Central University of Punjab, Bathinda

M.Sc. Program in Life Sciences
Specialization: Plant Sciences

Academic Session 2019-21

Department of Plant Sciences

School of Basic and Applied Sciences

M.Sc. Life Sciences (Plant Sciences)						
Semester-I						
Course Code	**Course Title**	**Course Type**	**L**	**T**	**P**	**Cr**
LPS.517	Biostatistics	Compulsory Foundation Courses	2	0	0	2
LPS.518	Research Methodology	Compulsory Foundation Courses	2	0	0	2
LPS.506	Microbiology	Core Courses	2	1	0	3
LAS.511	Cell Biology	Core Courses	2	1	0	3
LPS.508	Biochemistry	Core Courses	3	1	0	4
LPS.509	Biochemistry (P)	Core Courses	0	0	1	1
LPS.510	Genetics	Core Courses	2	1		3
LPS.511	Genetics (P)	Core Courses	0	0	1	1
LPS.512	Plant Systematics: Cryptogams	Discipline Elective	2	1	0	3
LPS.513	Plant Systematics: Cryptogams (P)	Discipline Elective	0	0	1	1
LPS.514	Basic Concepts in Genetics-1(IDC)	Interdisciplinary courses offered	2	0	0	2
LPS.515	Economic importance of plants (IDC)	Interdisciplinary courses offered	2	0	0	2
LPS.516	Fundamentals of Plant Biology (IDC)	Interdisciplinary Elective courses offered	2	0	0	2
	Total Credits		**17**	**5**	**3**	**25**

Semester II

Course Code	**Course Title**	**Course Type**	**L**	**T**	**P**	**Cr**
LPS.521	Molecular Biology	Core Course	2	1	0	3
LPS.522	Molecular Biology (P)	Core Course	-	0	1	1
LPS.523	Plant Physiology	Core Course	3	1	-	4
LPS.524	Plant Physiology (P)	Core Course	0	0	1	1
LPS.525	Plant Tissue and Organ Culture	Core Course	2	1	0	3
LPS.526	Plant Tissue and Organ Culture (P)	Core Course	0	0	1	1
LPS.527	Ecology, Environment and Biodiversity	Core Course	3	1	0	4
LPS.528	Ecology, Environment and Biodiversity(P)	Core Course	0	0	1	1
LPS.542	Seminar-1	Skill Based	0	0	1	1
LPS.531	Plant Systematics: Phanerogams	Discipline Electives	2	1	0	3

LPS.532	Plant Systematics:Phanerogams (P)	Discipline Electives	0	0	1	1
LPS.533	Basic Plant physiology and biochemistry (IDC)	IDC	2	0	0	2
LPS.534	Evolution and Humanity (IDC)	IDC	2	0	0	2
LPS.535	Plant Biotechnology (IDC)	IDC	2	0	0	2
	Total Credits		14	5	6	25

Semester-III						
Course Code	**Course Title**	**Course Type**	**L**	**T**	**P**	**Cr**
LPS.553	Recombinant DNA Technology	Core Courses	2	1		**3**
LPS.554	Recombinant DNA Technology (P)	Core Courses			1	**1**
LPS.555	Techniques in Life Sciences	Core Courses	2	1	-	**3**
LPS.556	Evolutionary Biology	Core Courses	2	1		**3**
LPS.561	Physiology and Molecular Biology of stress	Discipline Elective Courses/ MOOC course	2	1	-	**3**
LPS.562	Physiology and Molecular Biology of stress (P)	Discipline Elective Courses/ MOOC course	-		1	**1**
LPS.599	Project	Skill based course			6	**6**
	Total Credits		**8**	**4**	**8**	**20**

Evaluation Criterion	**Max percentage**
Literature survey/background information	20
Organization of content	5
Physical presentation	15
Question and Answer	10
Report evaluation	50
Total	100

Semester-IV						
Course Code	**Course Title**	**Course Type**	**L**	**T**	**P**	**Cr**
LPS.571	Metabolic Engineering	Core Course	2	1	0	3
LPS.572	Anatomy and Developmental Biology of Plants	Core Course	2	1	0	3
LPS.573	Anatomy and Developmental Biology of Plants	Core Course	0	0	1	1
LPS.574	Life Sciences, A Revision	Discipline Enrichment course	2	0	0	2
LPS.575	Life Sciences, Communication	Discipline Enrichment course	0	0	2	2
XXX.xxx	Course-1	Elective Foundation/Value based course	1	0	0	1
XXX.xxx	Course-2	Elective Foundation/Value based course	1	0	0	1
LPS.544	Research Seminar	Skill based course	0	0	1	**1**
LPS.599	Project (S/US)	Skill Base course	0	0	6	6
	Total Credits		**8**	**2**	**10**	**20**

