M.Sc LIFE SCIENCE
(SEMESTER PATTERN)

CHOICE BASED CREDIT SYSTEM (CBCS)

TWO YEARS FULL TIME PROGRAMME
COURSE OF STUDIES R-20

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 2020-2021)

I SEMESTER [FIRST YEAR]

Sl. No.	Course Category	Course Code	Course Title	L	T	P	Credits
THEORY							
1	LSPC	101	Biophysics and Biochemistry	3	1	0	4
2	LSPC	102	Cell Biology and Genetics	4	0	0	4
3	LSPC	103	Microbiology and Pathology	4	0	0	4
4	LSPC	104	Bioinformatics and Biostatistics	3	1	0	4
PRACTICAL / SESSIONAL							
5	LSPC	105	Practical (pertaining to theory papers 101,102,103,104)	0	0	6	4
6	LSPC	106	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	201	Molecular Biology and Instrumental Techniques	3	1	0	4
2	LSPC	202	Molecular Immunology	3	1	0	4
3	LSPC	203	Ecology and Environmental Toxicology	4	0	0	4
4	LSPC	204	Biodiversity and Evolution	4	0	0	4
PRACTICAL / SESSIONAL							
5	LSPC	205	Practical (pertaining to theory papers 201,202 & 203)	0	0	6	4
6	LSEC	206	Seminar and Project-II	0	0	2	2
TOTAL				**14**	**2**	**8**	**22**

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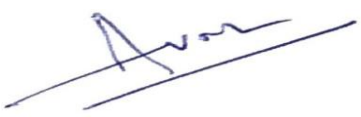
7. Mrs. Sagarika Satapathy 8. PW Jaya Kumar 9. Dr. Chaitanya Kumar A

BOS Approved
Date:01/06/2020



III SEMESTER [SECOND YEAR]

(PLANT SCIENCE)

Sl. No.	Course Category	Course Code	Course Title	L	T	P	Credits
THEORY							
1	LSPSPC	301	Plant Morphology and Reproduction	3	1	0	4
2	LSPSPE	302	Plant Physiology	4	0	0	4
		303	Taxonomy and Plant Pathology				
3	LSPSPE	304	Plant Biotechnology	3	1	0	4
		305	Plant Cell and Tissue Culture				
4	LSPSCBOE	306	Plant Metabolism	4	0	0	4
		307	Plant Developmental Biology				
PRACTICAL / SESSIONAL							
5	LSPSPE	308	Practical (pertaining to theory papers)	0	0	6	4
6	LSPSEC	309	Summer Internship / Seminar and Project-III	0	0	2	2
TOTAL				**14**	**2**	**8**	**22**

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III SEMESTER [SECOND YEAR]

(ANIMAL SCIENCE)

Sl. No.	Course Category	Course Code	Course Title	L	T	P	Credits
THEORY							
1	LSASPC	301	Biology of Nonchordata	3	1	0	4
2	LSASPE	302	Biology of Chordata	4	0	0	4
		303	System Biology				
3	LSASPE	304	Animal Biotechnology	3	1	0	4
		305	Applied Zoology				
4	LSASCBOE	306	Ethology and Developmental Biology	4	0	0	4
		307	Genomics and Epigenetics				
PRACTICAL / SESSIONAL							
5	LSASPE	308	Practical (pertaining to Theory papers)	0	0	6	4
6	LSASEC	309	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	401	Plant Anatomy & Embryology	4	0	0	4
2	LSPSPE	402	Biotechnology and Genetic Engineering	3	1	0	4
		403	Biotechnology				
3	LSPSOE	404	Ethics & IPR	4	0	0	4
PRACTICAL / SESSIONAL							
4	LSPSPC	405	Practical (pertaining to Theory papers)	0	0	6	4
5	LSPSEC	406	Major Project / Dissertation	0	0	10	8
6	VAC	407	Value added course/MOOCS	-	-	-	-
TOTAL				**11**	**1**	**16**	**24**

IV SEMESTER [SECOND YEAR]
(ANIMAL SCIENCE)

Sl. No.	Course Category	Course Code	Course Title	L	T	P	Credits
THEORY							
1	LSASPC	401	Animal Physiology and Taxonomy	4	0	0	4
2	LSASPE	402	Biotechnology and Genetic Engineering	3	1	0	4
		403	Biotechnology				
3	LSASOE	404	Ethics & IPR	4	0	0	4
PRACTICAL / SESSIONAL							
5	LSASPC	405	Practical (pertaining to Theory papers)	0	0	6	4
6	LSASEC	406	Major Project / Dissertation	0	0	10	8
7	VAC	407	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-2020-21)

