M.Sc. LIFE SCIENCE
(SEMESTER
PATTERN)

CHOICE BASED CREDIT SYSTEM (CBCS)

TWO YEARS FULL TIME PROGRAMME

COURSE OF STUDIES R-24

GIET UNIVERSITY, GUNUPUR
ODISHA

All the precautions have been taken to print the course curriculum accurate. However, mistakes if any will be corrected as and when noticed. The university reserves the right to include/exclude any content at any point of time during the progression of the course.

M.Sc. LIFE SCIENCE

Schedule for Instruction and Examination (Proposed Scheme for Academic year 2024-2026)

I SEMESTER [FIRST YEAR]

Sl. No.	Course Category	Course Code	Course Title	L	T	P	Credits
THEORY							
1	LSPC	24LSPC1001	Biophysics and Biochemistry	3	1	0	4
2	LSPC	24LSPC1002	Cell Biology and Genetics	4	0	0	4
3	LSPC	24LSPC1003	Microbiology and Pathology	4	0	0	4
4	LSPC	24LSPC1004	Molecular Biology and Instrumental Techniques	3	1	0	4
PRACTICAL / SESSIONAL							
5	LSPC	24LSPC1105	Practical (pertaining to theory papers 1001,1002,1003,1004)	0	0	6	4
6	LSPC	24LSPC1106	Seminar & Project-I	0	0	2	2
TOTAL				**14**	**2**	**8**	**22**

II SEMESTER [FIRST YEAR]

Sl. No.	Course Category	Course Code	Course Title	L	T	P	Credits
THEORY							
1	LSPC	24LSPC2001	Bioinformatics and Biostatistics	3	1	0	4
2	LSPC	24LSPC2002	Immunology	3	1	0	4
3	LSPC	24LSPC2003	Ecology and Environmental Toxicology	4	0	0	4
4	LSPC	24LSPC2004	Biodiversity and Evolution	4	0	0	4
PRACTICAL / SESSIONAL							
5	LSPC	24LSPC2105	Practical (pertaining to theory papers 2001,2002 & 2003)	0	0	6	4
6	LSEC	24LSPC2106	Seminar and Project-II	0	0	2	2
7	LSPC	24LSPC2107	MATLAB	0	0	1	1
TOTAL				**14**	**2**	**8**	**23**

BoS Members:

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1. Dr. Manoja Das
2. Dr. B. Rabi Prasad
3. Mrs. Sagarika Satapathy
4. Dr. Namita Panigrahi
5. Mr. G.K. Mohanty
6. Dr. D.K. Acharya
7. Ms. Ghanishtha Prusty

BoS Approved
Date:03.06.202

III SEMESTER [SECOND YEAR]

(PLANT SCIENCE)

Sl. No.	Course Category	Course Code	Course Title	L	T	P	Credits
THEORY							
1	LSPSPC	24LSPSPC3001	Plant Morphology and Reproduction	3	1	0	4
2	LSPSPE	24LSPSPC3002	Plant Physiology	4	0	0	4
		24LSPSPE3003	Taxonomy and Plant Pathology				
3	LSPSPE	24LSPSPE3004	Plant Biotechnology	3	1	0	4
		24LSPSPE3005	Medicinal Plants and their Application				
4	LSPSCBOE	24LSPSBOE3006	Plant Metabolism	4	0	0	4
		24LSPSBOE3007	Plant Developmental Biology				
PRACTICAL / SESSIONAL							
5	LSPSPE	24LSPSPE3008	Practical (pertaining to theory papers)	0	0	6	4
6	LSPSEC	24LSPSEC3009	Summer Internship / Seminar and Project-III	0	0	2	2
TOTAL				**14**	**2**	**8**	**22**

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BoS Approved
Date:03.06.2024

III SEMESTER [SECOND YEAR]

(ANIMAL SCIENCE)

Sl. No.	Course Category	Course Code	Course Title	L	T	P	Credits
THEORY							
1	LSASPC	24LSASPC3001	Biology of Invertebrate	3	1	0	4
2	LSASPE	24LSPE3002	Biology of Vertebrate	4	0	0	4
		24LSPE3003	Applied Zoology				
3	LSASPE	24LSPE3004	Animal Biotechnology	3	1	0	4
		24LSPE3005	System Biology				
4	LSASCBOE	24LSPE3006	Ethology and Developmental Biology	4	0	0	4
		24LSPE3007	Genomics and Epigenetics				
PRACTICAL / SESSIONAL							
5	LSASPE	24LSPE3008	Practical (pertaining to Theory papers)	0	0	6	4
6	LSASEC	24LSPE3009	Summer Internship / Seminar and Project-III	0	0	2	2
TOTAL				**14**	**2**	**8**	**22**

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IV SEMESTER [SECOND YEAR]
(PLANT SCIENCE)

Sl. No.	Course Category	Course Code	Course Title	L	T	P	Credits
THEORY							
1	LSPSPC	24LSPSPC4001	Plant Anatomy & Embryology	4	0	0	4
2	LSPSPE	24LSPSPE4002	Biotechnology and Genetic Engineering	3	1	0	4
		24LSPSPE4003	Environmental Biotechnology				
3	LSPSOE	24LSPSOE4004	Ethics & IPR	3	0	0	3
PRACTICAL / SESSIONAL							
4	LSPSPC	24LSPSPC4005	Practical (pertaining to Theory papers)	0	0	6	4
5	LSPSEC	24LSPSEC4006	Major Project / Dissertation	0	0	10	8
6	VAC	24LSVAC4007	Value added course/MOOCS	-	-	-	-
TOTAL				**10**	**1**	**16**	**23**

IV SEMESTER [SECOND YEAR]
(ANIMAL SCIENCE)

Sl. No.	Course Category	Course Code	Course Title	L	T	P	Credits
THEORY							
1	LSASPC	24LSASPC4001	Animal Physiology and Taxonomy	4	0	0	4
2	LSASPE	24LSASPC4002	Biotechnology and Genetic Engineering	3	1	0	4
		24LSASPC4003	Environmental Biotechnology				
3	LSASOE	24LSASOE4004	Ethics & IPR	4	0	0	4
PRACTICAL / SESSIONAL							
5	LSASPC	24LSASPC4005	Practical (pertaining to Theory papers)	0	0	6	4
6	LSASEC	24LSASPC4006	Major Project / Dissertation	0	0	10	8
7	VAC	24LSVAC4007	Value added course/MOOCS	0	0	0	0
TOTAL				**11**	**1**	**16**	**24**

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SCHEME OF INSTRUCTION SUMMARY

SL. NO.	COURSE WORK - SUBJECTS AREA	CREDITS / SEMESTER				TOTAL CREDITS	%
		I (550 marks)	II (550 marks)	III (550 marks)	IV (600 marks)	Total (2250 marks)	
1	Professional Course (PC)	20	20	8	4	52	58
2	Professional Electives (PE)	-	-	8	8	16	18
3	Choice Based Open Electives (CBOE)/ Open Electives (OE)	-	-	4	4	8	9
4	Project Work, Seminar and/or Internship in Industry or Elsewhere (EC)	2	2	2	8	14	15
5	Value added Courses/MOOCS	-	-	-	-	-	-
	TOTAL	**22**	**22**	**22**	**24**	**90**	**100**

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M.Sc. LIFE SCIENCE SYLLABUS STRUCTURE

(Credit-Hours- Marks System-2024-25)

Semester	Course	Course Title	Hrs per week L --P	Credit L-- P	Exam Hrs L- P	Marks		Total
						Mid Sem	End Sem	
I	LSPC101	Biophysics and Biochemistry	4	4	3	40	60	100
	LSPC102	Cell Biology and Genetics	4	4	3	40	60	100
	LSPC103	Microbiology and Pathology	4	4	3	40	60	100
	LSPC104	Bioinformatics and Biostatistics	4	4	3	40	60	100
	LSPC105	**Practical**	6	4	6	0	100	100
	LSPC105	Seminar and Project-I	2	2	2	0	50	50
			24	**22**				**550**
II	LSPC201	Molecular Biology and Instrumental Techniques	4	4	3	40	60	100
	LSPC202	Molecular Immunology	4	4	3	40	60	100
	LSPC203	Ecology and Environmental Toxicology	4	4	3	40	60	100
	LSPC204	Biodiversity and Evolution	4	4	3	40	60	100
	LSPC205	**Practical**	6	4	6	0	100	100
	LSEC206	Seminar and Project - II	2	2	2	0	50	50
			24	**22**				**550**
	PLANT SCIENCE							
III	LSPSPC301	Plant Morphology and Reproduction	4	4	3	40	60	100
	LSPSPE302	Plant Physiology	4	4	3	40	60	100
	LSPSPE303	Taxonomy and Plant Pathology						
	LSPSPE304	Plant Biotechnology	4	4	3	40	60	100
	LSPSPE305	Medicinal Plants and their Application						
	LSPSCBOE306	Plant Metabolism	4	4	3	40	60	100
	LSPSCBOE307	Plant Developmental Biology						
	LSPSPE308	**Practical**	6	4	6	0	100	100
	LSPSEC309	Summer Internship / Seminar and Project - III	**2**	**2**	**2**	**0**	**50**	**50**
			24	**22**				**550**
	ANIMAL SCIENCE							
III	LSASPC301	Biology of Invertebrates	4	4	3	40	60	100
	LSASPE302	Biology of Vertebrates	4	4	3	40	60	100
	LSASPE303	System Biology						
	LSASPE304	Animal Biotechnology	4	4	3	40	60	100
	LSASPE305	Applied Zoology						
	LSASCBOE306	Ethology and Developmental Biology	4	4	3	40	60	100
	LSASCBOE307	Genomics and Epigenetics						
	LSASPE308	**Practical**	6	5	6	0	100	100

	LSASEC309	Summer Internship / Seminar and Project - III	**2**	**2**	**2**	**0**	**50**	**50**
			24	**22**				**550**
	PLANT SCIENCE							
IV	LSPSPC401	Plant Anatomy & Embryology	4	4	3	40	60	100
	LSPE402	Biotechnology and Genetic Engineering	4	4	3	40	60	100
	LSPE403	Environmental Biotechnology						
		Ethics & IPR	4	4	4	40	60	100
	LSPSPE404	**Practical**	6	4	6	0	100	100
	LSPSEC405	Major Research Project / Dissertation	**10**	**8**	**6**	**0**	**200**	**200**
	VAC406	Value added course	**0**	**0**	**0**	**0**	**0**	**0**
			28	**24**				**600**
		Grand Total	**100**	**90**				**2250**
	ANIMAL SCIENCE							
IV	LSASPC401	Animal Physiology and Taxonomy	4	4	3	40	60	100
	LSPE402	Biotechnology and Genetic Engineering	4	4	3	40	60	100
	LSPE403	Environmental biotechnology						
		Ethics & IPR	4	4	3	40	60	100
	LSASPE404	**Practical**	6	4	6	0	100	100
	LSASEC405	Major Research Project / Dissertation	**10**	**8**	**6**	**0**	**200**	**200**
	VAC406	Value added course/MOOCS	**0**	**0**	**0**	**0**	**0**	**0**
			28	**24**				**600**
		Grand Total	**100**	**90**				**2250**

Note: Practical are pertaining to Theory papers

PC---Professional Courses, PE---Professional Elective, CBOE---Choice Based Open Elective, OE---Open Elective, EC---Elective Courses, VAC---Value Added Course, L----Lectures, Practical

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Date:03.06.2024

SCHEME OF INSTRUCTION SUMMARY

SL. NO.	COURSE WORK - SUBJECTS AREA	CREDITS / SEMESTER				TOTAL CREDITS	%
		I (550 marks)	II (550 marks)	III (550 marks)	IV (600 marks)	Total (2250 marks)	
1	Professional Core (PC)	20	16	12	8	56	62
2	Professional Electives (PE)	-	4	8	8	20	22
3	Project Work, Seminar and/or Internship in Industry or elsewhere (EC)	2	2	2	8	14	16
4	Value added Courses/MOOCS	-	-	-	-	-	-
	TOTAL	**22**	**22**	**22**	**24**	**90**	**100**

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Date:03.06.2024

SEMESTER-I

Course Code:	LSPC1001	No. of Credits:	4
Course Name:	BIOPHYSICS AND BIOCHEMISTRY	Sem End Exam & Cycle Test:	60+40

COURSE EDUCATIONAL OBJECTIVES:

CEO1: To focus on various bonding, configurations associated with biomolecule, thermodynamic principles of biomolecules and biological buffering system

CEO2: To study the structures, functions and metabolism of various biomolecules.

COURSE OUTCOMES:

Towards the end of the course the students will be able to:

CO1 To know the configuration, biophysical bonding in biomolecules.

CO2 To know about the thermodynamic concepts and acid base present in biological system.

CO3 To understand the structure and functions of carbohydrates, lipids, amino acids, proteins, nucleic acids, and enzymes.

CO4 To understand the metabolism of carbohydrates, fatty acids, amino acids and Nucleotides.

CO5 To learn basic function of enzymes, their properties, and components

CO6 To know various biochemical reactions and its properties.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1									2		
CO2	1	3	2									3		
CO3	1	2	1									2		
CO4	1	2	1									2		
CO5	1	3	2											
CO6	2	2	1											

COURSE CONTENT
SEMESTER I

BIOPHYSICS

UNIT – I: BONDINGS AND FORCES [13 Hours]

Chemical composition and bonding, three-dimensional structure of molecules (configuration and conformation, Isomerism and stereospecificity), Intermolecular forces: Dipoles, dipole moment, charged dipole, induced dipole, Ionic bonding, Hydrogen bonds, Vander Waal's forces & Dielectric constant. Colloidal system; Properties of colloids; Emulsion & Suspension, Ultrafiltration; Adsorption.

UNIT – II: THERMODYNAMIC PRINCIPLES [13 Hours]

Structure of Atom, Molecules, Chemical bonds, and Stabilizing interactions. Structure and ionization of water, Acids and bases, Relationship of pH and pK in a buffer, Blood buffering system, Principles of thermodynamics in relation to living organization. Concept of steady state, enthalpy, entropy and energy changes, Phosphoryl group transfer and ATP, Biological oxidation-reduction reactions.

BIOCHEMISTRY

UNIT – III: CARBOHYDRATES AND LIPIDS [13 Hours]

Carbohydrates: Structure, properties, function, and classification of carbohydrates (monosaccharides, oligosaccharides: important disaccharides, and polysaccharide: starch, glycogen, and cellulose).
Glycosylation of other biomolecules: glycosaminoglycans, proteoglycans, glycoproteins, and glycolipids.

Lipids: Classification, Structure, properties, and functions of important members of storage and membrane lipids; lipoproteins.

UNIT -IV: PROTEINS AND ENZYMES

Structure, functions and classification of amino acids and proteins (primary, secondary, tertiary, and quaternary structures), Ramachandran plot, Peptide bonds.
Structure and function of Nucleic acids, Classification of enzymes and coenzymes. Mechanism of enzyme action. Regulation of enzyme activity: Constitutive and regulatory enzymes.

UNIT - V: METABOLISM [13 Hours]

Glycolysis, Krebs cycle, Gluconeogenesis, Hexose Monophosphate shunt, Glyoxylate cycle, Glycogen Breakdown & Synthesis, electron transport and Oxidative phosphorylation, Photophosphorylation, proton pump, Biosynthesis and oxidation of fatty acids, Nucleotide metabolism, General reactions of amino acid metabolism.

Text Books:

1. Biophysics and Biophysical Chemistry by Debajyoti Das; Academic Publishers
2. Lehninger Principle of Biochemistry by D.L. Nelson & M.M. Cox
3. Biochemistry by U. Satyanarayana & Chakrapani; Elsevier

India Reference Books:

1. Introduction to Biophysics by Pranab Kumar; S. Chand
2. Biochemistry by V. Voet & J. G. Voet; John Wiley & Sons
3. Biochemistry by L. Stryer; W.H.Freeman & Co Ltd

Course Code:	LSPC1002	No. of Credits:	4
Course Name:	CELL BIOLOGY AND GENETICS	Sem End Exam & Cycle Test:	60+40

Course Educational Objectives
This course enables the students:

CEO1: To impart knowledge of structural and functional aspects of cells as unit of living systems and transport of information & matter across cell membrane.

CEO2: To provide students with a deep insight about the motility of the cell with emphasis on the molecular motors, cell adhesions, molecular biology involved in the movement process involved in movement of Cilia and Flagella.

CEO3: To acquire in-depth knowledge of the molecular events involved in cell division which includes mitosis, meiosis, cell cycle and its regulation.

CEO4: To understand classical genetics comprising Mendelian laws of inheritance and their significance in genetic diseases.