L: Hours T: Tutorial P: Practical Cr: Credits

Transaction Mode:

1) Lecture
2) Demonstration
3) Seminar
4) Group discussion
5) Field visit
6) Tutorial
7) Problem solving
8) Self-learning

Semester-I

L	T	P	Cr
2	0	0	2

Course Code: LPS.517
Course Title: Biostatistics

Learning Outcomes
Students' will learn basics of probability and statistics relevant to biological research and able to perform inferential statistics for the data analysis of biological data

Unit I **7 Hours**
Overview of Biostatistics: Types of Studies, Levels of Measurements, Presentation of Data: Frequency tables and diagrams, Descriptive statistics: Measures of central tendency and dispersal, Kurtosis and Skewness, Error Bars, Moments, Normality Tests and Outliers

Unit II **9 Hours**
Statistical Hypothesis Testing: Sampling techniques, Sampling theory, Various steps in sampling, collection of data-types and methods, Concepts of Population, Sample and Confidence Interval, Statistical Hypothesis Testing, Statistical Significance and P-Values, Relationship between Confidence Intervals and Statistical Significance, Statistical Power and Choosing the right Sample Size

Unit III **9 Hours**
Inferential Statistics: t-Distribution and tests of significance based on t-distribution, F-distribution and tests of significance based on F distribution, x2 Distribution and tests of significance based on x2 distribution, Comparing Proportions, Gaussian, Binomial, Lognormal and Poisson Distributions, Pearson's Correlation, Simple Linear Regression, Non-Linear Regression, Nonparametric tests

Unit IV **5 Hours**
Mathematical Biology: Permutations and Combinations, Probability, Bayes Theorem and Likelihood, Statistics with MS Excel and GraphPad Prism, Key concepts of statistics, Statistical Pitfalls to Avoid

Suggested Reading:

- Harvey Motulsky (2013) Intuitive Biostatistics: A Nonmathematical Guide to Statistical Thinking. OUP USA; 3 edition
- Biostatistics A Methodology For the Health Sciences - Gerald van Belle, Patrick J. Heagerty, Lloyd D. Fisher, Thomas S. Lumley
- Introductory Biostatistics - Chap T. Le
- Norman, G. and Streiner, D. (2008). *Biostatistics: The Bare Essentials.* 3/e (with SPSS). Decker Inc. USA.

- Sokal, R.R. and Rohlf, F.J. (1994). *Biometry: The Principles and Practices of Statistics in Biological Research*. W.H. Freeman publishers, USA.

Course Code: LPS.518
Course Title: Research Methodology

L	T	P	Cr
2	0	0	2

Learning Outcomes
Student will learn basic principles of research, formulate hypothesis and scientific writing. Also learn about various search engines related to scientific literature, basic library tools and entrepreneurship.

Unit I **8 Hours**
General principles of research: Meaning and importance of research, critical thinking, formulating hypothesis and development of research plan, review of literature, interpretation of results and discussion.

Unit II **7 Hours**
Technical writing: Scientific writing that includes the way of writing Synopsis, research paper, poster preparation and presentation, and dissertation.

Unit III **8 Hours**
Web-based literature search engines: Introduction to Web Sciences, Google Scholar and PubMed, Impact factor metrics, Reviewing process of Journals, list of good publications houses and their contributions in plant sciences. A few examples of good journal with their scope and significant in Plant sciences. **Library:** Classification system (Colon, Dewey & others)

Unit IV **7 Hours**
Bio Entrepreneurship and overview of Plant based Industries: Importance of entrepreneurship and its relevance in career growth, characteristics of entrepreneurs, developing entrepreneurial competencies. A few examples of plant based company and their future prospective. General introduction to Intellectual Property Rights (IPRs), Patent, Trademarks, Domain names and Geographical indications

Suggested Reading:

1. Gupta, S. (2005). *Research methodology and statistical techniques.* Deep & Deep Publications (p) Ltd. New Delhi.
2. Kothari, C.R. (2008). *Research methodology (s).* New Age International (p) Limited. New Delhi.
3. Standard /Reputed Journal authors' instructions.