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	30	70	100
	LSPC102	Cell Biology and Genetics	4	4	3	30	70	100
	LSPC103	Microbiology and Pathology	4	4	3	30	70	100
	LSPC104	Bioinformatics and Biostatistics	4	4	3	30	70	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	30	70	100
	LSPC202	Molecular Immunology	4	4	3	30	70	100
	LSPC203	Ecology and Environmental Toxicology	4	4	3	30	70	100
	LSPC204	Biodiversity and Evolution	4	4	3	30	70	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	30	70	100
	LSPSPE302	Plant Physiology	4	4	3	30	70	100
	LSPSPE303	Taxonomy and Plant Pathology						
	LSPSPE304	Plant Biotechnology	4	4	3	30	70	100
	LSPSPE305	Plant Cell and Tissue Culture						
	LSPSCBOE306	Plant Metabolism	4	4	3	30	70	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 Nonchordata	4	4	3	30	70	100
	LSASPE302	Biology of Chordata	4	4	3	30	70	100
	LSASPE303	System Biology						
	LSASPE304	Animal Biotechnology	4	4	3	30	70	100
	LSASPE305	Applied Zoology						
	LSASCBOE306	Ethology and Developmental Biology	4	4	3	30	70	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	30	70	100
	LSPE402	Biotechnology and Genetic Engineering	4	4	3	30	70	100
	LSPE403	Biotechnology						
		Ethics & IPR	4	4	4	30	70	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	30	70	100
	LSPE402	Biotechnology and Genetic Engineering	4	4	3	30	70	100
	LSPE403	Biotechnology						
		Ethics & IPR	4	4	3	30	70	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, P----Practical

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SEMESTER-I

Course Code:	LSPC101	No. of Credits:	4
Course Name:	BIOPHYSICS AND BIOCHEMISTRY	Sem End Exam & Cycle Test:	70+30

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.

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		

1–Slight, 2 –Moderate, 3 –Substantial

COURSE CONTENT

UNIT – I: BIOPHYSICS-I [10 Hours]

Chemical composition and bonding, three dimensional structure of molecules (configuration and conformation, Isomerism and steriospecificity), 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: BIOPHYSICS-II [10 Hours]

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

UNIT – III: BIOCHEMISTRY-I [13 Hours]

Carbohydrates: Classification and structures of monosaccharides, important disaccharides. Structural and storage polysaccharides, Glycosylation of other biomolecules: glucosaminoglycans, proteoglycans, glycoproteins and glycolipids. **Lipids:** Classification, Structure, properties and functions of important members of storage and membrane lipids; lipoproteins. Structure of amino acids and proteins (primary, secondary, tertiary and quaternary structures); Domain structure of protein, 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 - IV: BIOCHEMISTRY-II [12 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, 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:	LSPC102	No. of Credits:	4
Course Name:	CELL BIOLOGY AND GENETICS	Sem End Exam & Cycle Test:	70+30

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, cell cycle regulation, 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.

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	-							

COURSE CONTENT

Unit – I: ***Membrane Structure and Function*** ***[12 Hours]***

General organization of Prokaryotic and Eukaryotic cells. Cell Wall and Cell Membranes: Cell wall of Eubacteria, lipopolysachharides, Peptidoglycans and related molecules. Prokaryotic cell inclusions: Endospores and gas vesicles, Eukaryotic cell wall and plasma membrane (composition and dynamics, membrane carobohydrates 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*** ***[12 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: Lampbrush 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 Organalles*** ***[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*** ***[12 Hours]***

Mendel's laws of inheritance and chromosomal theory of heredity. Neo-mendelism, Linkage, crossing over and recombination, Chromosomal mapping. Gene interaction, 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 abberations). Principles of population genetics and Hardy-Weinberg Law. 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:	LSPC103	No. of Credits:	4
Course Name:	MICROBIOLOGY AND PATHOLOGY	Sem End Exam & Cycle Test:	70+30

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.

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											

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: [8 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: [10 Hours]

Reproduction in Viruses with special reference to lytic and lysogeny cycle. Genetic recombination in bacteria (Transformation, Conjugation, Transduction),Virus as a tool for Genetic Engineering. Metagenomics.

UNIT – IV: [10 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,

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	LSPC104	No. of Credits:	4
Course Name:	BIOINFORMATICS AND BIOSTASTICS	Sem End Exam & Cycle Test:	70+30

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.

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											

1–Slight, 2 –Moderate, 3 –Substantial

COURSE CONTENT

Unit-I **[12 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 **[10Hours]**

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 ***[*12 Hours]**

Homology Modelling; 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; 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:	LSPC105	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.

Course Code:	LSPC106	No. of Credits:	2
Course Name:	SEMINAR AND PROJECT-I	End Exam:	50

Every student will be assigned one individual project under the guidance of the professors of the department. The project can be a theoretical or experimental related to advanced topic, industrial project, training in a research institute, training of handling of sophisticated equipments etc. Each student will submit a technical report with details regarding the Literature survey, References, Objective and Plan of the project work assigned.

CRITERIA	Max. Marks
Literature Survey/Reference	10
Abstract/Synopsis on Project work	15
Presentation/seminar	25
Total Marks	50

SEMESTER-II

Course Code:	LSPC201	No. of Credits:	4
Course Name:	MOLECULAR BIOLOGY & INSTRUMENTAL TECHNIQUES	Sem End Exam & Cycle Test:	70+30

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.