Course Outcomes
Towards the end of the course, a student should be able to:

CO1: acquire knowledge about the organizational and functional aspects of both prokaryotic & eukaryotic cell and cell organelles.

CO2: learn about the interactions of the cells with outside environment through exchange of information and transport of molecules.

CO3: Identify, formulate, and solve problems arisen due to the inefficient functioning of the various life processes like cell-to-cell communication and movement processes of a cell or system.

CO4: learn about the classical genetics and transmission of characters from one generation to the next which will make foundation for the advanced genetics and develop innovative research ideas for curing genetic disorders in humans.

CO5: Knowledge about the events of cell cycle and its regulation

CO6: Understood cell signaling and how it regulates cellular functions and how its dysregulation leads to cancer and other diseases.

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-	2	2	1							
CO2	1	2	2	2	-							
CO3	1	3	3	3	-							
CO4	1	2	2	1	-							
CO5	1	3	3	2								
CO6	2	2	3									

COURSE CONTENT

Unit – I: ***Membrane Structure and Function*** ***[15 Hours]***

General organization of Prokaryotic and Eukaryotic cells. Cell Wall and Cell Membranes: Cell wall of Eubacteria, lipo-polysachharides, Peptidoglycans and related molecules. Prokaryotic cell inclusions: Endospores and gas vesicles, Eukaryotic cell wall and plasma membrane (composition and dynamics, membrane carbohydrates and their role in cell recognition).Social context of cells: Cell junction, cell adhesion and extra-cellular matrix. Cell motility: Cilia and flagella of prokaryotes and eukaryotes. Cytoskeleton: Microtubules, intermediate filaments and microfilaments.

Unit – II: ***Nucleus*** ***[15 Hours]***

Nucleus: Structure and function of nuclear envelope, nucleolus, Chromatin organization and its packaging, role of nuclear matrix in chromosome organization and function, matrix binding proteins. Global structure of chromosome: Lam-pbrush chromosome, Polytene chromosome, Interphase chromatin, Euchromatin and Heterochromatin. Cell cycle: Molecular models and events, Regulators and checkpoints in cell cycle (Cyclin and CDKs). Molecular mechanisms of cell division, Mitosis and Meiosis. Cell signaling: Endocrine, Exocrine & Synaptic signaling; Extracellular Messengers & their receptors; G-protein- Coupled receptors; Second messengers and their mode of action.

Unit – III: ***Cellular Organelles*** ***[10 Hours]***

Mitochondria: Structure, function, mitochondrial DNA, origin and evolution of mitochondria, Chloroplast: Structure, function, chloroplast DNA and its significance, chloroplast biogenesis, origin and evolution. Intracellular compartments-I: Golgi apparatus and

endoplasmic reticulum (structure & function). Intracellular compartments-II: Lysosomes, Ribosomes and peroxisomes (structure and function). Macromolecular trafficking into and out of nucleus. Protein sorting: Transport of proteins into mitochondria, chloroplast and lysosomes.

Unit – IV: ***Genetics I*** ***[15 Hours]***

Mendel's laws of inheritance and chromosomal theory of heredity. Neo-mendelism, genomic imprinting, penetrance, and expressivity, phenocopy, Linkage, crossing over and recombination, sex linkage, sex limited and sex influenced characters. Extra-chromosomal inheritance: Inheritance of Mitochondrial and chloroplast genes, maternal inheritance.Gene mapping methods: Linkage maps, Tetrad analysis, Pedigree analysis, lod score for linkage testing, Mapping with molecular markers, Mapping by using somatic cell hybrids, Development of mapping population in plants.

Quantitative genetics: Polygenic inheritance, Heritability and its measurements, QTL analysis, Gene interaction.

Unit-V: Genetics II **[9 Hours]**

Cytoplasmic inheritance, Structural and numerical changes in chromosome (including polyploidy). The origin of genetic variability through mutation (Spontaneous and chemical, Frame-shift mutation, point mutations and chromosomal aberrations). Principles of population genetics and Hardy-Weinberg equilibrium and the factors influencing, Gene flow and Genetic drift, Human chromosomes, Genetic diseases, and syndromes

Text Books

1. Molecular biology of the cell. By Alberts. et al.
2. Molecular cell biology. By Lodish et al.
3. Cell, a molecular approach. By Cooper.
4. Cell Biology. By De Robertes and De Robertes.
5. Genetics by Strickberger.
6. Genetics by Gardner.

Reference Books

1. Smith & Wood, Cell Biology, 2nd Edition, Chapman & Hall, London.
2. Watson et al., Molecular Biology of the gene, 5th Edition, Pearson Prentice Hall. USA.
3. Benjamin Lewin, Gene X, 10th Edition, Jones and Barlett Publishers.
4. Gerald Karp, Cell and Molecular Biology: Concepts and Experiments, 7th Edition.

Course Code:	LSPC1003	No. of Credits:	4
Course Name:	MICROBIOLOGY AND PATHOLOGY	Sem End Exam & Cycle Test:	60+40

COURSE EDUCATIONAL OBJECTIVES:

CEO 1: To enhance the student's knowledge on the historical aspects and development of microbiology and classification of microbes.

CEO 2: To understand the reproduction in Viruses and principles of microbial pathogenesis.

COURSE OUTCOMES:

Towards the end of the course the students will be able to:

CO1 Knowledge on Landmark discoveries in Microbiology and different domains classification of living organisms and sterilization process

CO2 Understand about the outline survey of other microbes and use of microbes.

CO3 Know the Virus reproduction and use of virus in Genetic Engineering

CO4 Learn the general principles of microbial pathogenesis and other pathogenic disorders.

CO5 Knowledge of microbiology in various field

CO6 Idea to evaluate methods used to identify infectious agents in the clinical microbiology lab.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	1											
CO2	2	3	1											
CO3	1	2	2											
CO4	2	3	1											
CO5	3	2	2											
CO6	2	3	1											

1–Slight, 2 –Moderate, 3 –Substantial

COURSE CONTENT

UNIT – I: **[12 Hours]**

Beginning of Microbiology, Milestones in the development of microbiology, spontaneous generation, Classification of microorganisms, Classification of Bacteria according to Bergey's manual, Application of microbiology, Bacterial cell structure and morphological features (cell wall, outer membrane, flagella, endospores and gas vacuoles), microbes beyond cellular organization (Viruses, viroids, and prions) Microbiology: Sterilization, Culture Media, Pure culture technique, Microbial staining methods.

UNIT – II: **[12 Hours]**

Other Microbes –A brief outline survey of other Microbes such as Protozoa, Mycoplasma, Yeasts and Cyanobacteria. Use of microbes in industry and agriculture, Microbial growth, Nutrition, Elementary idea of antibiotics.

UNIT – III: **[13 Hours]**

Reproduction in Viruses with special reference to lytic and lysogeny cycle, bacteriophages, general properties of viruses, viral structure, taxonomy of virus, viral replication, cultivation, and identification of viruses; Genetic recombination in bacteria (Transformation, Conjugation, Transduction), Virus as a tool for Genetic Engineering. Metagenomics.

UNIT – IV: **[12 Hours]**

General principles of microbial pathogenesis, Cellular adaptation cell injury and cell death: Mechanism, morphology and examples of cell injury, necrosis and apoptosis, Fundamental concepts of neoplasia – Benign & malignant, Biology of tumor growth, Common environmental and occupational exposures leading on to diseases. Nutritional deficiencies and obesity related disorders.

UNIT – V **[15 Hours]**

Host-pathogen interaction, ecological impact of microbes; symbiosis (Nitrogen fixation and ruminant symbiosis); microbes and nutrient cycles; microbial communication system; bacterial quorum sensing; microbial fuel cells; prebiotics and probiotics.

Text Books:

1. Microbiology, Prescott., Harley and Klein, William C Brown Press.
2. Text book of Microbiology, R.C. Dubey and D.K.Maheswari, S.Cahnd andCompany.
3. Modern concepts of Microbiology, H.D.Kumar and S.Kumar, Vikas Publications.
4. Microbiology, Pelczar, Chan and Creig, Tata Mc Graw Hill Pub.

5. BASIC PATHOLOGY by KUMAR V. ROBBINS S.
6. Surgical Pathology by Ackerman.

Reference Books:

1. Pahologic Basis of Disease by Kumar,Vinay.
2. General Microbiology, S.B.Sullia and V. Santharam, Oxford & IBH, New Delhi
3. Brock Biology of Microorganisms, Maidgan,Martinko and Parker, Prentice HallInc., New York

Course Code:	LSPC1004	No. of Credits:	4
Course Name:	MOLECULAR BIOLOGY & INSTRUMENTAL TECHNIQUES	Sem End Exam & Cycle Test:	60+40

Course Educational Objectives
This course enables the students:

CEO1: To Provide a thorough understanding of chemistry, structure and organization of genetic material (DNA) in prokaryotes and higher organisms.

CEO2: To understand DNA damage, DNA repair mechanisms, storage of genetic information and its translation at molecular level in prokaryotic and eukaryotic systems.

CEO3: To provide the students with the understanding of various analytical techniques used in biotechnology-based research and industry.

CEO4: TO acquaint with various instruments, their configuration and working principle, operating procedures, data generation and its analysis.

Course Outcomes
Towards the end of the course, a student should be able to:

CO1: Acquire knowledge about genome organization in higher organisms and describe kinetic classes of DNA and Gene families.

CO2: Explain the properties of genetic materials and storage and processing of genetic information and apply mechanisms of DNA replication, damage and repair in applied molecular genetics.

CO3: Apply basic principles of different analytical techniques and able to use microscopy, spectroscopy, and centrifugation.

CO4: Assimilate the principles and applications of electrophoresis, blotting, chromatography and spectroscopy in research and related experiments.

CO5: To be familiar with the various genetic and molecular changes occur in a normal cell during malignant transformation.

CO6: To introduce the tools and techniques available for studying biochemical and biophysical nature of life

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	1	2	-							
CO2	1	1	2	3	-							
CO3	-	2	-	3	2							
CO4	3	-	2	2	-							
CO5	3	2	2	1								
CO6	3	2	2	-								

COURSE CONTENT

UNIT – I: MOLECULAR BIOLOGY-I [12 Hours]

Chemistry of nucleic acids, Structure and types of nucleic acids, Prokaryotic and eukaryotic Genome organization, organelles genomes (mitochondrial and chloroplast genome), DNA re- association kinetics (Cot curve analysis); Repetitive and unique sequences; Satellite DNA, C- Value paradox, Central dogma, DNA as the genetic material. Gene as recon, muton and cistron, split gene, jumping gene, and over-lapping gene concepts.

UNIT – II: MOLECULAR BIOLOGY-II [14 Hours]

DNA Replication: Mechanism of DNA replication (Initiation, elongation, and termination). DNA damage and repair mechanisms, Homologous and Site-specific Recombination.
Transcription: Transcription machinery, Transcription process, Post transcriptional modifications (capping and polyadenylation, splicing), Signal transduction and control of transcription and control of transcriptional regulators, Gene silencing, siRNA, RNA editing, RNA transport.

UNIT – III: MOLECULAR BIOLOGY-III [12 Hours]

Expression of gene regulation in Prokaryotes and eukaryotes: The Operon concept, (lac-, trp operon), Transcription factors, Transcription attenuation, Lytic and Lysogenic cascades
Translation: Translation machinery, Mechanism of initiation, elongation and termination; Co- and post-translational modifications, translational inhibitors.
DNA amplification: Polymerase Chain Reaction, Genetic Engineering: Restriction enzymes, Different methods of construction of recombinant DNA, Cell transformation and Cloning, Transgenic animal, Expression of recombination protein using bacterial/animal vectors, Gene Knock out strategies.

Unit-IV: INSTRUMENTAL TECHNIQUES-I [12 Hours]

Microscopy: Principles and types: Phase contrast Microscopy, Fluorescence Microscopy and Electron Microscopy. Spectrophotometer: laws of absorption of light, Beer-Lambert's Law, Ultraviolet-visible absorption spectroscopy: Principle, Instrumentation and application. Fluorescence spectrophotometry: Principle, Instrumentation and application. MASS spectrophotometry: Principle, Instrumentation and application. Other types (IR, NMR and ESR) of spectrophotometry: Basic principle and application. Elementary idea on X-ray crystallography.

Unit-V: INSTRUMENTAL TECHNIQUES-II [15 Hours]

Chromatography: Principles and types of Chromatography (Paper and Thin-layer chromatography), Column chromatography (Adsorption chromatography, Gel exclusion/permeation chromatography, Ion-exchange chromatography, and Affinity chromatography), Gas chromatography and HPLC. Centrifugation: General Principles and types of centrifugations. Electrophoresis: Principles and types (Agarose, SDS PAGE & 2-D gel). Polymerase Chain Reaction (PCR), Nucleic acid hybridization: Principle & applications of Southern blotting, Northern blotting, and Western blotting.

Text Books:

1. **Cell and Molecular Biology** by P. Khanna; I K International Publishing House Pvt. Ltd
2. **Biophysics and Biophysical Chemistry** by Debajyoti Das; Academic Publishers
3. **Principles and Techniques of Biochemistry and Molecular Biology** by Keith Wilson and John Walker; Cambridge University Press.

Reference Books:

1. Molecular Biology of the Cell by Bruce Alberts et al; Garland Science
2. Molecular Biology of the Gene by James D. Watson et al; Pearson
3. **Biophysical Chemistry** by Upadhyay & upadhyay

Course Code:	LSPC1105	No. of Credits:	4
Course Name:	PRACTICAL	End Exam:	100

1. Study of stages of mitosis by squashing technique
2. Study of stages of meiosis
3. Karyotype Analysis
4. Micrometry & measurement of Cell size
5. Sterilization of glass ware & preparation of media
6. Gram staining of bacteria
7. Preparation of liquid and solid media for growth of microorganisms.
8. Isolation and maintenance of organisms by plating, streaking and serial dilution methods.
9. Isolation of pure cultures from soil, water and air.
10. Streak plate culture of bacteria
11. Qualitative Analysis of amino acids, sugars and lipids.
12. Estimation of protein content by Lowry's & Biuret method.
13. Estimation of DNA content in the given sample by Diphenylamine method.
14. Estimation of RNA content by the Orcinol method.
15. Estimation of reducing sugars by DNS method.
16. Isolation and estimation of casein from milk.
17. Measurements of Central tendency and their variance.
18. Comparison of two samples by Students''t' test & study of ANOVA.

SEMESTER II

Course Code	LSPC2001	No. of Credits:	4
Course Name:	BIOINFORMATICS AND BIOSTASTICS	Sem End Exam & Cycle Test:	60+40

COURSE EDUCATIONAL OBJECTIVES:

CEO 1: Objectives of this course focuses on the development of skills of students for a successful career in industry or research. The course emphasizes enough effort on theory and practical applications.

CEO 2: The course emphasizes on the delivery of the state of the art technologies in Genomics, Proteomics, 3-D structure of the protein and its statistical analysis.

COURSE OUTCOMES:

Towards the end of the course the students will be able to :

CO1 Understand the types of biological databases available in open source domain and their uses.

CO2 Acquire knowledge in pair wise, multiple sequence alignments and phylogenetic analysis

CO3 Able to analyze secondary and tertiary structure and its modeling of proteins for drug designing by using bioinformatics tools.

CO4 Understand the use of statistical analysis using different algorithm and their applications.

CO5 Acquire knowledge in the working of analytical instruments

CO6 Basic knowledge in analytical techniques to pursue career in allied health fields and other technical programs.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	1		3									
CO2	2	3	1		1									
CO3	1	2	2		3									
CO4	2	3	1											
CO5	2	3	2											
CO6	2	3	1											

1–Slight, 2 –Moderate, 3 –Substantial

COURSE CONTENT

Unit-I **[15 Hours]**

Introduction To Bioinformatics; Concept and importance of Bioinformatics; NCBI Data model; EMBL Database; DDBJ Database; PIR Database; PDB Database; Structural Database (SCOP,CATH); Structural Viewers (RasMol,PyMOL,Cn3D,Swiss PDB Viewer); Metabolic Pathway Database (KEGG, Meta Cyc, EMP).

Unit-II **[10 Hours]**

Sequence alignment (Local, Global, Multiple); Sequence alignment algorithm (Dot Matrix, Needleman & Wunch, Smith-Waterman, FASTA and BLAST); Substitution matrix (PAM, BLOSUM); Phylogentic analysis; Hidden Markov Model; Algorithms of Non-redundant Sequence Datasets.

Unit-III **[15 Hours]**

Homology Modelling; Model Validation - SAVES Server, Ramachandran Plot. Protein-Nucleic Acid interaction. Visualization Tools, Threading Modelling; Algorithms of Prediction of 2D structure of protein (Chao-Fasman, Gor, Neural Network); Algorithms of prediction of 3D structure of protein; Protein Stability; Hydrophobicity profile; Protein-Protein interaction Database; Protein-ligand Interaction Database; Computational added drug design.