Course Code: LPS.506
Course Title: Microbiology

L	T	P	Cr
2	1	0	3

Learning Outcomes
To learn the basics of microbiology, growth and nutrition of microbes, their cultivation and applied use.

Unit I **12 Hours**
Introduction to Microbiology: Scope and history of Microbiology, Cell structure, function and classification of Bacteria, Fungi, Protozoa, Algae, and viruses.

Unit II **14 Hours**
Growth, Nutrition & Control: Phases in bacterial growth, Growth Curve, Calculation of G-time, Physical and environmental requirements of growth, Microbial nutrient requirements – macro-nutrients, micro-elements – growth factors - sources of nutrients – nutritional classification of bacteria - Phototroph, Chemotroph, Autotroph (lithotroph), Heterotroph (organotroph), Photoautotroph, Photoheterotroph, Chemoautotroph, Chemoheterotroph - Nutritional patterns of pathogens – Saprophytes – Auxotroph.

Unit III **12 Hours**
Cultivation and Control of Microbes: Types of growth media (natural, synthetic, complex, enriched, selective- definition with example), pure culture methods (streak plate, spread plate, pour plate, stab culture, slant culture). Control of microbes- Sterilization, disinfection, antiseptic, tyndallization, pasteurization: Physical- dry heat, moist heat, UV light, ionizing radiation, filtration, HEPA filter, Chemical methods- antimicrobial drugs, Antibiotic assays, and Drug resistance in bacteria.

Unit IV **14 Hours**
Applied Microbiology: Environmental microbiology, Microbial ecology, Aquatic Microbiology, Food, Dairy and Agricultural Microbiology, Industrial Microbiology. Major bacterial diseases of animals and plants, Airborne, Food-borne, Soil-borne, Nosocomial and Sexually Transmitted/Contagious Diseases, Principles of disease and epidemiology, Host-Microbe relationship, Viral pathogenesis, Major viral diseases of plants and animals.

Suggested Reading:

1. Bauman, R.W. (2011). Microbiology with Diseases by Body System. Benjamin Cummings, USA.
2. Capuccino, J.G. and Sherman, N. (2004). Microbiology-A Laboratory Manual. Benjamin Cummings, USA.
3. Pelczar, M. J., Chan, E.C.S. and Krieg, N.R. (2001). Microbiology: Concepts and Applications. McGraw-Hill Inc. USA.

4. Pommerville, J.C. (2010). Alcamo's Fundamentals of Microbiology. Jones & Bartlett Publishers, USA.
5. Prescott, L.M., Harley, J.P. and Klein, D.A. (2005). Microbiology. McGraw-Hill Science, USA. 6. Experiments In Microbiology, Plant Pathology and Biotechnology. 4th Edition (2010). New Age Intl. Publishers Ltd. - New Delhi Additional Reading:
6. Strelkauskas, A., Strelkauskas, J. and Moszyk-Strelkauskas, D. (2009). Microbiology: A Clinical Approach. Garland Science, New York, USA. 8. Tortora, G.J., Fun

Course Code: LAS.511
Course Title: Cell Biology

L	T	P	Cr
2	1	0	3

Learning Outcomes
Students will understand the structure and basic components of prokaryotic and eukaryotic cells, especially macromolecules, membranes, and organelles and their related functions.

Unit I **10 Hours**
Cell: Evolution of the cell, molecules to cell, prokaryotes and eukaryotes. **Membrane Structure and Function:** Models of membrane structure, membrane proteins, membrane carbohydrates, membrane transport of small molecules, membrane transport of macromolecules and particles.

Unit II **12 Hours**
Structural Organization and Function of Intracellular Organelles: Lysosomes, ribosomes, peroxisomes, golgi apparatus, endoplasmic reticulum and its types, mitochondria and chloroplast, Structure of mitochondria and nucleus, oxidation of glucose and fatty acids, electron transport chain (ETC): oxidative phosphorylation, chloroplast and photosynthesis.

Unit III **13 Hours**
The Cytoskeleton: The nature of cytoskeleton, intermediate filaments, microtubules, actin filaments, cilia and centrioles, organization of the cytoskeleton.
Cell Communication: Cell adhesions, cell junctions and the extra cellular matrix, cell-cell adhesion and communication, cell matrix adhesion, collagen the fibrous protein of the matrix, non-collagen component of the extra cellular matrix.

