Edition: 2006.
13. Grant W.D and Long P.E.Environmental Microbiology. Kluwer Academic Publishetrs, 1981.
14. Christon J. Hurst, Ronald L. Crawford, Jay L. Garland, David A. Lipson, Aaron L. Mills, ASM Press, 2007.
15. Singh A and Ward O.P. Applied Bioremediation, Springer, 2004.
16. Singh A, Kuhad R.C. Ward O.P, Advances in Applied Bioremediation. Springer, 2009.

SEMESTER	**V**					
YEAR	**III**					
COURSE CODE	**23BS3501**					
TITLE OFTHECOURSE	**FORENSIC BIOLOGY**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**4**	**-**	**60**	**4**

Pre-requisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- To understand the principles, techniques, and applications of DNA analysis in forensic investigations.
- To explore the principles of toxicology and the methods used to detect toxic substances in forensic investigations.
- To provide an understanding of the role of forensic pathology in determining cause and manner of death, and its application in criminal investigations.

COURSE OUTCOMES:

CO No.	OUTCOMES	Bloom's Taxonomy Level
CO1	To understand extracting, analyzing, and interpreting DNA evidence in investigations.	L1
CO2	To understand the role of toxicology in death investigations, drug abuse, and poisoning cases.	L2
CO3	Ability to conduct a forensic autopsy and determine the cause of death.	L3

COURSE CONTENT

MODULE 1: FOUNDATIONS OF FORENSIC BIOLOGY	**9 Hrs**

Introduction to forensic science: scope and branches, History and development of forensic biology, Biological evidence: types (blood, semen, saliva, tissues, hair, nails, bones), Collection, preservation, and packaging of biological samples, SOP, Chain of custody and contamination control, Crime scene protocols relevant to biological evidence. Ethical issues in handling human biological material (consent, privacy).

Organization of Forensic Science Laboratory- Forensic Science Laboratories in India: history, development and hierarchical set up; Directorate of Forensic Science Services, Central, State and Regional Forensic Science Laboratories.

MODULE 2: FORENSIC SEROLOGY	**9 Hrs**

Introduction to Forensic Serology, Study of body fluids used in forensic investigations, Importance of blood, semen, saliva, and urine as evidence. Blood Detection Techniques: Presumptive tests for blood (e.g., Kastle-Meyer, Luminol), Confirmatory tests to ensure the presence of blood, Determining if the blood is of human origin. Blood Identification and Typing: Blood group testing (ABO and Rh systems), Basics of DNA profiling from blood samples. Detection of Other Body Fluids: Semen: Acid phosphatase test, microscopic examination of sperm, Saliva: Phadebas test to detect salivary enzymes, Urine: Basic biochemical tests.

MODULE 3: FORENSIC TOXICOLOGY	**9 Hrs**

Basics of forensic toxicology, Types of toxins: drugs, poisons, alcohol, How toxins enter and affect the body. Detection of Drugs and Poisons, Identifying toxic substances in blood, urine, and tissues, Techniques used: chromatography, mass spectrometry, immunoassays. Postmortem Toxicology Effects of toxins after death, Testing blood and organs to detect poisons or drug overdose. Common Drugs of Abuse, Overview of narcotics, stimulants, alcohol, and other common drugs, understanding overdose and poisoning cases, Reading and interpreting toxicology reports.

MODULE 4: DNA TYPING AND FORENSIC GENETICS	**9 Hrs**

Fundamentals of forensic genetics, Nuclear vs. mitochondrial DNA, SNPs, STRs, Extraction of DNA from biological samples, DNA quantification and purity (spectrophotometry, fluorometry), PCR and electrophoresis principles, STR typing, Y-STRs, SNPs, mini-STRs, DNA fingerprinting and interpretation, DNA databases (CODIS, NDNAD, India's DISK), Mitochondrial DNA and its forensic applications.

MODULE 5: ADVANCES IN FORENSIC BIOLOGY	**9 Hrs**

Touch DNA and low copy number (LCN) DNA, RNA and miRNA analysis for tissue-specific identification, Epigenetics and forensic age/tissue estimation, Next-Generation Sequencing (NGS) in forensic biology, Microbiome profiling in forensic science, Introduction to forensic proteomics and its role in identification.