Unit-IV **[12 Hours]**

Introduction to Biostatistics; Measure of Central tendency (Mean, Median, Mode); Mean Deviation and Standard Deviation; Measures of central tendency and dispersion; probability distributions (Binomial, Poisson and normal); Sampling distribution; Difference between parametric and non-parametric statistics; Confidence Interval; Errors; Levels of significance; Test of significance: Regression and Correlation; t-test; Analysis of variance; X2 test; Basic introduction to Multivariate statistics.

UNIT- V **[12 Hours]**

Coefficient of Variation; Analysis of Variation (ANOVA); Test of Significance (t-test, f-test, chi-square test); Correlation and Regression Analysis.

Text Books

1. David W. Mount, Bioinformatics: Sequence and Genome Analysis.
2. Andreas D. Baxevanis, Bioinformatics: A Practical Guide to the Anlysis of Genes and Proteins.
3. John a. Rice, Mathematical Statistics and Data Analysis.
4. P.N. Arora & P.K. Malhan, Biostatistics; Himalaya Publishing House.
5. Wayne W. Daniel, Biostatistics: A foundation for Analysis in the Health Sciences.

Reference Books

1. M. Michael Gromiha, Protein Bioinformatics: From Sequence to Function, Academic Press, 2010.

2. D.E. Krane and M.L. Raymer, Fundamental concepts of bioinformatics, Pearson Education Inc. 2006.
3. S.C Rastogi, Bioinformatics: Methods and Applications Genomics, Proteomics and Drug Discovery.
4. Mishra and Mishra, Introductory Statistics.

Course Code:	**LSPC2002**	**No. of Credits:**	**4**
Course Name:	**IMMUNOLOGY**	**Sem End Exam & Cycle Test:**	**60+40**

Course Educational Objectives

This course enables the students:

CEO1: To acquire in-depth knowledge on immunity, immune system and structural features of the components of the immune system as well as their function.
CEO2: To learn the structure and functions of lymphoid organs, immune cells and molecules elicit immune response.
CEO3: Acquire proficiency and practical experiences in advanced immunological techniques such as RIA, ELISA and ELISPOT assay.
CEO4: To gain insight into the concept of autoimmunity and understand the mechanisms underlying the development of autoimmune diseases.

Course Outcomes

Towards the end of the course, a student should be able to:

CO1: Explain the role of immune cells, organs and their mechanism in body defence mechanism.
CO2: Evaluate usefulness of immunology in different pharmaceutical companies.
CO3: Identify proper research lab working in area of their own interests.
CO4: Apply their knowledge and design immunological experiments to demonstrate innate, humoral or cytotoxic T lymphocyte responses and figure out kind of immune responses in the setting of infection (viral or bacterial).
CO5: Find out the difference between active and passive immunity and the factors influencing the duration and efficacy of immune responses induced by vaccination.
CO6: Able to understand and relate to therapeutic agents used in medicine.

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

CO6	1	2	3	-	-	-						

COURSE CONTENT

Unit –I: ***Immunology- fundamental concepts*** **[14 Hours]**

Introduction, Phylogeny of Immune system, Components of innate and acquired immunity, Cells of the Immune system: Haematopoiesis, and differentiation of stem cells to different cellular elements in blood (Lymphocytes, Macrophages, Dendritic cells, Natural Killer cells, Lymphokine activated killer cells, Eosinophils, Neutrophils and Mast cells). Organization and Structure of Lymphoid Organs: primary and secondary lymphoid organs.

Unit – II: ***Immune responses generated by B and T lymphocytes*** **[12 Hours]**

Physiology of immune response, Activation and regulation of B and T lymphocytes, Basis of self and non-self-discrimination; Humoral immune response, Cell-mediated immune responses, ADCC; Structure and function of antibody molecule, classes & subclasses of immunoglobulins; Nature and Biology of antigens and super antigens, Cytokines: properties, Production, biological function and therapeutic uses; Major histocompatibility complex and MHC restriction; Antigen processing and presentation.

Unit –III: ***Antigen-antibody interactions*** **[12 Hours]**

Antigen – Antibody interaction: Precipitation, agglutination and complement mediated immune reactions; Haptens and adjuvants: structure and properties, Complement system. Advanced immunological techniques: RIA, ELISA, ELISPOT assay; Immuno-electrophoresis; Biotinylation; Avidin-Streptavidin.

Unit – IV: ***Humoral, Natural and clinical Immunology*** **[14 Hours]**

B and T cell maturation, activation and differentiation; B-cell receptor, T-cell receptor. Immunity to Infection: Bacteria, viral, fungal and infections; Hypersensitivity reactions-types (I, II, III, and IV); Autoimmunity; types of autoimmune diseases (Hashimoto's disease, Systemic lupus erythematosus & Multiple sclerosis); Mechanism and role of CD4+ T cells; Transplantation: Immunological basis of graft rejection; Immunodeficiency diseases: Primary and Acquired.

Unit –V: ***Vaccinology*** **[12 Hours]**

Active and passive immunization; live, killed, attenuated, subunit vaccines; vaccine technology: role and properties of adjuvants, recombinant DNA and protein-based vaccines, plant-based vaccines, reverse vaccinology; peptide vaccines, conjugate vaccines; antibody genes and antibody engineering: chimeric, generation of monoclonal antibodies, hybrid monoclonal antibodies.

Text Books

1. Kuby Immunology, 5th edition, by R. A. Goldsby et al.

2. Immunology by Roitt
3. Immunology by Khan
4. Cellular and Molecular Immunology by Abdul, K., Abbas, Andrew K. L., Jordan, SP

Reference Books

1. Roitt, I.M. Essential Immunology.
2. Tizard I.R. Immunology.
3. Fundamentals of immunology By William Paul

Course Code:	LSPC2003	No. of Credits:	4
Course Name:	ECOLOGY & ENVIRONMENTAL TOXICOLOGY	Sem End Exam & Cycle Test:	60+40

Course Educational Objectives

This course enables the

students:

CEO1: To understand various concepts related to Ecosystem.

CEO2: To acquire knowledge regarding Population and Community ecology.

CEO3: To relate human activities with degradation of environment and solutions to restore it.

CEO4: To get a complete idea regarding Ecotoxicology.

Course Outcomes

Towards the end of the course, a student should be able to:

CO1: Gain understanding regarding the structure and functional aspects of an ecosystem.

CO2: Acquire deep understanding about Population ecology and Community ecology.

CO3: Gain knowledge about Environmental pollution, its effects and solutions to protect and restore it.

CO4: Describe various toxic agents, their mode of action and their effects on environment.

CO5: Understanding of the ethical issues with emphasis on ecology and biology.

CO6: Communicate effectively about ecological and toxicological concepts, issues, and solutions.

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12

CO1	2	1	1				2					
CO2	1	2	1				1					1
CO3	1	3	2	3			2					3
CO4	1	3	3	3			3					2
CO5	2	3	2	1								
CO6	2	3	2	1			1					

COURSE CONTENT

Unit –I: ECOLOGY-I [10 Hours]

Concept of Ecosystem (Emergent Properties, Biological levels of Organization, Structure, Classification of Ecosystems, Ecological energetics, Gaia hypothesis and Cybernetics). Leibig's Law of Minimum and concept of limiting factors, Law of Tolerance

Unit –II: ECOLOGY-II [12 Hours]

Population and community ecology: Concept of autecology and synecology, Concept of population and population attributes: Density, natality, mortality, survivorship curves, life table, age structure, population growth forms, Concept of carrying capacity and environment resistance, Community Ecology, Ecological succession, Ecological niche,

Unit –III: ENVIRONMENTAL CONCERNS [15 Hours]

Environmental Pollution: Sources & control (Air Pollution, Water Pollution, Soil Pollution, Noise pollution, Radioactive Pollution), Greenhouse effect, Ozone depletion, Global warming, Climate change; Factors responsible for climate change, El-Nino and La Nina phenomenon and its consequences; Effect of climate change on reproductive biology and biogeography. Environmental laws, environmental monitoring and bio indicators, environmental safety provisions in Indian constitution, major environmental laws in India; Waste Management & Bioremediation; Diversity Ecology and Evolutionary Biology Conservation

Unit –IV: ENVIRONMENTAL TOXICOLOGY [10 Hours]

Definition and classification toxic agents and their mode of action, Pesticides, Solvents, Metals, Carcinogens, Xenobiotics; Food additives; Geno toxicology

Unit – V PRINCIPLES OF TOXICOLOGY [15 Hours]

Basic concepts: Dose and dose response relationship, types of toxic effects (allergic reactions, Idiosyncratic reactions, reversible and irreversible effects, acute toxicity, sub-acute toxicity, sub chronic effects and chronic effects); Factors affecting toxicity; Absorption and distribution of toxins, Portals of entry; Concept of toxicokinetic and

toxicodynamic; ADME, Bioaccumulation, Biotransformation and biomagnification, Antagonism, synergism.

Text Books:

1. **Ecology and Environment** by P. D. Sharma; Rastogi Publications
2. **Environmental Biology** by P. S. Verma & V. K. Agarwal; S. Chand
3. **Environmental Toxicology** by Suresh C. Joshi & Priyanka Sharma; Pointer Publishers

Reference Books:

1. **Fundamentals of Ecology** by Eugene Odum; Cengage Learning
2. **An Introduction to Environmental Toxicology by Ph. D. Dong & Micheal H.; Createspace Independent Pub**

Course Code:	LSPC2004	No. of Credits:	4
Course Name:	BIODIVERSITY & EVOLUTION	Sem End Exam & Cycle Test:	60+40

COURSE EDUCATIONAL OBJECTIVES:

CEO1: To provide idea about types of biodiversity and its significance in ecosystem

CEO2: To have knowledge on conservation of biodiversity with application of biotechnology

CEO3: To provide inspiration on organic evolution and its principles

CEO4: To introduce the concept of radiation biodiversity and biogeography of plant

COURSE OUTCOMES:

Towards the end of the course the students will be able to:

CO1 To know the importance of biodiversity in nature

CO2 Be familiar with methods of conservation of biodiversity

CO3 To have idea about origin of life and organic evolution of organisms

CO4 To know about the system of classification, tools and techniques used in systematic biology

CO5 To analyze the relationship between biodiversity and ecosystem function, including the roles of keystone species and trophic interactions.

CO6 To e valuate the impacts of human activities on biodiversity, including habitat destruction, pollution, and climate change.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	2	1									
CO2	2	3		1								1
CO3	1	2	1									
CO4	2	1										
CO5	3	2	1									
CO6	2	2	1									

1–Slight, 2 –Moderate, 3 –Substantial

COURSE CONTENT

UNIT – I: CONCEPT OF BIODIVERSITY [12 Hours]

Biodiversity- Concept of Biodiversity (α, β, γ), Significant of biodiversity, Status of Biodiversity at global and National level. Biodiversity hot spots and megadiversity countries. Assessment of Biodiversity (Species Richness, dominance); Biodiversity index (Simpson's Index, Shannon-Wiener index), Similarity index (Sørensen index).

UNIT – II: CONSERVATION OF BIODIVERSITY I [12 Hours]

Needs to conserve biodiversity. Principle of conservation of Biodiversity (*Ex Situ* and *In Situ*). Strategies for Biodiversity conservation and salient features of biodiversity Act. Efforts in India to conserve biodiversity. Biotechnological approaches, Cryopreservation. JFM- Joint Forest Management, Chipko movement as case studies.

UNIT – III: CONSERVATION OF BIODIVERSITY II [15 Hours]

Concept of conservation with special reference to forest and wildlife management a) Conservation verses preservation b) Conservation Genetics-Genetic management of threatened species and c) Management and Conservation Practice d) Values of biodiversity and conservation ethics e) Significance of ecological restoration in conservation, Concept of stakeholders.

International conservation bodies; IUCN, UNDP, FAO, WWF, Organisms of conservation concern: Rare, endangered species. Conservation strategies; Genomics and Biodiversity Molecular Tools for diversity Studies-Significance of Molecular Tools in Diversity and

Conservation Studies, Barcoding.

UNIT – IV: EVOLUTION-I **[12 Hours]**

Origin of life, Theories of evolution, Modern synthetic theory of evolution; Pattern of evolution (Sequential evolution, convergent and Divergent evolution, micro, macro, and mega evolution; Molecular evolution, molecular clocks). Natural selection, Speciation, species concept, levels of selection. Types of selection (stabilizing, directional etc.), sexual selection, genetic drift, isolation mechanisms, sympatric and allopatric populations.

UNIT – V: EVOLUTION-II **[12 Hours]**

Animal distribution: Cosmopolitan, Discontinuous, Bipolar, and isolated distribution and factors effecting animal distribution, Adaptive radiation, biogeography and evolutionary ecology. systems of classification: cladistics and phonetics, molecular systematic, gene expression and evolution, Geological Time Scale, Continental drift; Neoteny and Paedogenesis in animals, Fossil and fossilization, Dating of Fossils.

Teaching Methods: Chalk& Board/ PPT/Video Lectures

Text Books:

1. **Fundamentals of ecology** by Prof. M.C. Dash
2. **Concept of ecology** by.Kormundy,
3. **Organic evolution** by Veer Bala Rastogi

Reference Books:

1. **Ecology** by O.P. Odum
2. **Evolution** by Douglas Futuyma

Course Code:	LSPC2105	No. of Credits:	4
Course Name:	PRACTICAL	End Exam:	100

1. Isolation of genomic DNA from Plant tissue.
2. Isolation of genomic DNA from human blood sample.
3. Purity determination and quantitation of DNA.
4. Extraction and estimation of DNA & RNA
5. Electrophoresis of DNA.
6. Isolation and electrophoresis of Proteins.
7. Estimation of protein content
8. Spectrophotometer, Centrifugation and pH meter - Instrumentation & Principle
9. Blood film preparation and identification of various blood corpuscles.
10. Study of Antigen-Antibody interaction by Double and Radial Immuno-diffusion.
11. Demonstration of Southern and Western blotting.
12. Species - Area curve

13. Frequency, Density and abundance - Community study
14. Ecological anatomy
15. Central Tendency- Measurement of mean, median, mode.
16. Measurement of dispersion
17. Student 't ' test and χ^2 test

Course Code:	**LSPC2107**
Course Name:	**MATLAB**
No. of Credits:	**1**

MATLAB LABORATORY SYLLABUS

List of the Experiments

1. MATLAB variables and data selection using colon operator.
2. Arithmetic, Trigonometric, and logical operations using MATLAB.
3. Numbers with different bases and their conversion technique using MATLAB.
4. Matrix operations using MATLAB.
5. Solving n^{th} order linear equations using MATLAB.
6. Solving integration, differential equations and partial differential equations using MATLAB.
7. Graphics in MATLAB, 2D plots, 3D plots, bar plots.
8. Programming in MATLAB 1: if-else statement, for loop.
9. Programming in MATLAB 2: while loop, switch case statements.
10. Functions in MATLAB: built-in functions and user defined functions with single and multiple variables.

References

1. Understanding MATLAB: A Textbook for Beginners by S. N. Alam S. S. Alam.
2. Getting Started with MATLAB: A Quick Introduction for Scientists & Engineers by Rudra Pratap.
3. MATLAB: An Introduction with Applications, 4ed by Amos Gilat.

(PLANT SCIENCE)
SEMESTER-III

Course Code:	LSPSPC3001	No. of Credits:	4
Course Name:	PLANT MORPHOLOGY AND REPRODUCTION	Sem End Exam & Cycle Test:	60+40

COURSE EDUCATIONAL OBJECTIVES:

CEO1: To provide the information on thallus organization and reproduction in algae

CEO2 : To impart knowledge on thallus organization and reproduction in fungi

CEO3: To provide an idea on origin and evolution of bryophyte and pteridophyta

CEO4: To introduce the concept of origin and classification of angiosperms

COURSE OUTCOMES:

Towards the end of the course the students will be able to:

CO1 To know the structure and importance of algae found in nature

CO2 Understand the classification and economic importance of fungi

CO3 Be familiar with bryophyte group and their evolution

CO4 To have an idea about taxon of pteridophyta.

CO5 To know about various angiosperms of the world and their systematic

CO6 Identify the plant and able to know its importance

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	O110	PO11	PO12
CO1	2	1		1								
CO2	1	2	1									
CO3	2	1										
CO4	2	1		1								1
CO5	2	3										
C06	2	2										

1–Slight, 2 –Moderate, 3 –Substantial

COURSE CONTENT

UNIT-I: ALGAE [13 Hours]

Algae: General account and classification of algae, Range of thallus organization and reproduction in algae. Pigmentation and storage products in algae. Economic importance of algae: Algae as environmental indicators, algae in agriculture, algae as sources of food, animal feed and pharmaceuticals; algal blooms.