Unit IV **10 Hours**
Cell Division and Cell Cycle: Mitosis and meiosis, their regulation, steps in cell cycle, regulation and control of cell cycle events.

Suggested reading:

1. Alberts, B., Bray, D., Lews, J., Raff, M., Roberts, K. and Watson, J.D. (2010). *Molecular Biology of the cell*. Garland publishers, Oxford.
2. Celis, J.E. (2006). *Cell biology: A laboratory handbook*, Vol 1, 2, 3. Academic Press, UK.
3. Gupta, P.K. (2008). *Cytology, Genetics and Evolution*. Rastogi publications, Meerut, India.
4. Karp, G. (2010). *Cell and Molecular Biology: Concepts and Experiments*. John Wiley & Sons. Inc. New Delhi, India.

Course Code: LPS.508
Course Title: Biochemistry

L	T	P	C
3	1	0	4

Learning Outcomes

Students will understand basic biophysical chemistry, structure and function of biomolecules, metabolic pathways, and enzymatic machinery involved in metabolic pathways.

Unit I **10 Hours**

Principles of biophysical chemistry, pH, Buffer, Reaction kinetics, Thermodynamics, Colligative properties, Structure of atoms, Molecules and chemical bonds. Stabilizing interactions: Van der Waals, Electrostatic, Hydrogen bonding, Hydrophobic interaction, etc.

Unit II **15 Hours**

Composition, structure and function of Biomolecules: Carbohydrates, Lipids, Proteins, Nucleic acids and Vitamins, Human energy requirements, Nutraceuticals.

Unit III **20 Hours**

Metabolism: Bioenergetics and metabolism of Carohydrates, TCA cycle, ETC, Oxidative phosphorylation, Pentose phosphate pathway, Lipids Breakdown and biosynthesis, Amino Acids and Nucleic acid metabolism.

Unit IV **15 Hours**

Enzymology: Classification, Principles of catalysis, Mechanism of enzyme catalysis, Enzyme kinetics; Michaelis Menten, Lineweaver burk and Bisubstrate kinetics, Enzyme inhibition, Enzyme regulation, Isozymes, Clinically important enzymes.

Suggested Reading:

1. Berg, J.M., Tymoczko, J.L. and Stryer, L. (2010). *Biochemistry.* W.H. Freeman & Company. USA.

2. Brown, T.A. (2016). *Gene Cloning and DNA analysis: In Introduction*. Blackwell Publishing Professional. USA.
3. Haynie, D.T. (2007). *Biological thermodynamics*. Cambridge University. UK.
4. Mathews, C.K., Van Holde, K.E. and Ahern, K.G. (2000). *Biochemistry*. Oxford University Press Inc. New York.
5. Nelson, D. and Cox, M.M. (2017). *Lehninger Principles of Biochemistry*. W H Freeman & Co; 7 edition.)
6. Ochiai, E. (2008). *Bioinorganic chemistry: A survey*. Academic Press. Elsevier, India.
7. Randall, D. J., Burggren, W. and French, K. (2001). *Eckert animal physiology*. W.H. Freeman & Company. USA.
8. Shukla AN (2009). *Elements of enzymology*. Discovery Publishing. New Delhi, India.
9. Voet, D. and Voet, J.G. (2017). *Principles of biochemistry*. CBS Publishers & Distributors. New Delhi, India.

Course Code; LSS.509:
Biochemistry – Practical

L	T	P	C
0	0	2	1

Learning Outcomes
Basic training related to protocols and methods related to biochemistry.

- Preparation of Solutions, buffers, pH setting etc.
- Amino acid and carbohydrate separations by paper & thin layer chromatography.
- Quantitative Estimation of Proteins, Sugars, total lipids and amino acids.
- Assay and estimation of different enzymes e.g. invertase, amylases, acid and alkaline phosphatases in plant seeds.
- Principle and application of electrophoresis, Native, SDS PAGE.
- Estimation of total phenolic compounds.
- Extraction and estimation of vitamins.