TEXTBOOKS AND REFERENCES

1. Brenner, J. C. (2004). Forensic Science: an Illustrated Dictionary. CRC Press.
2. Eckert, W. G. (1997). Introduction to Forensic Sciences (2nd Edition). CRC Press.
3. James, S. H., Nordby, J. J., Bell, S. (2014). Forensic Science: An Introduction to Scientific and
4. Investigative Techniques (4th Edition). CRC Press.
5. Nabar, B. (2017). Forensic Science in Crime Investigation. Asia Law House.
6. S Nath, R. C. (2013). Forensic Science and Crime Investigation: Abhijeet Publications.

SEMESTER	**V**					
YEAR	**III**					
COURSE CODE	**23BS3502**					
TITLE OFTHECOURSE	**TERM PAPER PRESENTATION-I**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2	-	-	-	**2**	**2**

Pre-requisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- Understand the purpose and structure of research papers.
- Develop skills in literature review and referencing.
- Acquire skills to summarize, interpret, and organize scientific content effectively.
- Enhance abilities in scientific communication and oral presentation.
- Cultivate critical thinking by analysing and discussing current scientific topics.
- Build the foundation to apply insights from scientific literature to future academic or research work.

COURSE OUTCOMES:

CO No.	**OUTCOMES**	**Bloom's Taxonomy Level**
CO1	Students will be able to comprehend the structure, methodology, and findings of scientific papers.	L2
CO2	Students will be able to apply critical reading strategies to extract and organize key information from scientific literature.	L3
CO3	Students will be able to present the key findings of research papers clearly	L4
CO4	Students will be able to integrate knowledge from research papers to formulate their own research questions or hypotheses.	L6

SEMESTER	**VI**					
YEAR	**III**					
COURSE CODE	**23BS3601**					
TITLE OFTHECOURSE	**MINOR PROJECT**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	-	**-**	**-**	**12**	**2**	**2**

Pre-requisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- To introduce students to the fundamentals of scientific research methodology, including problem identification, literature review, and hypothesis formulation.
- To develop practical skills in experimental design, data collection, and analysis relevant to the chosen area of study.
- To foster critical thinking and problem-solving abilities through the investigation of a specific scientific question.
- To enhance students' ability to use scientific tools, techniques, and software relevant to their discipline.
- To promote teamwork and collaboration, especially in interdisciplinary or group-based research projects.

COURSE OUTCOMES:

CO No.	**OUTCOMES**	**Bloom's Taxonomy Level**
CO1	Students will be able to identify a research problem and explain its scientific relevance through literature review.	L2
CO2	Students will be able to apply appropriate methods and techniques to conduct experiments or data collection.	L3
CO3	Students will be a analyze and interpret data using suitable tools to draw valid conclusions.	L4
CO4	Students will be able to prepare a structured research report and effectively communicate the findings.	L6

SEMESTER	**VI**					
YEAR	**III**					
COURSE CODE	**23MY3603**					
TITLE OF THE COURSE	**PHARMACEUTICAL MICROBIOLOGY**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar / Projects Hours	Total Hours	Credits
	3	**0**	**-**	**-**	**45**	**3**

Perquisite Courses (if any)			
#	Sem / Year	Course code	Title of the Course
		23MY3502	**Microbial Fermentation Technology**

COURSE OBJECTIVES:

- To make students understand the applications of microorganisms in production of pharmaceutically active compounds.
- To know the importance of microbiology knowledge in maintaining the microbial standards in pharmaceutical productions.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Should be able to identify different antimicrobial agents, antibiotics produced by them and its mode of action.	L1
CO2	Should be able to outline the process involved in drug discovery and development	L2
CO3	Should be able to understand regulatory guidelines in pharmaceuticals product production.	L2

COURSE CONTENT:

MODULE 1: ANTIBIOTICS — **9 Hrs**

History of Chemotherapy, classification of antibiotics - β-lactam, aminoglycosides, tetracyclines, ansamycins, macrolides. Antifungal antibiotics: Griseofulvin; Antiviral drugs: Amantidines; Nucleoside analogues, Interferons, Peptide antibiotics. Synthetic antibiotics: Sulphonamides; Chloramphenicol; Quinolone. Chemical disinfectants, antiseptics and preservatives.

MODULE 2: THERAPEUTICS — **9 Hrs**

Therapeutic and prophylactic usage of drugs. Adverse reactions of drugs. Drug resistance – mechanism and consequences. Development of new therapeutics - Antimicrobial peptides, phage therapy, plant-based therapeutics. Immobilization procedures for pharmaceutical applications (liposomes). Macromolecular, cellular and synthetic drug carriers.