UNIT-II: FUNGI [13 Hours]

Fungi: Classification of Fungi, Reproduction in fungi. Degeneration of sexuality in Ascomycetes. Para sexuality – sex hormones in fungi. Economic importance of fungi. Mycorrhiza- structure and applications.

UNIT-III: BRYOPHYTES AND PTERIDOPHYTA [13 Hours]

Bryophytes: History and classification. Anthocerotales as the connecting link between Bryophyte and Pteridophytes, Degeneration of sporogenous tissues in bryophyte. Economic importance of bryophytes – direct and indirect uses (ethno medicinal uses, phyto indicators and other uses).

Pteridophyta: General characteristics and classification of Pteridophytes; Origin of Pteridophytes and Relationship of Pteridophytes with Bryophytes and Gymnosperms; Stelar evolution in pteridophytes; Heterospory and seed habit.

UNIT-IV: GYMNOSPERMS AND PALAEOBOTANY [13 Hours]

Gymnosperms: General Structure, reproduction, evolution, relationship with Pteridophytes and Angiosperms and classification of gymnosperms; Economic importance of gymnosperms. Cycadalas as relic of ancient Gymnosperms, angiosperm character of Gnatales,

Palaeobotany-Geological era, Fossil, and Fossilization process.

UNIT-V: ANGIOSPERMS [13 Hours]

Angiosperms - Origin and evolution of angiosperms. Different systems of classification up to order. International code of Botanical Nomenclature (ICBN). Diagnostic characteristics, systematic phylogeny and economic importance of families: Magnoliaceae, Rosaceae, Apocynaceae, Asclepiadaceae, Convolvulaceae, Bignoniaceae, Lamiaceae, Euphorbiaceae, Orchidacae, Zingiberaceae, Cyperaceae and Poaceae

Teaching Methods: Chalk& Board/ PPT/Video Lectures

Reference Books:

1. **A Textbook of Algae** by A. V. S. S. Sambamurty; I K International Publishing House Pvt. Ltd
2. **An Introduction to Fungi** by H. C. Dube; Scientific Publishers
3. **Bryophyta** by O. P. Sharma; Mc Graw Hill Education
4. **Pterydophyta** by O. P. Sharma; Mc Graw Hill Education
5. **Gymnosperms** by S. P. Bhatnagar; New Age International Publishers
6. **Taxonomy of Angiosperms** by B. P. Pandey; S. Chand
7. **A Textbook on Algae** by H. D. Kumar and H. N. Singh
8. **The Fungi** by Sarah Watkinson, Lynne Boddy, Nicholas Money
9. **A Textbook of Bryophytes**, Pteridophytes, Gymnosperms and Paleobotany by A.V.S.S. Sambamurty

Course Code:	LSPSPE3002	No. of Credits:	4
Course Name:	PLANT PHYSIOLOGY	Sem End Exam & Cycle Test:	60+40

COURSE EDUCATIONAL OBJECTIVES:

CEO1: To convey the knowledge on phenomenon on absorption and translocation of water in plant

CEO2 : To provide acquaintance on essential elements of plant and their role in plant CEO3: To make available idea on respiration in plant and its importance

CEO4: To introduce the various types of photosynthesis in green plants

COURSE OUTCOMES:

Towards the end of the course the students will be able to:

CO1 To be familiar with the absorption of water, transpiration mechanism in plant

CO2 Be well-known with different essential minerals and their role in plant

CO3 To have an idea about respiration in plants

CO4 To know about process of photosynthesis in plants and its application

CO5 Understand the physiology of flowering in plants

CO6 Know the different plant hormones and its application

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	O110	PO11	PO12
CO1	2	3	1									
CO2	1	2		1								1
CO3	2	1	1									
CO4	2	1										1
CO5	2	1										
CO6	2	2	1									

1–Slight, 2 –Moderate, 3 –Substantial

COURSE CONTENT

UNIT - I: WATER RELATION **[13 Hours]**

Diffusion, osmosis, osmotic potential, water potential and chemical potential. Mechanism of absorption of water. Mechanism of ascent of sap: Vital Theories, Root Pressure theory; Physical force theories – capillary theory, imbibitional theory, Atmospheric Pressure theory, transpiration pull theory; Factors affecting ascent of sap.

Loss of water: Transpiration, types, structure of stomata, distribution of stomata, mechanism of stomatal transpiration, theories of stomatal movement, significance of transpiration, adaptations to reduce transpiration, factors affecting transpiration, anti-transpirants; guttation.

UNIT - II: MINERAL NUTRITION **[13 Hours]**

Translation of organic materials in phloem. source sink concept. Mineral nutrition - essential elements, role of essential elements and deficiency symptoms. factors affecting mineral salt uptake and ion antagonism. hydroponics, absorption of elements, passive and active transport.

UNIT - III: RESPIRATION **[13 Hours]**

Respiration- Introduction, ultra-structure of Mitochondrion, Types – aerobic and anaerobic Respiration and Respiratory quotient, Alternative pathways of electron transport and significance of Oxidative phosphorylation, Energetics of respiration, lipids as respiratory substrates, Cyanide – resistant respiration

UNIT - IV: PHOTOSYNTHESIS **[13 Hours]**

Photosynthesis- Principles of light absorption in chloroplast, Organization of light absorbing systems, Mechanism of electron flow C_3, C_4 and CAM pathway for carbon reduction. Photorespiration. Germination of seed, physiology of flowering and senescence.

UNIT V: PLANT GROWTH REGULATORS **[13 Hours]**

Plant Growth Regulators – Discovery, structure, biosynthesis, bioassays, roles and mechanism of action of auxins, gibberellins, cytokinins, ethylene and abscisic acid.

Plant Movements: Autonomic or spontaneous movements, paratonic or induced movements, tactic movements, tropic movements, nastic movements, haptonastic movements, seisomonastic movements.

Teaching Methods: Chalk& Board/ PPT/Video Lectures

Reference Books:

1. **Plant Physiology** by S. N. Pandey & B. K. Sinha; Vikas Publication House Pvt Ltd
2. **Fundamentals of Plant physiology** by V. K. Jain; S. Chand
3. **Plant Physiology** by Ross & Salisbury; CBS
4. **Outline of Plant Physiology** by Robert M. Devlin; Medtech

Course Code:	LSPSPE3003	No. of Credits:	4
Course Name:	TAXONOMY AND PLANT PATHOLOGY	Sem End Exam & Cycle Test:	60+40

COURSE EDUCATIONAL OBJECTIVES:

CEO1: To impart the knowledge on cause of plant diseases and host parasite interaction

CEO2 : To provide knowledge different bacterial diseases in plant

CEO3: To make available idea on fungal diseases of plant

CEO4: To introduce the current plant disease management systems

COURSE OUTCOMES:

Towards the end of the course the students will be able to:

CO1 To know the causes, effect and host parasite interaction in plant

CO2 Be well-known with different bacterial diseases and their remedies

CO3 To acquainted with fungal diseases and their symptoms

CO4 To know about the pest-disease management in plants

CO5 Have idea about Natural pesticides obtained from plants

CO6 Identify the plant diseases and suggest foe remedy

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	O110	PO11	PO12
CO1	2	3		1								
CO2	1	3	1									1
CO3	1	1										
CO4	2	1		1								1
CO5	2	1										
CO6	2	1	1									

1–Slight, 2 –Moderate, 3 –Substantial

COURSE CONTENT

UNIT – I: **PRINCIPLES OF PLANT PATHOLOGY** **[13 Hours]**

Importance, definitions and concepts of plant diseases, **History and Development of Plant Pathology,** biotic and abiotic causes of plant diseases. Host- parasite interaction: Mechanism of penetration and the process of disease development.

UNIT – II : **PLANT BACTERIOLOGY** **[13 Hours]**

History and introduction to phytopathogenic procarya, viz., bacteria, MLOs, spiroplasmas and other fastidious procarya. Importance of phytopathogenic bacteria.

UNIT – III : **PLANT MYCOLOGY** **[13 Hours]**

General Symptoms of Plant diseases caused by Fungi. Mode of Infection and Pathogenesis. Mechanism of Defense: Structural Defense Mechanism. Chemical Defense Mechanism. Symptoms, causal organism and control measure of fungal diseases: a) Blights b) Mildews c) Rusts d) Smuts e) Wilts f) Rots

UNIT – IV: PLANT VIROLOGY **[13 Hours]**

History of plant viruses, composition and structure of viruses. Symptomatology of important plant viral diseases, transmission, chemical and physical properties, host virus interaction, virus- vector relationship. Management of Plant Diseases, Chemical control (fungicides), Quarantine. Biological Control, Integrated Pest management.

UNIT -V: NATURAL PESTICIDES AND ANTIBIOTICS **[13 Hours]**

Natural pesticides – introduction, method of pest control, classification, essentials of a good pesticide, pesticide and environment, examples – *Pyrethrum* (flowers), *Derris* (root), *Nicotiana* and *Azadirachta* (leaf) and *Cymbopogon* (Citronella oil).

Antibiotics – Introduction and classification – Aminoglycosides, Cephalosporins, Tetracyclines and Pencillins.

Teaching Methods: Chalk& Board/ PPT/Video Lectures

Reference Books

1. **A Textbook of Plant Pathology**, by A.V.S.S. Sambamurty
2. ***Fundamentals of Plant Pathology*** by R. S. Mehrotra, Ashok Aggarwal.
3. ***Plant Pathology***. Author, Dr. *P.D. Sharma*. Publisher, Rastogi Publications
4. **Recent Trends in Plant Pathology** by Bishwanath Chakraborty & Usha Chakraborty
5. ***Introduction to Principles of Plant Pathology*** by R. S. Singh. Oxford & IBH Publishing Company

Course Code:	LSPSPE3004	No. of Credits:	4
Course Name:	PLANT BIOTECHNOLOGY	Sem End Exam & Cycle Test:	60+40

COURSE EDUCATIONAL OBJECTIVES:

CEO1: To provide basic concept on plant tissue culture
CEO2 : To determine the factors influencing plant cell differentiation and development.
CEO3: To provide knowledge on techniques of plant genome transformation
CEO4: To establish the application of plant biotechnology for development of society

COURSE OUTCOMES:

Towards the end of the course the students will be able to:

CO1 To know the composition and preparation of tissue culture media for culture of plant tissue
CO2 Be acquainted with culture of different plant tissue and protoplast at laboratory
CO3 To have idea about vector and vector less gene transformation in plant
CO4 To get practical knowledge on application of plant biotechnology
CO5 Get hands on knowledge on advance techniques of plant biotechnology
CO6 Know about to start the plant biotechnology firm

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	O110	PO11	PO12
CO1	2	3	1									
CO2	1	2		1				1				1
CO3	2	1	2									
CO4	2	1		1				1				1
CO5	1	2										
CO6	2	2										

1–Slight, 2 –Moderate, 3 –Substantial

COURSE CONTENT

UNIT I: Basic of Plant Tissue culture [13 Hours]

Plant tissue culture: historical perspective; Concept of totipotency and plasticity of plant cell, Tissue culure media- preparation and composition. Plant growth regulators in plant tissue culture, application of plant tissue culture

UNIT II: *In Vitro* culture [13 Hours]

Initiation and establishment of culture: Explant preparation, sterilization techniques, Callus culture, Single cell culture, Suspension culture, Microspore culture Micropropagation: Organogenesis, Somatic embryogenesis, Artificial seed; Protoplast technology: Isolation and culture of protoplast, Somatic hybridization, Screening and selection of somatic hybrid.

UNIT III: Plant transformation technology [13 Hours]

Concept of genetic transformation: Vector based transformation (*Agrobacterium*, Virus), Direct transformation (Gene gun, Electroporation, Microinjection etc.). promoter tagging, use of markers. germplasm conservation and cryopreservation;

UNIT IV: Application Plant transformation technology [13 Hours]

Herbicide resistance, insect resistance, disease resistance, virus registance, molecular farming, terminator seed technology; Products of genetic transformation: golden rice, Bt cotton and Flavr savr tomato, industrial enzymes. Plant based antibodies, Biotransformation with case studies.

UNIT V: Advanced methodologies in Plant transformation technology [13 Hours]

Chloroplast transformation; marker-free methodologies; advanced methodologies - cisgenesis, intragenesis and genome editing; molecular pharming - concept of plants as biofactories, production of industrial enzymes and pharmaceutically important compounds. Molecular markers - hybridization and PCR based markers RFLP, RAPD, STS, SSR, AFLP, SNP markers.

Teaching Methods: Chalk& Board/ PPT/Video Lectures

Reference Books

1. **A Text Book of Biotechnology** R C Dubey, S Chand publication
2. **Plant Biotechnology** by S. Umesha
3. **Introduction to plant biotechnology** by H. S. Chawla
4. **Plant biotechnology**: the genetic manipulation of plants by Slater A, Scott N, Fowler M. Oxford: Oxford University Press
5. **Handbook of Plant Biotechnology**, Volumes 1 & 2 Edited by P. Christou

Course Code:	LSPSPE3005	No. of Credits:	4
Course Name:	MEDICINAL PLANTS AND THEIR APPLICATION	Sem End Exam & Cycle Test:	60+40

COURSE EDUCATIONAL OBJECTIVES:

CEO1: To provide basic concept of plant tissue culture and significance of totipotency
CEO2 : To impart knowledge on composition nutrient medium used in plant tissue culture. CEO3: To provide techniques of plant tissue culture of explants at laboratory
CEO4: To introduce the processes of cryopreservation of plant tissue

COURSE OUTCOMES:

Towards the end of the course the students will be able to:

CO1 To know the history of medicinal and aromatic plants
CO2 Be acquainted with different remedy systems of the world
CO3 To have idea about herbal medicine
CO4 Know about History, significance, scope and objectives of Ethnobotany
CO5 Get deep knowledge on poisonous and allergic plants
CO6 To get acquaintance on Psychoactive plants and its importance

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	O110	PO11	PO12
CO1	2	3		2								
CO2	3	2	1					1				
CO3	2	3		1				1				
CO4	2	2		1								1
CO5	2	3		1								
CO6	2	3										

1–Slight, 2 –Moderate, 3 –Substantial

COURSE CONTENT

UNIT-I: HISTORY OF MEDICINAL AND AROMATIC PLANTS [13 Hours]

History of medicinal and aromatic plants - some important terms used in herbal medicine; Herbal industry; WTO Indian scenario- Prospects and constraints, export and import status; AAYUSH – Amchi (Tibetian), Ayurveda, Unani, Siddha and Homoeopathy; Chinese; Bach's flower remedy; Aromatherapy.

UNIT II: IMPORTANCE OF MEDICINAL PLANTS [13 Hours]

Relevance of herbal medicine as primary health care package; sources of information on medicinal plants; Organization of information in database (national and international); Causes for the decline and the current scenario in Indigenous systems of medicine; a comparative evaluation of accessibility and benefits of different systems of medicine

UNIT III: ETHNOBOTANY AND POISONOUS PLANTS [13 Hours]

Ethnobotany – History, significance, scope and objectives of Ethnobotany, branches of ethnobotany; ethno medicine in India

Poisonous plants – classification; chemical constituents, symptoms, treatment and systematic description of some poisonous plants - *Papaver somnifera, Calotropis gigantea, Gloriosa superba, Digitalis purpurea, Datura metel, Strychnos nux-vomica*

UNIT IV: ALLERGIC PLANTS [13 Hours]

Plant Allergens – Types and classification; description, symptoms, chemical constituents and treatment of the following allergic plants - *Parthenium hysterophorus, Urtica sp., Acacia sp., Eucalyptus globulus, Arachis hypogaea and Solanum*.

UNIT V: Remedial and Psychoactive plants [13 Hours]

Remedial plants: or heart, respiratory, skin, cancer, autoimmune, and liver diseases; nutraceuticals and cosmeceuticals; Vrikshayurveda - herbal remedies for plant disease

Psychoactive plants – classification; stimulants, nootropic plants (Plants for mental health), hallucinogens, depressants, and anti-depressants.