Course Code: LPS.510
Course Title: Genetics

L	T	P	C
2	1	0	3

Learning outcomes
The course is focused on the basics and advancements in the area of Genetics and its application to understand various phenomena of inheritance in living world. The course is divided into classroom Hours, Assignments, mutual discussions and experimental planning. The overall aim of the course is to develop research aptitude of the students.The students will be expected to gain knowledge in the frontier fields of population, evolutionary and quantitative genetics.

Unit I **12 Hours**

Introduction and scope of genetics, DNA as genetic material: The vehicles of inheritance, Chemical structure and base composition of nucleic acids, Double helical structure, Structure of DNA and RNA, Different types of DNA molecules, forces stabilizing nucleic acid structure, super coiled DNA, properties of DNA, denaturation and renaturation of DNA and Cot curves. **DNA replication:** Messelson and Stahl Experiment, Carins Experiment, Okazaki Experiment, Basic mechanism of DNA replication.

Unit II **12 Hours**

Cell division and Cell cycle: Mitosis, Meiosis, Chromosomal basis of inheritance. Basic principles of Mendelian inheritance: Segregation and independent assortment, Alleles and multiple alleles, Human pedigrees and inheritance. Linkage analysis and gene mapping: Coupling and repulsion phase linkage, Crossing over and recombination**.** Population genetics: Application of Mendel's laws to populations, Hardy-Weinberg principle, inbreeding depression and heterosis, inheritance of quantitative traits.

Unit III **10 Hours**

Gene Interaction: Sex determination and Sex linked inheritance, Sex determination in humans, *Drosophila* and other animals, Sex determination in plants, Sex linked genes and dosage compensation. Human genetics: pedigree analysis. Gene concept: Fine structure of gene and gene concept, Fine structure analysis – Benzer's experiments, Complementation analysis and fine structure of gene, Complementation and recombination, Concept of gene.

Unit IV **11 Hours**

Extra-chromosomal inheritance and mutations: Chloroplast and Mitochondrial inheritance, Yeast, *Chlamydomonas/Neurospora* and higher plants Chromosomal aberrations: Types of changes– deletions, duplications, inversions, translocations,Change in chromosome number: trisomy and polyploidy. Evolutionary history of bread wheat, Aneuploids–nullisomics, monosomics, and trisomics, Somatic aneuploids, Changes in chromosome structure, Properties of chromosomes for detection of structural changes. Mutations: Spontaneous and induced mutations, Somatic vs germinal mutation.

Suggested Reading:

1. Anthony, J.F., Miller, J.A. ,Suzuki, D.T., Richard, R.C., Gilbert, W.M. (1998). *An introduction to Genetic Analysis*. W.H. Freeman publication, USA.
2. Atherly, A.G., Girton, J.R., Mcdonald, J.F. (1999). *The science of Genetics*. Saundern College publication.

3. Snusted, D.P., Simmons, M. J. (2010). *Principles of Genetics*. John Wiley & Sons, New York.
4. Jocelyn, E.K., Elliott, S.G., Stephen, T.K. (2009). *Lewin's Genes X*. Jones & Bartlett Publishers, USA.
5. Tamarin, R.H. (1996). *Principles of Genetics, International edtn.* McGrawhill, USA.

Course Code: LPS.511

L	T	P	Cr
0	0	2	1

Course Title: Genetics - Practical

Learning outcomes

To learn about the practical applicability of genetics

- Calculation of allele frequencies.
- Calculating recessive gene frequency, Calculating frequency of sex –linked alleles.
- Karyotyping of normal & abnormal chromosome sets.
- Monohybrid and dihybrid ratios, Multiple alleles, Epistasis – Problems.
- Inheritance patterns in Man – Numericals on Pedigree analysis- Autosomal patterns, X–linked patterns, Y–linked patterns.
- Mitochondrial inheritance patterns.
- To test PTC tasting ability in a random sample and calculate gene frequencies for the taster and non–taster alleles.
- Identification of inactivated X chromosome as Barr body and drumstick.
- Blood group typing using haemagglutination tests.
- Studies of a Model organism: Identification of normal and mutant flies (Drosophila melanogaster) & Preparation of Drosophila polytene chromosomes.
- To study fingerball and palmar dermatogylphics and calculate indices.
- To test for colour blindness using Ishihara charts.
- Molecular Mapping of Genes.

Course Code: LPS.512

L	T	P	Cr
2	1	0	3

Course Title: Plant Systematics: Cryptogams

Learning Outcome

Student will acquire necessary skills related to plant taxonomy and systematic also in depth coverage of algal, moss, and Ferns.