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	-							

COURSE CONTENT

UNIT – I: MOLECULAR BIOLOGY-I [10 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 geneconcepts.

UNIT – II: MOLECULAR BIOLOGY-II [12 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), RNA editing, RNA transport. Expression of gene regulation in Prokaryotes and eukaryotes: The Operon concept, (lac-, trp operon), Transcription factors.
Translation: Translation machinery, Mechanism of initiation, elongation and termination; Co- and post-translational modifications, translational inhibitors.

Unit-III: 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-IV: INSTRUMENTAL TECHNIQUES-II [12 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 centrifugation. 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:	LSPC202	No. of Credits:	4
Course Name:	MOLRCULAR IMMUNOLOGY	Sem End Exam & Cycle Test:	70+30

Course Educational Objectives
This course enables the students:

CEO1: To acquire in-depth knowledge about immunity, human immune system and make students learn about the structural features of the components of the immune system as well as their function.
CEO2: To provide thorough understanding of structure & functions various organs, cells and molecules involved in immune response.
CEO3: To provide students with a deep insight about the immunological reactions with emphasis on the effector mechanisms as well as applications of immunological techniques.
CEO4: To recapitulate the knowledge of immunology and predict about the nature of immune response that develops against bacterial, viral or parasitic infection, and prove it by designing new experiments.

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 defense mechanism.
CO2: apply knowledge of immunology in various cellular functions, inculcate knowledge of various issues related to immunological reactions.
CO3: identify, formulate, and solve problems arisen due to the inefficient functioning of the immune system leading to various immunological diseases and to interpret association of immune system with cancer, autoimmunity & transplantation.
CO4: apply the knowledge of immune associated mechanisms in medical biotechnology research, to develop and demonstrate immunological techniques.

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

COURSE CONTENT

Unit –I: *Immunology- fundamental concepts* **[10 Hours]**

Introduction, Phylogeny of Immune system, Components of innate and acquired immunity, Cells of the Immune system: Haematopoiesis and differentiation, Lymphocytes trafficking, B lymphocytes, T-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* **[10 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; Immunoelectrophoresis; Biotinylation; Avidin-Streptavidin.

Unit – IV: *Humoral, Natural and clinical Immunology* **[13 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.

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:	LSPC203	No. of Credits:	4
Course Name:	ECOLOGY & ENVIRONMENTAL TOXICOLOGY	Sem End Exam & Cycle Test:	70+30

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.

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

COURSE CONTENT

Unit –I: ECOLOGY-I [10 Hours]

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

Unit –II: ECOLOGY-II [8Hours]

Population Ecology (structure anddynamics), Community Ecology, Ecological succession, Ecological niche

Unit –III: ENVIRONMENTAL CONCERNS [10 Hours]

EnvironmentalPollution:Sources&control(AirPollution,Water Pollution,Soil Pollution,Noise pollution), Greenhouse effect,Ozonede pletion,Global warming,Climate change; Waste Management & Bioremediation; Environmental education and awareness; Biodiversity &itsconservation.

Unit –IV: ENVIRONMENTAL TOXICOLOGY [8Hours]

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

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:	LSPC204	No. of Credits:	4
Course Name:	BIODIVERSITY & EVOLUTION	Sem End Exam & Cycle Test:	70+30

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

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										

1–Slight, 2 –Moderate, 3 –Substantial

COURSE CONTENT

UNIT – I: CONCEPT OF BIODIVERSITY [8 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 and Diversity Indices, Similarity index etc.).

UNIT – II: CONSERVATION OF BIODIVERSITY [10 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: EVOLUTION-I [8 Hours]

Origin of life, evolution and diversification of life, natural selection, levels of selection. Types of selection (stabilizing, directional etc.), sexual selection, genetic drift, isolation mechanisms, sympatric and allopatric populations,

UNIT – IV: EVOLUTION-II [12 Hours]

Species concepts, adaptive radiation, biogeography and evolutionary ecology. Molecular evolution; molecular clocks, systems of classification: cladistics and phonetics, molecular systematic, gene expression and evolution.

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:	LSPC205	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:	BTEC206	No. of Credits:	2
Course Name:	Seminar and Project - II	End Exam:	50

Every student will present a seminar on a topic related to theoretical or experimental, advanced topic, industrial project, training in a research institute, training of handling of sophisticated equipments etc. Each student will submit a technical report.

CRITERIA	Max. Marks
Presentation	10
Communication	15
Seminar contents	25
Total Marks	**50**

(PLANT SCIENCE)
SEMESTER-III

Course Code:	LSPSPC301	No. of Credits:	4
Course Name:	PLANT MORPHOLOGY AND REPRODUCTION	Sem End Exam & Cycle Test:	70+30

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 Be familiar with classification and economic importance of fungi

CO3 To have an idea about taxon of bryophyte and pteridophyta.

CO4 To know about various angiosperms of the world and their systematic

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

1–Slight, 2 –Moderate, 3 –Substantial

COURSE CONTENT

UNIT-I: ALGAE AND FUNGI [12 Hours]

Algae: Range of thallus organization and reproduction in chlorophyceae, Phaeophyceae and Rhodophyceae.