Teaching Methods: Chalk& Board/ PPT/Video Lectures

Reference Books

1. Medicinal Plants Oxford & Ibh Publishing Medicinal Plants 2018 Edition by Joshi SG
2. Medicinal Plants Used In Ayurveda: Rastrya Ayurvedic Vidyapeeth, India
3. Hand Book Of Medicinal & Aromatic Plants, Engineers India Research Institute
4. Medicinal Plants For Forest Conservation And Health Care Daya Publishing House by Bodeker, Gerard

Course Code:	LSPSCBOE306	No. of Credits:	4
Course Name:	PLANT METABOLISM	Sem End Exam & Cycle Test:	60+40

COURSE EDUCATIONAL OBJECTIVES:

CEO1: To provide basic concept of lipid metabolism in plant
CEO2 : To impart knowledge on role of sulphur and its metabolism in plant system CEO3: To endow with nitrogen fixation processes in nature
CEO4: To introduce the different secondary metabolites present in plants

COURSE OUTCOMES:

Towards the end of the course the students will be able to:

CO1 To know the importance of lipid and lipid metabolism in plant
CO2 Understand the concept of Protein synthesis
CO3 Have depth knowledge on Phyto molecules and their importance
CO4 Be familiar with importance of Sulphur and its utilization in plant
CO5 To have idea about different types of nitrogen fixation processes and nitrogen cycle
CO6 To get knowledge on biosynthesis and biological significance of secondary metabolites

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	PO11	PO12
CO1	2	3	1									1
CO2	3	2		1								
CO3	2	3		1								
CO4	2	2	1									
CO5	2	3										
CO6	3	2										

1–Slight, 2 –Moderate, 3 –Substantial

COURSE CONTENT

UNIT-I: PROTEIN SYNTHESIS [13 Hours]

Biosynthesis of proteins in prokaryotes – Aminoacyl t RNA activity, Translation – initiation, elongation and termination, post translation modifications. Biosynthesis of proteins in Eukaryotes. Importance of protein in cell. Proteomics and its application

UNIT-II: LIPID METABOLISM [13 Hours]

Lipid metabolism: Biosynthesis of Fatty Acids (Synthesis of Glycerol Synthesis of Fatty Acids, initiation, elongation of chain), Biosynthesis of Triacylglycerols, Fatty Acid Oxidation (β-, α- and ω-Oxidation), Ketogenesis.

UNIT-III: SULPHUR METABOLISM [13 Hours]

Sulphur metabolism: Role of sulphur and its compounds in plant metabolism, sulphur uptake transportation and assimilation of sulphur in plant. Sulfur nutrition and its role in plant growth and development. Manipulating the Sulfur Composition of Seeds

UNIT–IV: NITROGEN METABOLISM [13 Hours]

Nitrogen metabolism: role of nitrogen in plant, source of nitrogen, nitrogen cycle. Non biological fixation and biological nitrogen fixation, non-symbiotic nitrogen fixation. Mechanism of nitrogen fixation, genetics of nitrogen fixation, synthesis, and regulation of nitrogenase enzyme.

UNIT-V: SECONDARY METABOLITES [13 Hours]

Characteristic features of secondary metabolites of plant origin; Basic metabolic pathways and origin of secondary metabolites; biosynthesis and biological significance of terpenes, phenolics and nitrogen containing compounds.

Teaching Methods: Chalk& Board/ PPT/Video Lectures

Reference Books:

1. **Biochemistry** by V. Voet & J. G. Voet; John Wiley & Sons
2. **A Textbook of Plant Physiology, Biochemistry and Biotechnology** by S K Verma and Mohit Verma; S. Chand

3. **Biochemistry** by L. Stryer; W.H.Freeman & Co Ltd
4. **Lehninger Principles of Biochemistry** by David L. Nelson and Michael Cox; W.H Freeman

Course Code:	LSPSCBOE3007	No. of Credits:	4
Course Name:	ANATOMY AND PLANT DEVELOPMENTAL BIOLOGY	Sem End Exam & Cycle Test:	60+40

COURSE EDUCATIONAL OBJECTIVES:

CEO1: To provide basic concept on plant anatomy and development of plant organs

CEO2 : To impart knowledge on different stresses of plants and response to stresses

CEO3: To endow with on life cycle of angiospermic plants

CEO4: To introduce the process of pollination and fertilization of angiospermic plant

COURSE OUTCOMES:

Towards the end of the course the students will be able to:

CO1 To know the internal structure and tissue system in higher plants

CO2 Be acquainted with structural response of plants to diseases and other stresses

CO3 To have an idea about details of development of angiospermic plants

CO4 To get acquaintance on pollination and process of fertilization in plant

CO5 Know the palynology and its significance in plant breeding

CO6 Get the depth knowledge on sexual incompability of plants

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	O110	PO11	PO12
CO1	2	3										
CO2	3	2		1								
CO3	2	3	1									1
CO4	2	2		1								
CO5	2	2	1									
CO6	3	2					1					2

1–Slight, 2 –Moderate, 3 –Substantial

COURSE CONTENT

UNIT I **[13 Hours]**

Introduction to Plant Anatomy: Primary and secondary tissues in plants; Anatomy of root, stem, leaf of monocot and dicot plants; differentiation of vascular tissue in higher plants; Secondary growth in stem and root.

Shoot Development: organization of shoot Apical meristem and types of vegetative shoot apex

Root Development: organization of root apex and significance of Quiscentcenter

Leaf: Structure with reference to C3 and C4 plants – Kranz and CAM Syndrome

UNIT II **[13 Hours]**

Structural Response of Plants to Diseases and other stresses: Abscission, Tissue regeneration, Grafting; Cytological reaction to invasion of parasites; Structural basis of Resistance: Trichomes, Laticifers, Dutch elm disease and Tylosis; Virus movement in Plants; Anatomical responses to mineral deficiency

UNIT III **[13 Hours]**

Development in flowering plants: Angiosperm life cycle, Anther: Structure and development, microsporogenesis, male gametophyte development, Arabidopsis model organism

Palynology: Pollen morphology, pollen kit, NPC formula. Applications of palynology in relation to taxonomy. Viability of pollen grains. Pollination, pollen germination, growth and nutrition of pollen tube

UNIT IV **[13 Hours]**

Pollination and Fertilization: Structural, Functional aspects of pollen style stigma. Current view of double fertilization and development of endosperm and its function. Embryo development - different types. Endosperm development, types of endosperms, haustorial behavior of endosperm. Xenia and metaxenia.

UNIT V **[13 Hours]**

Sexual incompatibility: Self incompatibility, Genetic basis of self-incompatibility, Physiology and biochemistry of incompatibility, biological significance, Methods to overcome incompatibility.

Teaching Methods: Chalk& Board/ PPT/Video Lectures

Reference Books

1. Parihar, N.S. An introduction to Embryophyta: Vol. I. Bryophyta. Allahabad, India: Central Book Depot. 1991.
2. Raven, P.H., Johnson, G.B., Losos, J.B. and Singer, S.R. Biology. New Delhi: Tata McGraw Hill,
3. Dickison, W.C. Integrative Plant Anatomy.USA: Academic Press, 2000.
4. Fahn, A. Plant Anatomy. Sydeny: Pergamon Press.
5. Beck, Charles B. An introduction to plant structure and development: plant anatomy for the twenty-first century. Cambridge University Press, 2010.

6. Johansen, Donald Alexander. Plant embryology.Chronice Botanica Company; Waltham, Mass

Course Code:	LSPSPE308	No. of Credits:	4
Course Name:	PRACTICAL	End Exam:	100

1. Algal mixture separation
2. Study of diseased plant samples- identification of Fungi with symptoms of disease.
3. Anatomical studies of Bryophyta
4. Anatomical studies of pteridophyta
5. Anatomical studies of Gymnosperm
6. Floral characters & Identification of families: Graminae, cyperaceae, Ranunculaceae, Umbllifrae, Malvaceae , Apocynaceae etc.
7. Osmotic potential - calculation using *Rhoeo* leaf.
8. Estimation of chlorophyll pigment in various leaves
9. Stomatal Index/ Stomatal frequency.
10. Identification of amino acids by paper chromatography.

(ANIMAL SCIENCE)
SEMESTER-III

Course Code:	LSASPC3001	No. of Credits:	4
Course Name:	BIOLOGY OF INVERTEBRATE	Sem End Exam & Cycle Test:	60+40

Course Educational Objectives

This course enables the students:

CEO1: To obtain required knowledge regarding animal phyla and functional aspects of phyla from Protozoa to Ctenophora.

CEO2: To gain knowledge regarding Helminth parasites, structural and aspects of Annelida and Arthropoda.

CEO3: To acquire knowledge regarding the phyla, Onychophora, Mollusca, Echinodermata and Hemichordata.

CEO4: To gain thorough understanding about the structure and affinities of some minor phyla. And to gain some basic knowledge of Economic Zoology.

Course Outcomes
Towards the end of the course, a student should be able to:

CO1: Classify animal kingdom upto phyla on the basis of certain defining features, differentiate between major and minor phyla and describe various functional aspects of Protozoa, Porifera, Coelenterate and Ctenophora

CO2: Describe various helminth parasites of humans, structural features of phylum Annelida, vision in insects and larval forms in Crustacea

CO3: Illustrate the structure & affinities of Peripatus and Hemi-chordata, respiration & torsion in Mollusca, larval forms & water vascular system in Echinodermata.

CO4: Explain the structure and affinities of Lophophorate phyla & phylum Gastrotricha along with their evolutionary significance. And gain some basic knowledge regarding Apiculture, Sericulture, Lac culture & Pearl culture.

CO5: To evaluate scientific literature related to non-chordate biology and apply this knowledge to solve problems in the field.

CO6: To understand the economic importance of zoology

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12

CO1	1	1										1
CO2	1	1										
CO3		1										
CO4	2	2	1	1			1					1
CO5	2	2	1	1								1
CO6	2	1	2									2

course content

Unit I: PROTIST TO PSEUDOCOELOMATES [14 Hours]

Protozoan diseases in humans (Life cycle and mode of transmission of parasites in Amoebiasis, Malaria, Trypanosomiasis); Origin and evolution of metazoan; Biological and medicinal importance of sponges; Polymorphism in coelenterates; Corals, Coral reefs and their economic importance; Helminth parasites and human diseases (Life cycle and mode of transmission of parasites in Ascariasis, Filariasis, Schistosomiasis, Taeniasis).

Unit II: COELOMATES-I [12 Hours]

Origin of coelom and coelomates; Metamerism and segmentation in Annelida; Excretory system in Annelida; Torsion and detorsion in Gastropoda; Respiration in Mollusca; Larval forms in Echinodermata; Water vascular system in Echinodermata.

Unit III: COELOMATES-II [14 Hours]

Crustacean Larvae; Crustacean parasites; Adaptive radiation in the mouthparts of Insects; Economic importance of Insects; Metamorphosis in Insects; Adaptive radiation in the respiration of Arthropods; Vision in Arthropods; Locomotion in Arthropods: types, structural organisation and mechanism for locomotion.

Unit IV: MINOR PHYLA [11 Hours]

Concept of minor phyla; Structure and affinities of Ctenophorans; Structure and affinities of Lophophorate (Phoronida, Ectoprocta and Brachiopoda); Structure and affinities of Onychophorans.

Unit V: ECONOMICALLY IMPORTANT INVERTEBRATES [14 Hours]

Apiculture: Honey bee biology, Beekeeping equipment, Management of honey hives and apiary, Techniques of honey production and harvesting, Ecological and socio-economic importance; **Sericulture:** Silkworm biology, Sericulture techniques and management, Silk types and properties, Ecological and socio-economic importance; **Pearl culture:** Pearl-production molluscs, pearl formation, farming systems, pearl harvesting and processing, Quality control and Economic importance; **Vermiculture:** Earthworm biology, Vermicomposting systems and management, Economic importance.

Text Books:

1. **Invertebrate Series (Protozoa-Minor Phyla)-9 Books** by R. L. Kotpal; Rastogi Publications
2. **Invertebrate Zoology** by E. L. Jordan & P. S. Verma; S. Chand
3. **Biology of Animals: Vol-1** by Ganguly, Sinha & Adhikary; NCBA
4. **Introduction to Economic Zoology by** S Sarkar, G Kundu, K K Chaki; NCBA

Reference Books:

1. **Invertebrates** by Richard C. Brusca & Gary J. Brusca; Sinauer Associates
2. **Biology of the Invertebrates** by Jan A. Pechenick ; Mc Graw Hill India
3. **Text book of Zoology: Invertebrates** by Parker and Haswell; AITBS PUBLISHERS

Course Code:	LSASPE3002	No. of Credits:	4
Course Name:	BIOLOGY OF VERTEBRATES	Sem End Exam & Cycle Test:	60+40

Course Educational Objectives

This course enables the

students:

CEO1: To get a detailed idea regarding lower chordates, jawless vertebrates and lung fishes.
CEO2: To gain knowledge regarding various aspects of fishes and amphibia.
CEO3: To obtain required knowledge regarding Reptiles, Aves, Prototheria and Metatheria.
CEO4: To acquire thorough understanding regarding Eutherian along with comparative anatomy of integument and jaw of vertebrates**.**

Course Outcomes
Towards the end of the course, a student should be able to:

CO1: Gain conceptual knowledge regarding of Protochordates, Cyclostomes, and lung fishes.
CO2: Obtain conceptual knowledge about Fishes and Amphibia and their behavior during parental care.
CO3: Gain conceptual knowledge about Reptiles, Birds, Prototheria and Metatheria

CO4: Gain conceptual knowledge about Eutherians along with knowledge regarding comparative anatomy
CO5: Analyze the ecological roles of chordates in different ecosystems and their impact on biodiversity.
CO6: Able to explain the evolutionary relationships between different groups of chordates and their adaptations to various environments.

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	2										
CO2	1	2										
CO3	1	2	1									1
CO4	2	3	2	1			3					2
CO5	2	3	1									
CO6	2	2	1	1								2

COURSE CONTENT

Unit –I: HEMICHORDATES [12Hours]

Outline classification of Phylum: Chordata; Geological time scale (GTS); Origin and ancestry of Chordata.; Inter-relationship of Urochordata and Cephalochordata- General characters, similarities, and differences; Structure of Myxine, Petromyzon and Ammocoete larva; Structure and affinities of Hemichordate.

Unit –II: FISHES & AMPHIBIA [12 Hours]

Parental care in fishes; Origin and evolution of Amphibia (Tetrapoda); Structure & General account of Gymnophiona (Cecaelians); Affinities of Cyclostomata; Distribution, structure and affinities of Dipnoi; Parental care in Amphibia-Protection by nests & nurseries and direct caring by parents; Neoteny in Amphibia

Unit –III: REPTILIA, AVES, PROTOTHERIA & METATHERIA [12 Hours]

Evolution and Adaptive radiation in Reptiles; Classfication of reptiles basing on skull pattern; Distribution, Structure & affinities of Sphenodon; Mammal-like reptiles-two successive orders: Pelycosauria & Therapsida; Flight adaptations and perching mechanism in birds; General account of Prototheria and Metatheria; Distribution of metatheria

Unit –IV: EUTHERIA [12 Hours]

General characteristics and classification up to order lever, Affinities of eutheria, Aquatic mammals; Dentition in mammals; Adaptive radiation in general, Adaptive radiation in marsupials and placental mammals; Adaptive convergence in mammals, Economic importance of mammals, Origin and evolution of Jaw and types of jaw suspensoria in Vertebrates

Unit –V: COMPARITIVE ANATOMY [14 Hours]

Comparative anatomy and function of epidermal and dermal derivatives of Integument in Vertebrates, Glands, scales, horns, claws, nail, hoofs, feather and hairs; Comparative account of respiratory organs; Comparative account on jaw suspension; Nervous system: Comparative anatomy of the brain in relation to its functions; Comparative anatomy of spinal cord and Nerves-Cranial, Peripheral and Autonomous nervous system

Teaching Methods: Chalk& Board/ PPT

Text Books:

1. **Modern Text Book of Zoology: Vertebrates** by R. L. Kotpal; Rastogi Publications
2. **Biology of Animals: Vol-2** by Ganguly, Sinha &Adhikary; NCBA
3. **Colbert's Evolution of the Vertebrates** by Edwin H. Colbert et al; Mc Graw Hill India

Reference Books:

1. **Vertebrates: Comparative Anatomy, Function, Evolution** by Kenneth V. Kardong et al; McGraw-Hill Science Engineering
2. **Vertebrate Life** by F. Harvey Pough et al; Pearson
3. **Chordate Zoology** by E. L. Jordan & P. S. Verma; S. Chand
4. **Text book of Zoology: Vertebrates** by Parker and Haswell; AITBS PUBLISHERS
5. **WATERMAN, A.J (1971),** Chordate Structure and Function, The Macmillan Company.
6. **COLBERT, H. EDWIN (1989),** Evolution of the Vertebrates, II Ed., Wiley Eastern Limited, New Delhi.
7. **HARREY POUGH, JOHN B. HEISHER, WILLIAM N. McFARLAND (1990),** Vertebrate Life, Macmillan Publishing Co., New York.
8. **JOLLIE, M (1962),** Chordate Morphology, Reinholt Publishing Corporation, NewYork. 5. KENT, G.C (1976), Comparitive anatomy of the Vertebrates, McGraw Hill Book Co., Inc., New York

Course Code:	LSASPE3003	No. of Credits:	4
Course Name:	APPLIED ZOOLOGY	Sem End Exam & Cycle Test:	60+40

Course Educational Objectives
This course enables the students:

CEO1: To gain understanding about systems biology networks and pathways.
CEO2: To obtain knowledge regarding simulation pathways in relation to whole cells.
CEO3: To acquire knowledge w. r. t. signaling and experimental methods in systems biology and robustness and optimality in biology
CEO4: To design circuits & databases. And to gain understanding about synthetic biology

Course Outcomes
Towards the end of the course, a student should be able to:

CO1: Acquire deeper understanding about various aspects of computer networks, microarrays, self-organizing maps, connectivity maps and metabolic maps.
CO2: Enumerate various simulation pathways relating to virtual erythrocytes, pathological analysis, flux balance analysis, biochemical and metabolic regulation.
CO3: Explain regarding slow & auto regulation and memory & irreversibility. And to describe about model & integral feed-back and linking models & measurement.
CO4: Gain deep understanding regarding databases relating to system biology and optimal design of gene circuits along with some basics of directed evolution and Microbial engineering.
CO5: Explain the fundamental concepts and theoretical frameworks of systems biology, including network theory, feedback loops, and emergent properties.
CO6: Develop mathematical and computational models to describe and simulate biological systems, including regulatory networks, signaling pathways, and metabolic pathways.