UNIT-I **9 Hours**

General Introduction to Plant Systematics: Taxonomy, Classification and Biological nomenclature; use of dichotomous taxonomic keys, Tree of life, Basic Latin used in systematics, Concepts of species and hierarchical taxa, Speciation: Allopatry, Sympatry, Parapatry and Peripatry; Reproductive

isolation mechanisms, The species problem, International Code of Botanic Nomenclature (ICN): principles of priority, typification, effective and valid publications; voucher specimens in plant systematics, herbarium vouchers and herbariums, the tree of life with special focus on kingdom plantae

UNIT-II **12 Hours**

Phycology: Cyanobacteria and picoplankton; primary, secondary and tertiary endosymbiosis; systematics of superkingdom Chromalveolata, dinoflagellates and HABs, diatoms, brown algae; systematics of superkingdom archeplastida, biliphyta, rhodophyta, glaucophyta, viridaeplantae, chlorophyta and streptophyta; ecological and economic importance of algae, algal life cycles, algal cultivation methods, algal resources of India.

UNIT-III **12 Hours**

Bryophytes: Defining features of embryophytes, Classification of bryophytes; Major phylogenetic groups: Liverworts, non-peristomate, peristomate, and hornworts, Origin and evolution of heterotrichy in plants; Comparative account of gametophyte structure; Sporophytic structure and evolution; Peristome structure and its significance in the classification of Mosses, Moss life cycle, Common mosses of India, ecological and economic importance of mosses.

UNIT-IV **12 Hours**

Pteridophytes: Defining features of tracheophytes, Classification of pteridophytes; Euphyllophytes, Evolution of vascular systems in plants; Early vascular plants: Rhyniophyta, Trimerophylophyta and Zosterophylophyta; Major phylogenetic groups: Lycophytes and Monilophytes; Brief account of structure and reproduction in Ferns; Telome concept, apogamy and apospory, heterospory and seed habit, Common ferns of India, ecological and economic importance of ferns.

Suggested Reading:

1. Judd, W.S., Campbell, C.S., Kellogg, E.A., Stevens, P.F. and Donoghue, M.J. (2007). *Plant Systematics, A Phylogenetic Approach*. Sinauer Associates, Inc. USA.
2. Schuh, R.T. and Brower, A.V.Z. (2009). *Biological Systematics: Principles and Applications*. Comstock Pub Assoc.
3. Gangulee, H.C. and Kar, A.K., College Botany Vol. II- 2011 (Algae+Fungi+Brophyta+Pteridophyta), New Central Book Agency, Kolkata
4. Singh, Pande, Jain, A Text Book of Botany, 2014 (Algae+Fungi+Brophyta+Pteridophyta) ,Rastogi Publication, Meerut
5. Rashid, A., An Introduction to Pteridopyta by, 2nd edition, 2011 (Reprint), Vikas Publishing House Pvt. Ltd., Noida.
6. Lee, R.E., 2008, Phycology, Cambridge University Press, Cambridge

7. Bold, H.C. and Wynne, M.J., 1985, Introduction to the Algae, 2nd Edition, Prentice-Hall Inc.
8. Webster, John, 1980, Introduction to fungi, Cambidge University Press
9. Webster, John and Roland, W.S., 2007, Introduction to Fungi, Cambridge University Press.
10. Alexopoulos, C.J., Minus, C.W. and Blackwell, M. 1996, Introductory Mycology, Wiley
11. Maheshwari, R., 2012, Fungi: Experimental Methods in Biology, CRC Press, Boka Raton, Florida
12. Prescott, G. W. 1969.The Algae: A Review. Thomson Nelson & Sons. London
13. Parihar. N.S., 1967 – An introduction of Embriyophyta, Vol.III – Pteriodophyta, Central book depot, Allahabad.

Course Code: LPS.513
Course Title: Plant Systematics: Crptogams – Practical.