Fungi: Sexual and asexual reproduction in Phycomycetes and Basidiomycetes. Economic importance of fungi. Degeneration of sexuality in Ascomycetes.

UNIT-II: BRYOPHYTES AND PTERIDOPHYTA [10 Hours]

Bryophytes - : Evolution of sporophytes in Marchantiales. Anthocerotales as the connecting link between Pteridophytes and Bryophytes, Degeneration of sporogenous tissues in bryophyte.

Pteridophyta- Origin and evolution in Pteridophytes, Origin of Heterospory and its significance. Fillicales as the most advanced group of Pteridophyta.

UNIT-III: GYMNOSPERMS AND PALAEOBOTANY [8 Hours]

Gymnosperms - Origin and outline classification. Cycadofillicales as intermediate group between bryophytes and pteridophyta, Cycadalas as relic of ancient Gymnosperms, angiospermic character of Gnatales,

Palaeobotany-Geological era, Fossil and Fossilization process.

UNIT-IV: ANGIOSPERMS [12 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

Text Books:

1. 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

Reference Books:

1. **A Textbook on Algae** by H. D. Kumar and H. N. Singh
2. **The Fungi** by Sarah Watkinson, Lynne Boddy, Nicholas Money
3. **A Textbook of Bryophytes, Pteridophytes, Gymnosperms and Paleobotany** by A.V.S.S. Sambamurty

Course Code:	LSPSPE302	No. of Credits:	4
Course Name:	PLANT PHYSIOLOGY	Sem End Exam & Cycle Test:	70+30

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

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

1–Slight, 2 –Moderate, 3 –Substantial

COURSE CONTENT

UNIT - I: WATER RELATION [10 Hours]

Water relations in plants: Concepts of water potential, principles of absorption of water, ascent of sap, Transpiration, stomatal mechanism and transpiration ratio, Translation of organic materials in phloem.

UNIT - II: MINERAL NUTRITION [10 Hours]

Mineral nutrition - essential elements, role of essential elements and deficiency symptoms hydroponics, absorption of elements, passive and active transport.

UNIT - III: RESPIRATION [10 Hours]

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 [12 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. Plant growth regulators and their mode of action: Auxin, Cytokinin, Gibberellins, ABA, Ethylene.

Text 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

Reference Books:

1. **Plant Physiology** by Ross & Salisbury; CBS
2. **Outline of Plant Physiology** by Robert M. Devlin; Medtech

Course Code:	LSPSPE303	No. of Credits:	4
Course Name:	TAXONOMY & PLANT PATHOLOGY	Sem End Exam & Cycle Test:	70+30

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 process disease management systems

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

1–Slight, 2 –Moderate, 3 –Substantial

COURSE CONTENT

UNIT – I: PRINCIPLES OF PLANT PATHOLOGY [10 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 [12 Hours]

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

UNIT – III : PLANT MYCOLOGY [10 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 [12 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.

Text 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

Reference Books

1. **Recent Trends in Plant Pathology** by Bishwanath Chakraborty & Usha Chakraborty
2. ***Introduction to Principles of Plant Pathology*** by R. S. Singh. Oxford & IBH Publishing Company

Course Code:	LSPSPE304	No. of Credits:	4
Course Name:	PLANT BIOTECHNOLOGY	Sem End Exam & Cycle Test:	70+30

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

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

1–Slight, 2 –Moderate, 3 –Substantial

COURSE CONTENT

UNIT I: Basic of Plant Tissue culture [10 Hours]

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 [12 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 [10 Hours]

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

UNIT IV: Application Plant transformation technology [12 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.

Text 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

Reference Books

1. ***Plant biotechnology****: the genetic manipulation of plants* by Slater A, Scott N, Fowler M. Oxford: Oxford University Press
2. ***Handbook of Plant Biotechnology***, Volumes 1 & 2 Edited by P. Christou

Course Code:	LSPSPE305	No. of Credits:	4
Course Name:	PLANT CELL AND TISSUE CULTURE	Sem End Exam & Cycle Test:	70+30

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 scope of plant cell and tissue culture
CO2 Be acquainted with different culture mediums of plant tissue culture and their preparation
CO3 To have idea about culture technique of different plant organs at laboratory.
CO4 To get acquaintance on storage techniques of plant tissue both in short term and long term periods

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

1–Slight, 2 –Moderate, 3 –Substantial

COURSE CONTENT

UNIT-I **[10 Hours]**

History of Tissue Culture technique. Requirements for a Cell Tissue Culture lab like Laminar Air Flow device, sterilisation scheme for culture chamber. Totipotency of plant cells-dedifferentiation and dedifferentiation.

UNIT II **[12 Hours]**

Nutrient media: Composition of commonly used nutrient culture media with respect to their contents like inorganic chemicals, organic constituents, vitamins, amino acids etc. Sterilisation of the media and appliances by autoclaving.