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	2	1	3								1
CO2	1	2	1	2								
CO3	2	1	2	1								
CO4	2	2	1	3								2
CO5	3	2										
CO6	2	2	1									

COURSE CONTENT

Unit –I: INTRODUCTION [10Hours]

Systems biology networks-basics of computer networks, Biological uses and integration; Micro array-definition, Applications of Micro Arrays in systems biology. Self-organizing maps and connectivity maps-definition and uses; Networks and Pathways-Types and methods; Metabolic networks

Unit –II: SIMULATION OF PATHWAYS [11Hours]

Whole cell: Principles and levels of simulation-Virtual erythrocytes; Pathological analysis; Flux balance analysis; Biochemical metabolic regulation; Metabolomics and enzymes; Interconnection of pathways; Metabolic regulation; Translating biochemical networks into linear algebra: Cellular models

Unit–III: Signalling& Experimental methods in systems biology [12Hours]

Slow and auto-regulation; The coherent FFL-temporal order, FIFO, DOR, Global, Development; memory and irreversibility-signalling networks and neuron circuits-robust adaptation-any model.

Unit–IV: Design of Circuits and Databases [10Hours]

Introduction-databases KEGG, EMP, MetaCyc, AraCycetc; Expression databases and various databases related to systems biology; Optimal design of gene circuits-I, cost and benefit; Gene circuits-II, selection of regulation; Stochasticity in gene expression.

Unit –V: Pathways and Synthetic Biology [15 hours]

Robustness and optimality in Biology

Model and integral feedback-signaling/bifunctional enzymes; Perfect Robustness-Role and its measurement; Linking models and measurement, concepts, calibration and identification

Synthetic Biology

Introduction, definition and basics; Technological applications of Directed evolution and Microbial engineering; Potential Hazards of Synthetic biology

Teaching Methods: Chalk& Board/ PPT

Text Books:

1. **Systems Biology: Definitions and perspectives** by L. Alberghina& H. V. Westerhoff; Springer
2. **Synthetic Biology, A New paradigm for Biological Discovery,** a report by Beachhead Consulting, 2006

Reference Books:

1. **Computational systems biology** by A. Kriete& R. Eils; Academic Press
2. **Systems biology and Synthetic Biology** by Pengcheng Fu & Sven Panke; Wiley

Course Code:	LSASPE3004	No. of Credits:	4
Course Name:	ANIMAL BIOTECHNOLOGY	Sem End Exam & Cycle Test:	60+40

COURSE EDUCATIONAL OBJECTIVES:

CEO 1: To know the basic equipments and materials required for animal cell culture and various methods used for cell cloning

CEO 2: To understand the in vitro fertilization, Embryo culture, Tissue engineering, transfection mechanism and application of animal cell culture.

COURSE OUTCOMES:

Towards the end of the course the students will be able to :

CO1 Know the laboratory equipments and materials required for animal cell culture and establishment of cell line.

CO2 Understand about Various methods of cell separation, Cell cloning, Characterization of cultured cell.

CO3 Know about the in vitro fertilization, Embryo culture, Tissue engineering and mechanism of apoptosis.

CO4 Learn about the transfection of animal cell lines and applications of animal cell culture.

CO5 Understand the molecular biology techniques such as PCR, gene Cloning.

CO6 Able to analyze the ethical, legal, and societal implications of animal biotechnology.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	2	1	2									
CO2	3	2	1	1	1									
CO3	1	2	2	1	1									
CO4	2	3	1	2	1									
CO5	3	2	2	1										
CO6	3	2	2	3										

1–Slight, 2 –Moderate, 3 –Substantial

COURSE CONTENT

Unit-I: INTRODUCTION TO ANIMAL BIOTECHNOLOGY [13 Hours]

Animal Biotechnology Equipment's and materials for animal cell culture, Balanced salt solutions, Brief discussion on the chemical, physical and metabolic functions of different constituents of culture medium, Sterilization and aseptic techniques, Primary culture and its maintenance, Development of cell line by enzymatic disaggregation

Biology and characterization of culture cell, Measuring parameters of cell growth, Transformation of cells: Characteristics of transformed cells and the process of Immortalization (by suppression of senescence genes, induction by viral genes, by induction of telomerase and by chemical carcinogens)

Unit-II BIOPROCESS ENGINEERING IN CELL CULTURE [11 Hours]

Various methods of cell separation, Measurement of viability and cytotoxicity, Cell culture in continuous, perfusion and hollow-fiber reactor, Preparation of chick fibroblast, Organ and isotypic cultures, Scaling up the cell culture to large scale/industrial level production, common cell culture contaminant

Unit-III: ADVANCED CELL CULTURE TECHNIQUES [13 Hours]

In vitro fertilization, Embryo culture, Cell cloning and its conservation, Future tissue engineering, Necrosis, and apoptosis (mechanism and assay), Cryopreservation, Stem cell technology and its application., Hybridoma technology

UNIT- IV: ANIMAL REPRODUCTIVE BIOTECHNOLOGY [14 Hours]

Animal reproductive biotechnology: structure of sperms and ovum; cryopreservation of sperms and ova of livestock; artificial insemination; super ovulation, embryo recovery and in vitro fertilization; culture of embryos; cryopreservation of embryos

UNIT-V: BIOTECHNOLOGICAL TECHNIQUES IN ANIMAL CELL CULTURE [13 Hours]

Transfection of animal cell lines and its applications, Construction of animal viral vectors for gene transfer into cell lines; Sperm mediated gene transfer; Embryo transfer technology, Somatic cell genetics; Molecular pharming; Cell culture-based vaccines and other therapeutic proteins, Culture of cells for production of various biologicals

Text Books

1. Culture of animal cells by R.I. Freshney.
2. Tissue Culture–Methods and Applications by Paul F. Kruse Jr. and M. K.Patterson, Jr.
3. Cell Culture Lab Fax by Butler and Dawson.
4. Cell and Tissue culture: Laboratory procedures by Doyle and Griffiths

Reference Books

1. B.Hafez, E.S.E Hafez, Reproduction in Farm Animals.
2. Louis-Marie Houdebine, Transgenic Animals: Generation and Use.
3. Ed. John R.W. Masters, Animal Cell Culture - Practical Approach.
4. Ed. Martin Clynes, Animal Cell Culture Techniques.

Course Code:	LSASPE3005	No. of Credits:	4
Course Name:	SYSTEMS BIOLOGY	Sem End Exam & Cycle Test:	60+40

COURSE EDUCATIONAL OBJECTIVES:

CEO 1: To know details about the sericulture, apiculture, vermin culture and aqua culture.
CEO 2: To learn about the history, importance and scope of dairy, poultry and their pathogens.

COURSE OUTCOMES:

Towards the end of the course the students will be able to:

CO1 Know about the process of sericulture, apiculture and their production process.
CO2 Know about the methods of vermiculture, aquaculture and their products and process of production.
CO3 Understand about the importance and scope of dairy, dairy Management and dairy products.
CO4 Learn about the poultry, Principles and techniques and methods of poultry breeding.
CO5 Analyze the diversity of animal species and their adaptations to different environments, including physiological, behavioral, and ecological adaptations.
CO6 To describe the ecological roles of animals in ecosystems

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	2	2	1	2									
CO2	1	2	2	1	3									
CO3	1	2	2	2	1									
CO4	2	3	1	1	1									
CO5	2	3	2	1										
CO6	3	2	3											

1–Slight, 2 –Moderate, 3 –Substantial

COURSE CONTENT

Unit-1 **[13 Hours]**

Sericulture: Modern rearing methods for chowki and late age silkworm, procurement and incubation of eggs, synchronization of hatching, brushing and feeding lea quality and its preservation. Rearing from brushing to mounting for seed production and silk production.

Apiculture: Importance, history and development of bee keeping. Different species of honeybees and their distribution. Management of bees, product and by product of apiculture and their use.

Unit-II **[13 Hours]**

Vermiculture: Introduction and importance of vermiculture, Uses of earthworms for biodegradation of organic waste materials, Earthworms as protein source, Vermiculture technique. Aquaculture: Fin-fish Culture: Freshwater, brackish-water and marine fish culture in India, Shell-fish Culture: Prawn edible bivalve and Pearl culture.

Unit-III **[13 Hours]**

Dairy: History, Importance and scope of Dairy, Dairy breeds and Management, Principles and methods of breeding: Inbreeding, out breeding and cross breeding. Fertility and breeding efficiency, Dairy products: Physico-chemical properties of cow and buffalo milk, Processing, preservation and marketing of milk and milk products.

Unit-IV **[13 Hours]**

Poultry: History and Importance and Scope of poultry, Poultry Breeds: Principles and techniques and methods of breeding, Poultry products: Egg, Meat, feather, excreta, nutritive value of egg and meat, Poultry pathology: Viral, Bacterial, fungal and protozoan diseases and their control, vaccines and for infections.

Unit-V **[12 Hours]**

Prospectus of sericulture in India. Sericulture industries in different states, employment, potential in mulberry and non-mulberry sericulture.

Text Books:

1. Jhingran, V.G. 1995. Fish and Fisheries of India, Hindustan Publ. Corp., New Delhi. 2. Deshmann, R. F. 1992. Wild life biology. Wiley Eastern Publisher, New Delhi.
3. Verman, L.R. 19990 Beekeeping in integrated mountain development. Oxford & IBH Publ. Co., New Delhi.
4. Atwal, A. S. 2000, Essentials. Of beekeeping & Pollination. Kalyani Publ. New Delhi.

Reference Books

1. Aruga, H. 1998. Principles of Sericulture. Oxford & IBH Publishing Co. New Delhi.
2. Harper, Physiological Chemistry

Course Code:	LSASCBOE3006	No. of Credits:	4
Course Name:	ETHOLOGY & DEVELOPMENTAL BIOLOGY	Sem End Exam & Cycle Test:	60+40

Course Educational Objectives
This course enables the students:

CEO1: To acquire knowledge about basic behavioral patterns and the mechanisms behind them.
CEO2: To gain understanding regarding advanced behavioral patterns.
CEO3: To obtain greater understanding regarding various events that take place during fertilization and development.
CEO4: To acquire knowledge regarding structures, events that support development.

Course Outcomes
Towards the end of the course, a student should be able to:

CO1: Distinguish between Instinct and Learning and acquire knowledge regarding the mechanisms and biochemistry involved.
CO2: Explain details about reproductive behavior in vertebrates, social behavior in insects and primates
CO3: Describe the sequential events involved starting from fertilization up to cellular differentiation besides gaining idea about totipotency, tissue culture and Regeneration
CO4: Enumerate various structures, phenomena, cyclic events that support development. And various methods like artificial insemination, processes like birth control, in vitro fertilization, and embryo transfer technique
CO5: To understand the various developmental disorders.
CO6: To understand step-by-step methods of development of embryo and its application in research.

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1											
CO2	2	1	1	1								1
CO3	1							1				
CO4	3	2	1	1								2

CO5	3	2	1									
CO6	2	3	1					1				

COURSE CONTENT

Unit –I: ETHOLOGY **[10 Hours]**

Instinct, Learning and types of learning, Orientation and navigation in animals, Pheromones, Reproductive behavior in Vertebrates(Courtship and Mating), Biological clock, social behavior in insects, social behavior in Primates

Unit –II: DEVELOPMENTAL BIOLOGY-I **[13 Hours]**

Gametogenesis: Spermatogenesis and Oogenesis. Fertilization: morphological aspects, Biochemical events of fertilization; Estrous and Menstrual cycle; Embryogenesis: cleavage, gastrulation, neurulation and primordial organ rudiments, origin, and fate of neural crest cells, Cellular differentiation, Differential gene expression, Concept of organizer and embryonic induction, Totipotency and tissue culture in animals, Regeneration epimorphic regeneration of reptile (salamander) limb.

Unit –III: DEVELOPMENTAL BIOLOGY-II **[13 Hours]**

Faetal membranes and their development, Placentation Post embryonic development-larval formation, metamorphosis, environmental regulation of normal development. Axes pattern formation in Drosophila, amphibian, and chick.
Organogenesis- vulva formation in Caenorhabditis elegans, eye lens induction, limb development and regeneration in vertebrates.

Unit –IV: DEVELOPMENTAL BIOLOGY-III **[10 Hours]**

Evolutionary Developmental Biology, Infertility and Artificial insemination and Birth control, embryonic stem cells and their applications.

Unit –V: DEVELOPMENTAL BIOLOGY-IV **[14 Hours]**

Medical implications of developmental biology: genetic errors of human development- the nature of human syndromes– pleiotropy, genetic heterogeneity, phenotypic variability, mechanism of dominance; gene expression and human disease– inborn errors of nuclear RNA processing, inborn errors of translation; Teratogenesis: Malformations and disruptions, Gene – phene relationship, Autophene, Allophene and Pleiotrophy; Teratogenic agents (Retinoic acid, pathogens, alcohol, drugs and chemicals, heavy metals); Environmental oestrogens.

Teaching Methods: Chalk& Board/ PPT

Text Books:

1. **Animal Behaviour** by Reena Mathur; Rastogi Publications
2. **Chordate Embryology** by P. S. Verma & V. K. Agarwal; S. Chand
3. **An Introduction to Embryology** by B. I. Balinsky; Cengage Learning India

Reference Books:

1. **An Introduction to Animal Behaviour** by A. Manning; Cambridge University Press India
2. **Developmental Biology** by Scott Gilbert; Sinauer Associates

Course Code:	LSASCBOE3007	No. of Credits:	4
Course Name:	GENOMICS AND EPIGENETICS	Sem End Exam & Cycle Test:	60+40

COURSE EDUCATIONAL OBJECTIVES:

CEO1: To study on genomics and study of whole genome by using various molecular markers.

CEO2: To study epigenetic concepts of DNA and gene silencing mechanism.

COURSE OUTCOMES:

Towards the end of the course the students will be able to:

CO1 To know about the genomics concepts, genome structure and whole genome sequencing and project.

CO2 To study the genome by using DNA-based markers, phylogenetic analysis and construction of genetic map.

CO3 To understand epigenesis and its development, concepts of epigenetics and regulation of gene expression.

CO4 To know the transcriptional silencing, Genomic imprinting and nuclear transplantation. .

CO5 To critically evaluate scientific literature in genomics and epigenetics.

CO6 To able to describe the role of genomics and epigenetics in human health and disease

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	2	3	1								1		
CO2	2	1	3	1								2		
CO3	1	2	1	1								1		
CO4	1	2	1	1								3		
CO5	2	3	2											
CO6	3	2	1											

1–Slight, 2 –Moderate, 3 –Substantial

COURSE CONTENT

UNIT -I **[15 Hours]**

Genomics: Definition, classification, and scopes, Structural and functional genomics, Introduction to Structural organization of genome in Prokaryotes and Eukaryotes; sequencing principles and translation to large scale projects; Recognition of coding and non-coding sequences and gene annotation. Whole genome sequencing and plant genome projects (Arabidopsis, rice, maize and legumes). Comparative genomics and gene prediction.