MODULE 3: MICROBIAL FERMENTATION — **9 Hrs**

Biochemical and molecular basis of screening for the active ingredients from microbes. Application of microbial enzymes in therapeutics. Microbial fermentation for the production of pharmaceutical compounds (Streptomycin, Influenza vaccine).

MODULE 4: FORMULATION OF DRUGS AND TOXICOLOGY — **9 Hrs**

Formulation of drugs, Packaging of products. Preservation of pharma – ideal preservatives,

antimicrobial preservatives. Database for Drug designing; Preclinical, clinical trials and Toxicology (LD50 and ED50).

MODULE 5: **REGULATORY ASPECTS IN PHARMACEUTICALS**	**9 Hrs**

FDA regulations, GMP and GLP in pharmaceuticals, Quality control through WHO; Good Regulatory Practices, Clinical Research Regulations. Regulation and legislation for drugs, cosmetics, medical devices, biologicals and herbals formulation.

TEXT BOOKS:

1. Pharmaceutical Microbiology – Edited by Stephen P. Denyer, Norman A. Hodges, Sean P. Gorman, Brendan F. Gilmore
2. Hugo and Russell's Pharmaceutical Microbiology – Edited by Stephen P. Denyer et al.
3. Aulton's Pharmaceutics: The Design and Manufacture of Medicines – Edited by Michael E. Aulton and Kevin M.G. Taylor

SEMESTER	**VI**					
YEAR	**III**					
COURSE CODE	**23MY3604**					
TITLE OF THE COURSE	**EXOMICROBIOLOGY AND NANOMICROBIOLOGY**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar / Projects Hours	Total Hours	Credits
	3	**0**	**-**	**-**	**45**	**3**

Perquisite Courses (if any)			
#	Sem / Year	Course code	Title of the Course
		23MY3501	**Microbial Physiology and metabolism**
		23MY3504	**Soil microbiology**

COURSE OBJECTIVES:

By the end of this course, students will be able to:

- Understand the principles of exomicrobiology, including the study of microbial life in extreme terrestrial and extraterrestrial environments.
- Explore the role of nanotechnology in microbiology, especially in diagnostics, therapeutics, and environmental applications.
- Analyze extremophiles as analogs for potential extraterrestrial life forms and their adaptations.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Describe the key features of extremophilic microorganisms and relate them to potential extraterrestrial ecosystems.	L1
CO2	Identify and explain nanoscale techniques used in the study and manipulation of microorganisms.	L2
CO3	Assess the impact of nano-microbiological tools on diagnostics, drug delivery, and environmental biotechnology.	L2

COURSE CONTENT:

MODULE 1: SPACE MICROBIOLOGY — **9 Hrs**

Aims and objectives of space research. ESA STONE experiment, Space environment – vacuum, pressure, gases, radiations, temperature, gravity, time.

Life detection methods: (a) Evidence of metabolism (Gulliver) (b) Evidence of photosynthesis (autotrophic and heterotrophic) (c) ATP production (d) Phosphate uptake (e) Sulphur uptake.

Simulation techniques, Role of gravity on basic biological processes, Microgravity and effect on microorganisms.

MODULE 2: SPACECRAFT STERILIZATION AND MICROBIAL FOOD SAFETY — **9 Hrs**

Microorganisms in spacecraft environment, Microflora of spacecrafts and evolution, Pathogenesis, virulence, biofilm formation. Omics technology in space, Space debris. Spacecraft sterilisation, Human microbiome and spaceflight. Monitoring of astronauts' microbial flora: Alterations in the load of medically important microorganisms, Astronaut's food and microorganisms, Microbial food safety in space production systems.