UNIT III **[10 Hours]**

Culture of plant materials- explants selection and technique of culturing the same. Growth conditions. Methods of sub culturing and transfer of regenerated plants to the field. Micro propagation: Proliferation of axillary buds, induction of adventitious buds and bulbs, callus regeneration

UNIT IV **[10 Hours]**

Somatic embryogenesis, continuous culture, immobilized cultures, estimation of growth and artificial seeds. Cloning: Isolation of single cells, culturing of single cell- different methods, culture cell viability test. Cryopreservation and slow growth cultures, Freezing and storage, thawing, reculture.

Text Books

1. Razdan M K : An Introduction to Plant Tissue Culture
2. Guptha P K : Elements of Biotechnology
3. Kalyan Kumar D : An introduction to Plant Tissue Culture

Reference Books

1. Hudson T Hartmann : Plant Propagation-Principle and Practices
2. Chopra V L, Sharma R P & Swaminathan M S : Agricultural Biotechnology
3. Hamish A, Collin & Sue Edwards : Plant Cell Culture

Course Code:	LSPSCBOE306	No. of Credits:	4
Course Name:	PLANT METABOLISM	Sem End Exam & Cycle Test:	70+30

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 Be familiar with importance of sulphur and its utilization in plant
CO3 To have idea about different types of nitrogen fixation processes and nitrogen cycle
CO4 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	O110	PO11	PO12
CO1	2	3	1									1
CO2	3	2		1								
CO3	2	3		1								
CO4	2	2	1									

1–Slight, 2 –Moderate, 3 –Substantial

COURSE CONTENT

UNIT-I: LIPID METABOLISM [12 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-II: SULPHUR METABOLISM [10 Hours]

Sulphur metabolism**:** Role of sulphur and its compounds in plant metabolism, sulphur uptake transportation and assimilation of sulphur in plant.

UNIT–III: NITROGEN METABOLISM [12 Hours]

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

UNIT-IV: SECONDARY METABOLITES [10 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.

Text 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

Reference Books:

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

Course Code:	LSPSCBOE307	No. of Credits:	4
Course Name:	PLANT DEVELOPMENTAL BIOLOGY	Sem End Exam & Cycle Test:	70+30

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

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								

1–Slight, 2 –Moderate, 3 –Substantial

COURSE CONTENT

UNIT I [12Hours]

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 [12 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 [12 Hours]

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

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 [10 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 endosperm, haustorial behavior of endosperm. Xenia and metaxenia.

Text 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.

Reference Books

1. Fahn, A. Plant Anatomy. Sydeny: Pergamon Press.
2. Beck, Charles B. An introduction to plant structure and development: plant anatomy for the twenty-first century. Cambridge University Press, 2010.
3. 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 mixtureseparation
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.

Course Code:	LSPSPE309	No. of Credits:	2
Course Name:	SEMINAR AND PROJECT-III	End Exam:	50

Every student will be assigned one individual project under the guidance of the professors of the department. The project can be a theoretical or experimental related to advanced topic, industrial project, training in a research institute, training of handling of sophisticated equipments etc. Each student will submit a technical report with details regarding the Literature survey, References, Objective and Plan of the project work assigned.

CRITERIA	Max. Marks
Literature Survey/Reference	10
Abstract/Synopsis on Project work	15
Presentation/seminar	25
Total Marks	50

(ANIMAL SCIENCE)
SEMESTER-III

Course Code:	**LSASPC301**	**No. of Credits:**	**4**
Course Name:	**BIOLOGY OF NON-CHORDATA**	**Sem End Exam & Cycle Test:**	**70+30**

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, Coelenterata 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 Hemichordata, 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.

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

COURSE CONTENT

Unit –I: PROTOZOA, PORIFERA, COELENTERATA & CTENOPHORA [12Hours]

Outline classification of Animals-Minor and Major Phyla; Locomotor organelles and locomotion inProtozoa; Reproduction inprotozoa-asexual and sexual; Parasitism inprotozoa, Protozoa and human diseases in brief-any two; Reproduction inPorifera-sexual and asexual, Regeneration in sponges; Polymorphism inCoelentrata;StructureandaffinitiesofCtenophora.

Unit –II: HELMINTHES, ANNELIDA & ARTHROPODA [12Hours]

HelminthParasiteswithspecialreferencetoman-*Taenia solium, Ascaris lumbricoides & Ancylostoma duodenale*; Coelom, metamerism, segmentation and segmental organs in Annelida; Vision ininsects-Simple eyes, compound eyes & working of compound eye; LarvalformsinCrustacea and their significance; Respiration in Arthropods in brief

Unit –III: ONYCHOPHORA, MOLLUSCA, ECHINODERMATA & HEMICHORDATA [10Hours]

StructureandaffinitiesofPeripetus; Respiration inMollusca-Cutaneous, branchial and pulmonary; Torsion and detorsion in Gastropoda;LarvalformsinEchinodermata and their significance;WatervascularsysteminEchinodermata;Diversity**,** Structure and affinities ofHemichordata.