UNIT –II **[15 Hours]**

DNA-based markers: Molecular markers based on DNA restriction-hybridization (RFLP), PCR (RAPD, SSR, ISSR, SNP) and combination approach (AFLP), DNA finger printing, characterization of genetic diversity and phylogenetic relationship, identification and mapping of QTLs, map based cloning, marker assisted selection for plant breeding. Genomics application to health and agriculture, including gene therapy. Molecular genetic maps, physical maps using YACs, BACs and in situ hybridization,

UNIT –III **[10 Hours]**

Epigenesis and development: Concept of epigenetics, Epigenetic mechanisms and regulation of gene expression; DNA-Methylation, Epigenome, Methylome. Histone Code: histone modifications (acetylations, methylations, phosphorylations, sumoylations, uniquitylation etc.) and enzymatic mechanisms. DNA-methyltransferases, Histone acetylases, histone deacetylases, (Histone) protein arginine methyltransferases and demethylases, (Histone) protein lysine methyltransferases and demethylases.

UNIT –IV **[10 Hours]**

Transcriptional silencing by polycomb group proteins and regulation by trithorax group proteins. Histone variants, chromosome inheritance, X-chromosome inactivation. Genomic imprinting, germ line and pluripotent stem cells. Epigenetics of human disese and epigenetic determinants of cancer. Nuclear transplantation and the reprogramming of the genome. RNA interference and regulation of gene expression (RNAi, microRNA, heterochromatin assembly). Position-effect Variegation, heterochromatin formation and gene silencing in Drosophila.

UNIT –V **[12 Hours]**

Human Genome Project, genome sequencing projects for microbes, plants and animals, accessing and retrieving genome project information from the web.

Identification and classification of organisms using molecular markers- 16S rRNA typing/sequencing, SNPs; use of genomes to understand evolution of eukaryotes, track emerging diseases and design new drugs; determining gene location in genome sequence.

Text Books:

1. Discovering Genomics, Proteomics and Bioinformatics (2ndEdition), byA. Malcolm Campbell and Laurie J. Heyer
2. Brown TA, Genomes, 3rd Edition. Garland Science 2006
3. Epigenetics by C. David Allis, Thomas Jenuwein, Danny Reinbergand Marie-Laure Caparros, Cold Spring Harbor Laboratory Press, CSH Press, NY,USA

Reference Books:

1. Primrose S &Twyman R, Principles of Gene Manipulation and Genomics, 7th Edition, Blackwell, 2006.
2. Glick BR & Pasternak JJ, Molecular Biotechnology, 3rd Edition, ASM Press, 1998
3. Epigenetics by Jörg Tost (Editor), Caister Academic Press.

Course Code:	LSASPE3008	No. of Credits:	4
Course Name:	PRACTICAL	End Exam:	100

Non-Chordata:

1. Nervous system of *Pila*
2. Nervous system of *Sepia*
3. Nervous systemof Prawn
4. Slides and Museum Specimens

Chordata:

1. Arterial system of *Calotes*
2. Venous system of*Calotes*
3. Arterial system of Toad
4. Slides and Museum Specimens

Embryology & Development Biology:

1. Study of blastula, gastrula of Frog
2. Tadpole larva of Frog
3. Study of 18hrs, 20hrs, 24hrs, 33hrs, 36hrs, 42hrs, 48hrs chick embryo
4. Preparation and mounting of incubated egg-Chick embryo.

Animal Physiology:

1. Test for carbohydrates
2. Test for Proteins
3. Test for Fats
4. Action of salivary amylase on starch

(PLANT SCIENCE)

SEMESTER-IV

Course Code:	LSPSPC4001	No. of Credits:	4
Course Name:	PLANT ANATOMY AND EMBRYOLOGY	Sem End Exam & Cycle Test:	60+40

COURSE EDUCATIONAL OBJECTIVES:

CEO1: To provide basic concept on secondary growth and anomalous secondary growth in plant

CEO2 : To convey knowledge on root development and organization of root apical meristem in plant

CEO3: To endow with developmental biology of angiospermic plants

CEO4: To introduce the endosperm development and its role in embryo development of plants

COURSE OUTCOMES:

Towards the end of the course the students will be able to:

CO1	To be familiar with the internal structure of plant organs and tissue system in plant
CO2	Be well-known with internal structure of plant root and root tip of plant
CO3	Have practical knowledge on ecological anatomy
CO4	To get knowledge on endosperm of plant and its importance
CO5	To have an idea about embryonic development in plant
CO6	To have an idea about sexual incompatibilityin plant

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	O110	PO11	PO12
CO1	2	1	1	2								1
CO2	1	2										
CO3	2	3	1									
CO4	2	1		1								1

1–Slight, 2 –Moderate, 3 –Substantial

COURSE CONTENT

Unit – I: PLANT ANATOMY-I (13 Hours)

Plant Tissues and Tissue system, Shoot development; Organization of the shoot, apical meristem (SAM). Secondary growth in plants and anomalous secondary growth. Principles of arrangement of mechanical tissues.

Unit – II: PLANT ANATOMY-II (13 Hours)

Leaf growth and differentiation; determination phyllotaxy, Epidermis with special reference to stomata and trichomes, Root development: Organization of root apical meristem (RAM)

Unit – III: PLANT ANATOMY-III

ECOLOGICAL ANATOMY: Hydrophytes – *Hydrilla* – Stem; Mesophytes – *Tridax* – leaf; Xerophytes - *Aloe* leaf, *Pinus* needle, *Casuarina* ; Epiphytes- *Vanda* and *Dischidia;* Halophytes *Sonneratia* – stem, leaf and pneumatophore, Parasites – *Striga* and Saprophytes – *Monotropa*.

Unit – IV: EMBRYOLOGY-I (13 Hours)

Microsporangium: Microsporogenesis, Anther Wall, Endothecium, Middle layers, Tapetum, Nuclear behavior in tapetal cells, Sporogenous tissue
Male Gametophyte: Pollen wall, Formation of vegetative and generative cells
Megasporangium: Types of ovule, Integuments, Nucellus, Megasporogenesis
Female Gametophyte: Types of female gametophytes, Mature Embryo sac, Haustorial behavior of embryo sac.

Unit – V: EMBRYOLOGY-II (13 Hours)

Endosperm: Types of endosperms: ruminate endosperm, cytology of endosperm, functions of endosperm, Embryo: Zygote, Proembryo, Embryogeny in dicotyledons, Embryogeny in monocotyledons, suspensor, Nutrition of embryo Polyembryony, Apomixis.

Sexual incompatibility**:** Self incompatibility, Genetic basis of self-incompatibility, Physiology and biochemistry of incompatibility, biological significance.

Reference Books:

1. **Plant Anatomy** by B. P. Pandey; S. Chand
2. **Plant Embryology** by H. P. Sharma
3. **Cytogenetics, Evolution, Biostatistics and Plant Breeding** by Shukla R.S. and Chandel P.S.;
4. **Plant Physiology** by Ross & Salisbury; CBS
5. **Outline of Plant Physiology** by Robert M. Devlin; Medtech

6. **The Embryology of Angiosperms** by S. S. Bhojwani & S. P. Bhatnagar; Vikas

Course Code:	LSPSPE4002	No. of Credits:	4
Course Name:	BIOTECHNOLOGY AND GENETIC ENGINEERING	Sem End Exam & Cycle Test:	60+40

Course Educational Objectives
This course enables the students:

CEO1: To impart knowledge on various types of restriction enzymes, vector-host systems and steps in creating a recombinant DNA molecule.

CEO2: To provide thorough understanding of recombinant DNA technology, gene cloning and their applications.

CEO3: To acquire in-depth knowledge about transfection methods, development of transgenic animals, plants and their applications.

CEO4: To provide students with a deep insight about advanced biotechnological techniques like hybridoma technology, animal husbandry, DNA fingerprinting and their applications.

Course Outcomes
Towards the end of the course, a student should be able to:

CO1: acquire knowledge about the structure and functions of restriction enzymes, modifying enzymes and other tools used in recombinant DNA technology.

CO2: learn about cloning vectors, expression vectors, host system and methodology of gene cloning.

CO3: to understand the principles and applications of transformation, gene library and DNA sequencing.

CO4: apply basic knowledge of genetic engineering in agricultural biotechnology and medical biotechnology research, to develop novel products.

CO5: Understand cellular and molecular biology techniques and their applications in genetic engineering.

CO6: Innovate new techniques or products using genetic engineering and biotechnological methods.

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

CO5	2	-	1	1								
CO6	2	2	-	1								

COURSE CONTENT

Unit-I: BASIC PRINCIPLES-I **[12Hours]**

Scope of Genetic engineering, Milestones in genetic engineering; Molecular tools: Enzymes (Nucleases, Restriction endonucleases, Alkaline phosphatase, Polynucleotide kinase, DNA ligase, DNA polymerases, Reverse transcriptase, terminal deoxynucleotidyl transferase, Poly A polymerase); Isolation, Purification, and yield analysis of DNA.

Unit-II: BASIC PRINCIPLES-II **[10Hours]**

Introduction to gene cloning vectors: Plasmid vectors, Bacteriophage vector, Cosmid vector, Phagemid vector, artificial chromosomes and expression vectors; Cloning in prokaryotic cells, Generation of Sticky ends, blunt ends, ligation. Cloning using linkers and adapters, Model cloning experiments.

Unit-III: GENETIC ENGINEERING **[12Hours]**

cDNA synthesis and its application, Gene transfer technology/DNA transfection: Physical methods (microinjection, electroporation, biolistic, pronuclear microinjection), Chemical method and Virus mediated transfection; Molecular Probe preparation; Strategies for construction of gene libraries (genomic and cDNA), strategies for Sequencing genome (Maxam-Gilbert and Sanger's method and automated sequencing).

Unit-IV: APPLIED BIOTECHNOLOGY **[10Hours]**

Application of genetic engineering: Hybridoma technology, production of transgenic plants and transgenic animals with reference to Agriculture and Animal husbandry; Protoplast fusion and somatic hybridization. DNA fingerprinting.

Text Books:

1. Molecular Cloning: A laboratory manual by J. Sambrook and E.F. Fritsch.
2. Genome by T.A. Brown.
3. Molecular Biotechnology by S.B. Primrose
4. Molecular Biotechnology by Glick.

Reference Books:

1. Biotechnology by H. K. Das; Wiley
2. Introduction to Biotechnolgy by Theiman W. J.; Pearson

Course Code:	LSPSPE4003	No. of Credits:	4
Course Name:	ENVIRONMENTAL BIOTECHNOLOGY	Sem End Exam & Cycle Test:	60+40

Course Educational Objectives
This course enables the students:

CEO1: To impart knowledge on various types of environmental pollution and their sources
CEO2: To provide thorough understanding on biological treatment of heavy metals.
CEO3: To acquire in-depth knowledge on bioremediation process and their advantages
CEO4: To provide a deep insight about Bio oxidation and Compost Technology

Course Outcomes
Towards the end of the course, a student should be able to:

CO1: acquire the basic knowledge in environmental pollution and source of pollution.

CO2: learn on biological treatment of heavy metals and to tackle the pollution.

CO3: understand the bioremediation process and their advantages.

CO4: learn about pollution control mechanisms by application of Biotechnology.

CO5: Know about biofuel production process and green energy

CO6: learn on Bio oxidation and Compost Technology

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	-	1	-							
CO2	1	-	1	-	2							
CO3	-	2	-	1	-							
CO4	2	-	2	3	-							
CO5	1	-	1									
CO6	-	2	1									

COURSE CONTENT

UNIT –I: Introduction to environment [13 Hours]

Introduction to environmental biotechnology, Environmental monitoring bioreporter, biomarker. Bioprospecting, Biomicroelectronics and biosensor technology; Introduction to environmental pollutants: Water, Soil and Air: their sources and effects. Removal of Specific Pollutants: Sources of Heavy Metal Pollution, Microbial Systems for Heavy Metal accumulation, Biosorption & detoxification mechanisms.

UNIT –II: Bioremediation [13 Hours]

Bioremediation: Fundamentals, methods and strategies of application (biostimulation, bioaugmentation) – examples, bioremediation of metals (Cr, As, Se, Hg), organic pollutants (PAHs, PCBs, Pesticides, TNT etc.), technological aspects of bioremediation (*in situ, ex situ*)

UNIT –III: Microorganism in bioremediation [13 Hours]

Application of bacteria and fungi in bioremediation: White rot fungi vs specialized degrading bacteria: examples, uses and advantages vs disadvantages; Phytoremediation: Fundamentals and description of major methods of application (phyto accumulation, phyto volatilization, rhizo filtration phyto stabilization)

UNIT –IV: Biofuels Production [13 Hours]

Environmental Biotechnology and biofuels: biogas; bioethanol; biodiesel; biohydrogen; Description of the industrial processes involved, microorganisms and biotechnological interventions for optimization of production; Biotechnology of fossil fuels: Desulfurization of coal, oil shales, microbial enhanced oil recovery (MEOR). Biotechnology of mineral processing.

UNIT –V Bio oxidation and Compost Technology [13 Hours]

Bio oxidation – Direct and Indirect Mechanisms, Recovery of metals from solutions; Microbes in petroleum extraction; Microbial desulfurization of coal. Clean technologies: Composting Technology and Organic farming, bio fertilizers, bio pesticides, microbial polymer production and bio plastic technology. Production of bio surfactants: bio emulsifiers; Paper production: use of xylanases and white rot fungi. Ethical issues in environmental biotechnology and regulatory framework.

Reference Books:

1. G. M. Evans and J. C. Furlong (2003), Environmental Biotechnology: Theory and Applications, Wiley Publishers.
2. B. Ritmann and P. L. McCarty, (2000), Environmental Biotechnology: Principle & Applications, 2nd Ed., McGraw Hill Science.
3. Scragg A., (2005) Environmental Biotechnology. Pearson Education Limited.
4. S. Devinny, M. A. Deshusses and T. S. Webster, (1998), Biofiltration for Air Pollution Control, CRC Press.

5. H. J. Rehm and G. Reed, (2001), Biotechnology – A Multi-volume Comprehensive Treatise, Vol. 11, 2nd Ed., VCH Publishers Inc

Course Code:	LSOE4004	No. of Credits:	4
Course Name:	ETHICS & INTELLECTUAL PROPERTY RIGHTS	End Sem Exam &Cycle Test:	60+40

Course Educational Objectives

This course enables the students:

CEO1: To provide thorough understanding on ethics, moral values, moral development theories, personal and professional ethics.

CEO2: To provide students with a deep insight about Profession and Professionalism, Professional accountability and ethical theories.

CEO3: To impart knowledge on intellectual properties, intellectual property rights and their need in research.

CEO4: To learn about patentable requirements, various IPRs and patent filling procedure.

Course Outcomes

At the end of the course, a student should be able to:

CO1: Recognize the philosophical assumptions that are embedded in moral ideas and in philosophical works in order to define one's moral responsibility in contemporary society.

CO2: To enable the students to internalize the ethical behaviour in the personal and professional lives

CO3: To facilitate the development of a holistic perspective among students towards their life and profession.

CO4: Reflect on and evaluate ethical arguments from diverse sources in order to communicate effectively with others who might have a different opinion from one's own.

CO5: Gain awareness about Intellectual Property Rights (IPRs) to take measure for the protecting their ideas and devise business strategies by taking account of IPRs.

CO6: Acquire more insights into the regulatory affair and assists in technology up-gradation for enhancing competitiveness.

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	-	-	1	-							
CO2	-	2	1	1	-							
CO3	2	3	-	2	1							
CO4	1	-	-	1	-			2	1			
CO5								1	1		3	
CO6					2	1						2

Unit-I

Introduction to Ethics: 1.1 Basic terms- Moral, Ethics, Ethical dilemma, Emotional intelligence 1.2 Moral development theories of Kohlberg and Piaget 1.3 View on ethics by Aristotle 1.4 Governing factors of an individual's value system 1.5 Personal and professional ethics.

Unit-II

Profession and Professionalism: 2.1 Clarification of the concepts: Profession, Professional, Professionalism, Professional accountability, Professional risks, Profession and Craftsmanship, Conflict of interest 2.2 Distinguishing features of a professional 2.3 Role and responsibilities of professionals 2.4 Professionals' duties towards the organization and vice-a-versa.

Unit-III

Ethical Theories: 3.1 Various ethical theories and their application- Consequentialism, Deontology, Virtue theory, Rights Theory, Casuist theory 3.2 Ethical terms: Moral absolutism, Moral Relativism, Moral Pluralism etc. 3.3 Resolving Ethical Dilemma.

Unit-IV

Concept of property, rights, duties and their correlation; Intellectual property rights and its types-Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge, Geographical Indications, Protection of new GMOs; Process patent vs product patent; International framework for the protection of IP; IP as a factor in R&D; IPs of relevance to Biotechnology and few Case Studies.

Unit-V

Basic requirement of a patentable invention- novelty, inventive step, Prior art and Stae of art;Patent databases; Searching International Databases; Analysis and report formation; Filing of a patent application; Role of a Country Patent Office; Precautions before patenting-disclosure/non-disclosure; International patenting-requirement; Introduction to History of GATT, WTO, WIPO, TRIPS, PCT and Implications; Patent infringement- meaning, scope, litigation, remedies; Case studies and examples-Rice, Neemetc.