MODULE 3: EXTREMOPHILES AND THEIR ADAPTATIONS — **9 Hrs**

Habitat, mechanism of survival and applications of extremophiles – temperature (thermophiles, psychrophiles), pH (acidophiles, alkalophiles), pressure (peizophiles, barophiles), xerophiles, radiations, methanogens. Extremophiles - bacteria, archaea and eukaryotes.
MODULE 4: **NANO-MATERIALS IN BIOLOGICAL SYSTEMS** **9 Hrs**
Classification of Nanostructures as 1D, 2D and 3D nanomaterials. Classification of NPs: Organic, inorganic and biological sources. Nano-materials in biological systems: Proteins, Lipids, RNA and DNA. Protein Targeting - Small Molecule/Nanomaterial - Protein Interactions Nanomaterial-Cell Interactions Manifestations of Surface Modification (Polyvalency).
MODULE 5: **NANOMATERIAL SYNTHESIS AND APPLICATIONS** **9 Hrs**
Different sources of microbes as NPs. Microbial synthesis of Nanoparticles. Synthesis of nanodrugs –Nanoparticles as drug systems. Diagnostic applications of nanotechnology. Biomedical nanotechnology (diagnostics, delivery and therapeutics), nano toxicology: Cytotoxicity, Gen-toxicity In vivo tests/assays etc. Applications of microbial NPs in agriculture, food, environmental and other sectors.
TEXT BOOKS:
1. "Life in Extreme Environments" by Ricardo Amils, et al. 2. "Planetary Volatiles: Microbial Life and Habitability" by Helmut Lammer, Johannes Leitner 3. "Nanotechnology in Biology and Medicine: Methods, Devices, and Applications" by Tuan Vo-Dinh 4. "Microbial Nanotechnology: Green Synthesis and Applications" by Mohammad Azam Ansari, Faheem Ahmed, Ali Alsalme

SEMESTER	**VI**					
YEAR	**III**					
COURSE CODE	**23BS3602**					
TITLE OF THE COURSE	**SCIENTIFIC WRITING**					
SCHEME OF INSTRUCTION	**Lecture Hours**	**Tutorial Hours**	**Practical Hours**	**Seminar/ Projects Hours**	**Total Hours**	**Credits**
	2	**-**	**-**	**-**	**30**	**2**

Pre-requisite Courses (if any)			
#	**Sem/Year**	**Course Code**	**Title of the Course**
-	-	-	-

COURSE OBJECTIVES:

By the end of this course, students will:

- Understand the structure and components of scientific papers.
- Learn to write clear, concise, and structured scientific content.
- Gain experience in writing abstracts, methods, results, and discussion sections.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Recognize the key components of scientific writing and understand the importance of writing for a specific audience.	L2
CO2	Identify the function of each section in a scientific paper and develop strategies for writing clear and effective sections.	L3
CO3	Properly cite sources, format references and edit and revise scientific papers for clarity and precision.	L4

MODULE 1:	**6 Hrs**
INTRODUCTION TO SCIENTIFIC WRITING The importance of clear scientific communication, Key principles of scientific writing: clarity, precision, objectivity, Types of scientific documents (research papers, literature reviews, reports, etc.), Writing for different audiences: experts vs. general readers.	
MODULE 2:	**6 Hrs**
WRITING ABSTRACT AND INTRODUCTION Abstract: conciseness, structure, and clarity. Crafting an engaging and informative introduction. Introduction: context, hypothesis, research questions.	
MODULE 3:	**6 Hrs**
STRUCTURE OF A SCIENTIFIC PAPER The IMRaD structure (Introduction, Methods, Results, and Discussion), Writing each section effectively, Literature review and background research, Sources of scientific literature (PubMed, Scopus, Web of Science, Google Scholar). Methods: clarity in experimental design, materials, and	

procedures	
MODULE 4:	**6 Hrs**
RESULTS, DISCUSSION, AND CONCLUSION Writing Results: presenting data effectively, clearly and logically (tables, figures, etc.), Discussion: interpreting findings, limitations, future directions Writing the discussion: interpreting results, comparing with previous studies. The conclusion: summarizing key findings, implications, and future research	
MODULE 5:	**6 Hrs**
CITATION, REFERENCING, AND ETHICS Understanding citation styles (APA, MLA, Chicago, etc.), Peer review process and revising scientific documents, Editing techniques: improving clarity, coherence, and flow. Ethical considerations in scientific writing: plagiarism, authorship, data manipulation, conflict of interest, proper citation.	

TEXT BOOKS AND REFERENCES:

13. "Scientific Writing and Communication" by Angelika H. Hofmann.
14. "The Craft of Scientific Writing" by Michael Alley.
15. "Technical Writing and Professional Communication" by M. Raman and S. Sharma.
16. "Research Methodology and Scientific Writing" by C. R. Kothari and Gaurav Garg.