Unit –IV: MINOR PHYLA & ECONOMIC ZOOLOGY [8Hours]

Lophophorate phyla-StructureandaffinitiesofBryozoa; Stucture and affinities of Brachiopoda; StructureandaffinitiesofPhoronida; StructureandaffinitiesofGastrotricha
Economic Zoology: Apiculture, Sericulture, Lac culture&Pearl culture
Teaching Methods: Chalk& Board/ PPT

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:	LSASPE302	No. of Credits:	4
Course Name:	BIOLOGY OF CHORDATA	Sem End Exam & Cycle Test:	70+30

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 Eutheria 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 behaviour 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

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

COURSE CONTENT

Unit –I: PROTOCHORDATES, CYCLOSTOMES & LUNGFISHES [12Hours]

Ouline 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; Affinities of Cyclostomata; Distribution, structure and affinities of Dipnoi.

Unit –II: FISHES & AMPHIBIA [10Hours]

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

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

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 mechanisms in birds; General account of Prototheria and Metatheria; Distribution of metatheria

Unit –IV: EUTHERIA & COMPARITIVE ANATOMY [11Hours]

Aquatic mammals; Dentition in mammals; Adaptive radiation in general, Adaptive radiation in marsupials and placental mammals; Adaptive convergence in mammals; Comparative anatomy, epidermal and dermal derivatives of Integument in Vertebrates; Origin and evolution of Jaw and types of jaw suspensoria in Vertebrates.

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

Course Code:	LSASPE303	No. of Credits:	4
Course Name:	SYSTEMS BIOLOGY	Sem End Exam & Cycle Test:	70+30

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.

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

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.

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

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.

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:	LSASPE304	No. of Credits:	4
Course Name:	ANIMAL BIOTECHNOLOGY	Sem End Exam & Cycle Test:	70+30

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.

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									

1–Slight, 2 –Moderate, 3 –Substantial

COURSE CONTENT

Unit-1: [12 Hours]

Laboratory Equipments and materials for animal cell culture; Sterilization and aseptic techniques, General considerations in media design, Balanced salt solutions; Various type of cell culture media; Primary culture and its maintenance,Contact inhibition,Anchorage dependence,Transformation of cells: Characteristics of transformed cells and the process of Immortalization(by suppression of senescence genes, induction by viralgenes, by induction of telomerase and by chemical carcinogens),Establishment of cell line.

Unit-2 : [10 Hours]

Various methods of cell separation, Cell cloning, Characterization of cultured cell: Morphology of cells, Species identification, identification of tissue of origin, identification of specific cell lines, Cell culture in continuous, perfusion and hollow-fiber reactor,Preparation of chick fibroblast,Organ and histotypic cultures, Measurement of cell death.

Unit-3 : [8 Hours]

In vitro fertilization, Embryo culture,Tissue engineering: Design stages for tissue engineering, cell substrates andsupport materials,cell sources,, Necrosis and apoptosis (mechanism and assay), Cryopreservation

Unit-4 : [10 Hours]

Transfection of animal cell lines, Construction of animal viral vectors for gene transfer into cell lines;Sperm mediated gene transfer;Embryo transfer technology; Micromanipulation,Application of animal cell culture; Somatic cell genetics; Molecular pharming; Cell culture based vaccines and other therapeutic proteins. Stem cell culture and its application.

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:	LSASPE305	No. of Credits:	4
Course Name:	APPLIED ZOOLOGY	Sem End Exam & Cycle Test:	70+30

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.

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									

1–Slight, 2 –Moderate, 3 –Substantial

COURSE CONTENT

Unit-1 **[10 Hours]**

Sericulture: Modren rearing methods for chawki 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 andtheir distribution. Management of bees, product and by product of apiculture and their use.

Unit-II **[10 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 **[10 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 **[10 Hours]**

Poultry: History and Importance and Scope of poultry,PoultryBreeds: Principles and techniques and methods of breeding, Poultryproducts: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.

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:	LSASCBOE306	No. of Credits:	4
Course Name:	ETHOLOGY & DEVELOPMENTAL BIOLOGY	Sem End Exam & Cycle Test:	70+30

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

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

COURSE CONTENT

Unit –I: ETHOLOGY-I [8Hours]

Instinct, Learning, types of learning, Neural mechanism of learning and learning in Vertebrates, Biochemical approach to the problem of memory, Orientation and navigation in animals, Pheromones

Unit –II: ETHOLOGY-II [8Hours]

Reproductive behavior in Vertebrates (Courtship and Mating), Biological clock, Social behavior in insects, Social behavior in Primates

Unit –III: DEVELOPMENTAL BIOLOGY-I [10Hours]

Molecular events during fertilization, Cleavage, morphogenetic movements and mechanism of gastrulation, Cellular differentiation, Differential gene expression, Concept of organizer and embryonic induction, Totipotency and tissue culture in animals, Regeneration.

Unit –IV: DEVELOPMENTAL BIOLOGY-II [10Hours]

Foetal membranes and their development, Placentation, Estrous and Menstrual cycle, Infertility and Artificial insemination and Birth control, Invitro fertilization, Nuclear cloning & Embryo transfer technique

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:	LSASCBOE307	No. of Credits:	4
Course Name:	GENOMICS AND EPIGENETICS	Sem End Exam & Cycle Test:	70+30

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. .