Text Books:

1. R. Subramanian, "Professional Ethics" , Oxford University Press, New Delhi, 2013

2. Edmund G. Seebauer and Robert L. Barry, "Fundamentals of Ethics", Oxford University Press, New Delhi, 2012.

Reference Books:

1. Stanley SA, Bioethics, Wisdom educational services

2. Sateesh MK, Bioethics and Biosafety, IK International Pvt. Ltd.

Course Code:	LSPSPC4005	No. of Credits:	4
Course Name:	PRACTICAL	End Exam:	100

Plant Anatomy

1. Study of abnormal secondary growth in-adaptive and non adaptivetypes
2. Embryological slides
3. Anatomy of anther of different stages of microsporogensis
4. Pollen germination by hanging drop method
5. Pollen wall morphology

Biotechnology

1. Isolation of Industrially important microbes.
2. Starch hydrolysis test
3. Plasmid isolation by alkaline lysis method.
4. Preparation of Plant tissue culture media.
5. Initiation of callus.
6. Restriction digestion of DNA.

(ANIMAL SCIENCE)
SEMESTER-IV

Course Code:	LSASPC4001	No. of Credits:	4
Course Name:	ANIMAL PHYSIOLOGY & TAXONOMY	Sem End Exam & Cycle Test:	60+40

Course Educational Objectives This course enables the students:

CEO1 To make the students familiar with various physiological processes. CEO2 To acquire in depth knowledge of various evolutionary processes.
CEO3 To get familiarize with various theories, laws and phenomena associated with the process of evolution.
CEO4 To get acquainted with various aspects of Taxonomy

Course Outcomes
Towards the end of the course, a student should be able to:

CO1: Explain the physiology of processes like digestion, cardiac cycle, respiration, muscle contraction and excretion.
CO2: Describe the importance of fossils and dating of fossils in the study of evolution and role of patterns of evolution and molecular evolution in shaping the organisms.
CO3: Explain Modern synthesis, illustrate the effect of natural selection on HW-equilibrium and get familiar with animal distribution and speciation
CO4: Describe various aspects of Taxonomy
CO5: Utilize taxonomic principles for species identification.
CO6: Apply knowledge of physiology to real-world biological problems.

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

CO6	2	1	1									

COURSE CONTENT

Unit –I: Animal Physiology I **[15 Hours]**

Digestion and absorption of food; Circulation of blood, Cardiac cycle and its regulation; Blood pressure; Breathing, gaseous exchange & Transportation of gases; Physiology of excretion, Reproductive biology. Organization of body: Structure of skeletal, cardiac, and smooth and Physiology of muscle contraction.

Structure of Brain and Neurons. Physiology of nerve impulse conduction, excitability of membranes, electrical and chemical transmission between cells. Chemical coordination - Endocrine organs and Hormones.

Unit –II: Animal Physiology II **[12 Hours]**

Secretory system: urine formation, glomerular filtration, tubular function, renal mechanism of concentrating and diluting urine; Acid-base balance.

Physiology of blood: composition and structure, haemopoesis, coagulation, Sensory organs: Vision, Hearing, Tactile response, Diseases (any two) associated with each organ system.

Unit –III: Adaptive Biology **[10 Hours]**

Mechanism of adaptation; Adaptations in fresh water and marine environment; Osmoregulation in marine and terrestrial invertebrates and vertebrates; Acclimation and acclimatization; Mechanism of cell volume regulation; Adaptation in extremophiles

Unit –IV: Histology and Histochemistry **[15 Hours]**

Histological preparation methods; Classification of tissue.

Basic requirements of a histochemical test: general principles and demonstration of carbohydrates, lipids, protein and nucleic acids; Enzyme histochemistry: principles and demonstration (dehydrogenases, esterases and phosphatases); Affinity histochemistry; Fixatives and stains.

Unit –V: Taxonomy **[12 Hours]**

History of Taxonomy; Taxonomic hierarchy Taxonomic procedures: Taxonomic collections, Preservation, Curetting, Taxidermy, Principles of taxonomy.

International Code of Zoological Nomenclature (ICZN): Operative principles, Interpretation and application of important rules; Concepts of Chemotaxonomy; Cytotaxonomy and Numerical Taxonomy; Preservation and Identification of animals; Ecology and physiology in taxonomy; General Classification of Animal Kingdom.

Text Books:

1. **Essentials of Animal Physiology** by S. C. Rastogi; New Age International Publishers

2. **Principles of Animal Physiology** by C. D. Moyes et al; Pearson
3. **Vertebrate Zoology & Evolution** by B. N. Yadav & D. Kumar; Daya Publishing House
4. **Principles of Animal Taxonomy** by Ashok Verma; Narosa

Reference Books:

1. **Guyton & Hall Text Book of Medical Physiology** by John E. Hall et al; Elsevier India
2. **Ganong's Review of Medical Physiology** Twenty sixth Edition (2019) by Kim Barrett et al; Mc Graw Hill India
3. **Principles of animal Taxonomy** by G. G. Simpson; Scientific Publishers
4. **Strickberger's Evolution by** Brian K. Hall et al; Jones and Barlett Publishers

Course Code:	LSASPE4002	No. of Credits:	4
Course Name:	BIOTECHNOLOGY AND GENETIC ENGINEERING	Sem End Exam & Cycle Test:	70+30

Course Educational Objectives
This course enables the students:

CEO1: To impart knowledge on various types of restriction enzymes, vector-host systems and steps in creating a recombinant DNA molecule.

CEO2: To provide thorough understanding of recombinant DNA technology, gene cloning and their applications.

CEO3: To acquire in-depth knowledge about trnsfection methods, development of transgenic animals, plants and their applications.

CEO4: To provide students with a deep insight about advanced biotechnological techniques like hybridoma technology, animal husbandry, DNA fingerprinting and their applications.

Course Outcomes
Towards the end of the course, a student should be able to:

CO1: acquire knowledge about the structure and functions of restriction enzymes, modifying enzymes and other tools used in recombinant DNA technology.

CO2: learn about cloning vectors, expression vectors, host system and methodology of gene cloning.

CO3: to understand the principles and applications of transformation, gene library and DNA sequencing.

CO4: apply basic knowledge of genetic engineering in agricultural biotechnology and medical biotechnology research, to develop novel products.

CO5: Understand cellular and molecular biology techniques and their applications in genetic engineering.

CO6: Innovate new techniques or products using genetic engineering and biotechnological methods.

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

CO5	2	-	1	1								
CO6	2	2	-	1								

COURSE CONTENT

Unit-I: BASIC PRINCIPLES-I **[12Hours]**

Scope of Genetic engineering, Milestones in genetic engineering; Molecular tools: Enzymes (Nucleases, Restriction endonucleases, Alkaline phosphatase, Polynucleotide kinase, DNA ligase, DNA polymerases, Reverse transcriptase, terminal deoxynucleotidyl transferase, Poly A polymerase); Isolation, Purification and yield analysis of DNA.

Unit-II: BASIC PRINCIPLES-II **[10Hours]**

Introduction to gene cloning vectors: Plasmid vectors, Bacteriophage vector, Cosmid vector, Phagemid vector, artificial chromosomes and expression vectors; Cloning in prokaryotic cells, Generation of Sticky ends, blunt ends, ligation. Cloning using linkers and adapters, Model cloning experiments.

Unit-III: GENETIC ENGINEERING **[12Hours]**

cDNA synthesis and its application, Gene transfer technology/DNA transfection: Physical methods (microinjection, electroporation, biolistics, pronuclear microinjection), Chemical method and Virus mediated transfection; Molecular Probe preparation; Strategies for construction of gene libraries (genomic and cDNA), strategies for Sequencing genome (Maxam-Gilbert and Sanger's method and automated sequencing).

Unit-IV: APPLIED BIOTECHNOLOGY **[10Hours]**

Application of genetic engineering: Hybridoma technology, production of transgenic plants and transgenic animals with reference to Agriculture and Animal husbandry; Protoplast fusion and somatic hybridization. DNA fingerprinting.

Unit-V: APPLICATIONS OF TRANSGENIC PLANTS AND ANIMALS

Applications of transgenic plants: Disease/Pest/Herbicide tolerance; Improvement of crop quality, Abiotic stress tolerance pharmaceutical products: Human protein replacement, Human therapeutics, and vaccines. Gene therapy: types, vectors, methods, safety, and advances.

Text Books:

1. Molecular Cloning: A laboratory manual by J. Sambrook and E.F. Fritsch.
2. Genome by T.A. Brown.
3. Molecular Biotechnology by S.B. Primrose
4. Molecular Biotechnology by Glick.

Reference Books:

1. Biotechnology by H. K. Das; Wiley

2. Introduction to Biotechnolgy by Theiman W. J.; Pearson

Course Code:	LSASPE4003	No. of Credits:	4
Course Name:	ENVIRONMENTAL BIOTECHNOLOGY	Sem End Exam & Cycle Test:	60+40

Course Educational Objectives
This course enables the students:

CEO1: To impart knowledge on various types of environmental pollution and their sources
CEO2: To provide thorough understanding on biological treatment of heavy metals.
CEO3: To acquire in-depth knowledge on bioremediation process and their advantages
CEO4: To provide a deep insight about Bio oxidation and Compost Technology

Course Outcomes
Towards the end of the course, a student should be able to:

CO1: acquire the basic knowledge in environmental pollution and source of pollution.

CO2: learn on biological treatment of heavy metals and to tackle the pollution.

CO3: understand the bioremediation process and their advantages.

CO4: learn about pollution control mechanisms by application of Biotechnology.

CO5: Know about biofuel production process and green energy

CO6: learn on Bio oxidation and Compost Technology

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

COURSE CONTENT

UNIT –I: Introduction to environment [13 Hours]

Introduction to environmental biotechnology, Environmental monitoring bioreporter, biomarker. Bioprospecting, Biomicroelectronics and biosensor technology; Introduction to environmental pollutants: Water, Soil and Air: their sources and effects. Removal of Specific Pollutants: Sources of Heavy Metal Pollution, Microbial Systems for Heavy Metal accumulation, Biosorption & detoxification mechanisms.

UNIT –II: Bioremediation [13 Hours]

Bioremediation: Fundamentals, methods and strategies of application (biostimulation, bioaugmentation) – examples, bioremediation of metals (Cr, As, Se, Hg), organic pollutants (PAHs, PCBs, Pesticides, TNT etc.), technological aspects of bioremediation (*in situ, ex situ*)

UNIT –III: Microorganism in bioremediation [13 Hours]

Application of bacteria and fungi in bioremediation: White rot fungi vs specialized degrading bacteria: examples, uses and advantages vs disadvantages; Phytoremediation: Fundamentals and description of major methods of application (phyto accumulation, phyto volatilization, rhizo filtration phyto stabilization)

UNIT –IV: Biofuels Production [13 Hours]

Environmental Biotechnology and biofuels: biogas; bioethanol; biodiesel; biohydrogen; Description of the industrial processes involved, microorganisms and biotechnological interventions for optimization of production; Biotechnology of fossil fuels: Desulfurization of coal, oil shales, microbial enhanced oil recovery (MEOR). Biotechnology of mineral processing.

UNIT –V Bio oxidation and Compost Technology [13 Hours]

Bio oxidation – Direct and Indirect Mechanisms, Recovery of metals from solutions; Microbes in petroleum extraction; Microbial desulfurization of coal. Clean technologies: Composting Technology and Organic farming, bio fertilizers, bio pesticides, microbial polymer production and bio plastic technology. Production of bio surfactants: bio emulsifiers; Paper production: use of xylanases and white rot fungi. Ethical issues in environmental biotechnology and regulatory framework.

Reference Books:

6. G. M. Evans and J. C. Furlong (2003), Environmental Biotechnology: Theory and Applications, Wiley Publishers.
7. B. Ritmann and P. L. McCarty, (2000), Environmental Biotechnology: Principle & Applications, 2nd Ed., McGraw Hill Science.
8. Scragg A., (2005) Environmental Biotechnology. Pearson Education Limited.
9. S. Devinny, M. A. Deshusses and T. S. Webster, (1998), Biofiltration for Air Pollution Control, CRC Press.

10. H. J. Rehm and G. Reed, (2001), Biotechnology – A Multi-volume Comprehensive Treatise, Vol. 11, 2nd Ed., VCH Publishers Inc

Course Code:	LSASOE4004	No. of Credits:	4
Course Name:	ETHICS & INTELLECTUAL PROPERTY RIGHTS	End Sem Exam &Cycle Test:	60+40

Course Educational Objectives

This course enables the students:

CEO1: To provide thorough understanding on ethics, moral values, moral development theories, personal and professional ethics.

CEO2: To provide students with a deep insight about Profession and Professionalism, Professional accountability and ethical theories.

CEO3: To impart knowledge on intellectual properties, intellectual property rights and their need in research.

CEO4: To learn about patentable requirements, various IPRs and patent filling procedure.

Course Outcomes

At the end of the course, a student should be able to:

CO1: Recognize the philosophical assumptions that are embedded in moral ideas and in philosophical works in order to define one's moral responsibility in contemporary society.

CO2: To enable the students to internalize the ethical behaviour in the personal and professional lives

CO3: To facilitate the development of a holistic perspective among students towards their life and profession.

CO4: Reflect on and evaluate ethical arguments from diverse sources in order to communicate effectively with others who might have a different opinion from one's own.

CO5: Gain awareness about Intellectual Property Rights (IPRs) to take measure for the protecting their ideas and devise business strategies by taking account of IPRs.

CO6: Acquire more insights into the regulatory affair and assists in technology up-gradation for enhancing competitiveness.

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	-	-	1	-							
CO2	-	2	1	1	-							
CO3	2	3	-	2	1							
CO4	1	-	-	1	-			2	1			
CO5								1	1		3	
CO6					2	1						2

Unit-I

Introduction to Ethics: 1.1 Basic terms- Moral, Ethics, Ethical dilemma, Emotional intelligence 1.2 Moral development theories of Kohlberg and Piaget 1.3 View on ethics by Aristotle 1.4 Governing factors of an individual's value system 1.5 Personal and professional ethics.

Unit-II

Profession and Professionalism: 2.1 Clarification of the concepts: Profession, Professional, Professionalism, Professional accountability, Professional risks, Profession and Craftsmanship, Conflict of interest 2.2 Distinguishing features of a professional 2.3 Role and responsibilities of professionals 2.4 Professionals' duties towards the organization and vice-a-versa.

Unit-III

Ethical Theories: 3.1 Various ethical theories and their application- Consequentialism, Deontology, Virtue theory, Rights Theory, Casuist theory 3.2 Ethical terms: Moral absolutism, Moral Relativism, Moral Pluralism etc. 3.3 Resolving Ethical Dilemma.

Unit-IV

Concept of property, rights, duties and their correlation; Intellectual property rights and its types-Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge, Geographical Indications, Protection of new GMOs; Process patent vs product patent; International framework for the protection of IP; IP as a factor in R&D; IPs of relevance to Biotechnology and few Case Studies.

Unit-V

Basic requirement of a patentable invention- novelty, inventive step, Prior art and Stae of art;Patent databases; Searching International Databases; Analysis and report formation; Filing of a patent application; Role of a Country Patent Office; Precautions before patenting-disclosure/non-disclosure; International patenting-requirement; Introduction to History of GATT, WTO, WIPO, TRIPS, PCT and Implications; Patent infringement- meaning, scope, litigation, remedies; Case studies and examples-Rice, Neemetc.

Text Books:

1. R. Subramanian, "Professional Ethics" , Oxford University Press, New Delhi, 2013

2. Edmund G. Seebauer and Robert L. Barry, "Fundamentals of Ethics", Oxford University Press, New Delhi, 2012.

Reference Books:

1. Stanley SA, Bioethics, Wisdom educational services

2. Sateesh MK, Bioethics and Biosafety, IK International Pvt. Ltd.

Course Code:	LSASPC405	No. of Credits:	4
Course Name:	PRACTICAL	End Exam:	100

Animal Physiology

1. Estimation of Hb%
2. RBC count of man/any vertebrate
3. WBC count of man
4. Preparation of Haemin crystals
5. Determination of blood type (Blood group)
6. Caesin content of milk
7. O_2 uptake by insect.
8. Determination of Haematocrit value of blood.

Evolution And Taxonomy

1. Taxonomical features & phylogenetic study of some selected species.

Biotechnology

1. Isolation of Industrially important microbes.
2. Starch hydrolysis test
3. Plasmid isolation by alkaline lysis method.
4. Preparation of Plant tissue culture media.
5. Initiation of callus.
6. Restriction digestion of DNA.