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		

1–Slight, 2 –Moderate, 3 –Substantial

COURSE CONTENT

UNIT -I **[10 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 **[10 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

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:	LSASPE308	No. of Credits:	4
Course Name:	PRACTICAL	End Exam:	100

Non-Chordata:

1. Nervous system of *Pila*
2. Nervous system of *Sepia*
3. Nervous system of 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

Course Code:	LSASEC**309**	**No. of Credits:**	**2**
Course Name:	**SEMINAR AND PROJECT-III**	**End Exam:**	**50**

Every student will be assigned one individual project under the guidance of the professors of the department. The project can be a theoretical or experimental related to advanced topic, industrial project, training in a research institute, training of handling of sophisticated equipments etc. Each student will submit a technical report with details regarding the Literature survey, References, Objective and Plan of the project work assigned.

CRITERIA	**Max. Marks**
Literature Survey/Reference	10
Abstract/Synopsis on Project work	15
Presentation/seminar	25
Total Marks	50

(PLANT SCIENCE)
SEMESTER-IV

Course Code:	LSPSPC401	No. of Credits:	4
Course Name:	PLANT ANATOMY AND EMBRYOLOGY	Sem End Exam & Cycle Test:	70+30

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 To have an idea about embryonic development in plant

CO4 To get knowledge on endosperm of plant 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	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 (10 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 (10 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: EMBRYOLOGY-I (12Hours)

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

Unit – IV: EMBRYOLOGY-II (10 Hours)

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

Text 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

Reference Books:

1. **Outline of Plant Physiology** by Robert M. Devlin; Medtech
2. **The Embryology of Angiosperms** by S. S. Bhojwani & S. P. Bhatnagar; Vikas

Course Code:	LSPE402	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.

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	-							

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.

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:	LSPE403	No. of Credits:	4
Course Name:	BIOTECHNOLOGY	Sem End Exam & Cycle Test:	70+30

Course Educational Objectives
This course enables the students:

CEO1: To impart knowledge on various types of cloning vector, steps in creating a recombinant DNA technology and blotting techniques.
CEO2: To provide thorough understanding on composition & preparation of animal cell culture media, development and maintenance of cell lines.
CEO3: To acquire in-depth knowledge on composition & preparation of plant tissue culture media, trnsfection methods, development of transgenic animals, plants and their applications.
CEO4: To provide students with a deep insight about drug designing, production of recombinant proteins and fermentation technology.

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

CO1: acquire knowledge about various types of cloning vector, steps in creating a recombinant DNA technology, blotting techniques and DNA sequencing.
CO2: learn about composition & preparation of animal cell culture media, development and maintenance of cell lines.
CO3: to understand the composition & preparation of plant tissue culture media, trnsfection methods, development of transgenic animals and plants.
CO4: apply basic knowledge of genetic engineering in drug designing, production of recombinant proteins and fermentation 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: BASIC BIOTECHNOLOGY [12 Hours]

Cloning Vectors for recombinant DNA (Plasmids, Phages, Cosmids, YAC and MAC), Restriction enzymes for cloning; cloning in bacteria and eukaryotes; Southern, Northern and Western blotting; Basic PCR, anchored PCR and asymmetric PCR; isolation of genes; sequencing of gene or a DNA segment: Maxam & Gilbert's and Sanger's method; gene synthesis mechanism, outline concepts on enzymology.

UNIT –II: ANIMAL BIOTECHNOLOGY [10 Hours]

Scope of animal cell culture, advantages and disadvantages, the gas phase for tissue culture, culture media for animal cells and tissues, culture procedures, maintenance of cultures - cell lines; cloning of cell lines; Gene transfection; targeted gene transfer; transgenic animals;

UNIT –III: PLANT BIOTECHNOLOGY [12 Hours]

Culture media and plant cell culture: Culture media and their constituents (MS, B_5 and White's media, cell culture. micropropogation; somaclonal variations, production of haploids: anther culture, ovule culture, protoplast culture.

UNIT –IV: INDUSTIRAL AND ENVIRONMENTAL BIOTECHNOLOGY

[12 Hours]

Engineering of macro molecules-basic outline of protein engineering, drug designing, Isolation and culturing of microorganisms; production of organic compounds by microbial fermentation: Biotechnology in paper industry, pollution Control: Cleaner technologies, reducing environmental impact of industrial effluents, biosensors; Renewable sources of energy, energy and fuel using microorganisms, use of biotech tools for biodiversity conservation.

Text Books:

1. **Elements of Biotechnology** by P. K. Gupta; Rastogi Publications
2. **Biotechnology by U. Satyanarayana;** Books & Allied Ltd

Reference Books:

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

Course Code:	LSPSPC405	No. of Credits:	4
Course Name:	PRACTICAL	End Exam:	100

Plant Anatomy

1. Study of abnormal secondary growth in-adaptive and non adaptive types
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:	LSASPC401	No. of Credits:	4
Course Name:	ANIMAL PHYSIOLOGY, EVOLUTION & TAXONOMY	Sem End Exam & Cycle Test:	70+30

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

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

COURSE CONTENT

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

Digestion and absorption of food; Cardiac cycle and its regulation; Breathing, gaseous exchange & Transportation of gases; Muscle contraction; Mechanism of Nerve impulse conduction, synaptic transmission; Physiology of excretion; Structure of human eye and physiology of vision.

Unit –II: Evolution-I **[10 Hours]**

Fossils, Fossilization, dating of fossils and some Indian fossils. Patterns of evolution– Sequential evolution, convergent and Divergent evolution, micro, macro and mega evolution; Molecular evolution.

Unit –III: Evolution-II **[10 Hours]**

Modern synthetic theory of evolution; Natural selection–Hardy-Weinberg's Law; Continental drift; Animal distribution (Cosmopolitan, Discontinuous, Bipolar and isolated distribution) and factors effecting animal distribution; Speciation.

Unit –IV: Taxonomy **[12 Hours]**

History of Taxonomy; Principles of classification and procedures inTaxonomy; Species concept; 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:	LSPE402	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.

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	-							

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.

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:	LSPE403	No. of Credits:	4
Course Name:	BIOTECHNOLOGY	Sem End Exam & Cycle Test:	70+30

Course Educational Objectives
This course enables the students:

CEO1: To impart knowledge on various types of cloning vector, steps in creating a recombinant DNA technology and blotting techniques.
CEO2: To provide thorough understanding on composition & preparation of animal cell culture media, development and maintenance of cell lines.
CEO3: To acquire in-depth knowledge on composition & preparation of plant tissue culture media, trnsfection methods, development of transgenic animals, plants and their applications.
CEO4: To provide students with a deep insight about drug designing, production of recombinant proteins and fermentation technology.

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

CO1: acquire knowledge about various types of cloning vector, steps in creating a recombinant DNA technology, blotting techniques and DNA sequencing.
CO2: learn about composition & preparation of animal cell culture media, development and maintenance of cell lines.
CO3: to understand the composition & preparation of plant tissue culture media, trnsfection methods, development of transgenic animals and plants.
CO4: apply basic knowledge of genetic engineering in drug designing, production of recombinant proteins and fermentation 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: BASIC BIOTECHNOLOGY [12 Hours]

Cloning Vectors for recombinant DNA (Plasmids, Phages, Cosmids, YAC and MAC), Restriction enzymes for cloning; cloning in bacteria and eukaryotes; Southern, Northern and Western blotting; Basic PCR, anchored PCR and asymmetric PCR; isolation of genes; sequencing of gene or a DNA segment: Maxam & Gilbert's and Sanger's method; gene synthesis mechanism, outline concepts on enzymology.

UNIT –II: ANIMAL BIOTECHNOLOGY [10 Hours]

Scope of animal cell culture, advantages and disadvantages, the gas phase for tissue culture, culture media for animal cells and tissues, culture procedures, maintenance of cultures - cell lines; cloning of cell lines; Gene transfection; targeted gene transfer; transgenic animals;

UNIT –III: PLANT BIOTECHNOLOGY [12 Hours]

Culture media and plant cell culture: Culture media and their constituents (MS, B_5 and White's media, cell culture. micropropogation; somaclonal variations, production of haploids: anther culture, ovule culture, protoplast culture.

UNIT –IV: INDUSTIRAL AND ENVIRONMENTAL BIOTECHNOLOGY

[12 Hours]

Engineering of macro molecules-basic outline of protein engineering, drug designing, Isolation and culturing of microorganisms; production of organic compounds by microbial fermentation: Biotechnology in paper industry, pollution Control: Cleaner technologies, reducing environmental impact of industrial effluents, biosensors; Renewable sources of energy, energy and fuel using microorganisms, use of biotech tools for biodiversity conservation.

Text Books:

3. **Elements of Biotechnology** by P. K. Gupta; Rastogi Publications
4. **Biotechnology by U. Satyanarayana;** Books & Allied Ltd

Reference Books:

3. **Biotechnology** by H. K. Das; Wiley
4. **Introduction to Biotechnolgy** by Theiman W. J.; Pearson

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.

Course Code:	LSEC406	No. of Credits:	8
Course Name:	Major Research Project /Dissertation	End Exam	200

Objectives:

Every student will have to complete one individual project under the guidance of the professors of the department. The project can be a theoretical or experimental related to advanced topic, industrial project, training in a research institute, training of handling of sophisticated equipments etc. Each student will submit a project report with details as per the Performa and sample provided.

The project report should be hard bound and the students will have to submit ***four*** ***copies*** of the project report for final evaluation of ***200 marks*** based on the following criteria.

CRITERIA	Max. Marks
Literature Survey/Reference	20
Objectives/Plan of the project	20
Experimental/Theoretical Methodology	40
Significance and originality of the study	20
Depth of knowledge in the subject	20
Results and Discussions	20
Presentation/seminar/Viva	60
Total Marks	**200**

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