L	T	P	Cr
0	0	2	1

Learning Outcome

Practical demonstration on algal/fungal/Bryophyte/pteridophytic taxonomy. Basics of taxonomic labwork including herbarium preparation, field trips and chemical taxonomy

- **Algae:** Identification of common algae of Indian Subcontinent, Sectioning and microscopy of algal specimen
- **Fungi:** Study of morphological and reproductive structures of the genera mentioned in theory. Isolation and identification of fungi from soil and air. Preparation of culture media.
- **Bryophytes:** External morphology and internal anatomy of the vegetative and reproductive organs of genera given in the theory.
- **Pteridophytes:** External morphology and internal anatomy of the vegetative and reproductive organs of genera given in the theory.
- Sample collection, preparation of herbarium, submission of report based on field trip.
- Field sampling trip and report using GPS. Herbarium preparation. Identification of plants by morphometry.
- Chemical taxonomy of plants using Gel Electrophoresis/HPLC.

Interdisciplinary courses

Course Code: LSS.514.
Course Title: Basic Concepts in Genetics.

L	T	P	Cr
2	0	0	2

Learning outcomes:
This course is designed for the students of sciences who have interest in genetics and want to witness the beauty of inheritance and evolution in day to day life. The overall aim of the course is to prepare the students to apply the understanding of Genetics into their field of interest. The students will be expected to gain knowledge in Mendel Genetics, DNA Biology and Population Genetics.

Unit-I **8 Hours**
Mendelian Genetics, Non-Mendelian Genetics: Linkage, Incomplete Dominance, Maternal Inheritance, Extra-nuclear inheritance, Sex-linked inheritance, Sex determination, Dosage Compensation, Epigenetics. The Chromosomal basis of inheritance.

Unit-II **8 Hours**
The Genetics of Bacteria and Bacteriophages. Vertical and Horizontal gene transfer. Transformation, Transfection & Transduction. Genetic Complementation.

Unit-III **8 Hours**
Genetic Mapping. Genetic screens as a basis for functional genomics. Deficiencies, Gene isolation Manipulation and the techniques that revolutionized modern genetics. Working with Nucleic Acids and Proteins. Polymerase Chain Reaction. DNA Sequencing, Southern, Western & Northern Blots. In-situ Hybridization.

Unit-IV **6 Hours**
Population genetics, Gene Pool, Genetic drift, Mendel's law to whole population, inbreeding depression and heterosis.

Suggestive Readings:

1. Anthony, J.F., Miller, J.A. ,Suzuki, D.T., Richard, R.C., Gilbert, W.M. (1998). *An introduction to Genetic Analysis*. W.H. Freeman publication, USA.
2. Atherly, A.G., Girton, J.R., Mcdonald, J.F. (1999). *The science of Genetics*. Saundern College publication.
3. Snusted, D.P., Simmons, M. J. (2010). *Principles of Genetics*. John Wiley & Sons, New York.
4. Jocelyn, E.K., Elliott, S.G., Stephen, T.K. (2009). *Lewin's Genes X*. Jones & Bartlett Publishers, USA.

5. Tamarin, R.H. (1996). *Principles of Genetics, International edtn.* McGrawhill, USA.

L	T	P	Cr
2	0	0	2

Course Code: LPS. 515.
Course Title: Economic importance of plants,

Learning Outcome
To know about various economically important plants and their products commonly utilized for basic human needs as food, clothing, shelter, health etc.

Unit-I **6 Hours**
Basic introduction to plant systematics, economic importance of Algae, Bryophytes, Pteridophytes and Gymnosperms

Unit-II **8 Hours**
Origin, evolution, botany, cultivation and uses of food (Wheat, rice, Potato and Sugarcane) crops, forage and fodder crops (Sorgham, bajra, Gram), Fibre crops (Cotton, Jute Sunhemp)

Unit-III **8 Hours**
Vegetable oil yielding plants (Groundnut, Soybean, Safflower, mustard), Medicinal and aromatic plants (*Atropha belladonna*, *Rauwolfia serpentina*, *Withania somifera* and *Phyllanthus amaraus*),

Unit-IV **8 Hours**
Spices and condiments, Important fiber – wood and timber yielding plants, non-wood forest products- raw materials for paper making, gums, tannins, dyes, resins and fruits, Plants used for shade, pollution control and aesthetics.

Suggestive Readings:

- Kochhar S. L., 5th Edition (2016) Economic Botany: A Comprehensive Study Cambridge University Press.
- Pandey.B.P., 17th edition (2017) Economic Botany. Pandey, S. Chand Publication.
- Singh, Pande, Jain (2015) A Text Book of Botany, Rastogi Publications.
- Verma. V (2009) – Economic Botany, ANE Books.
- Hill.A.W. (1981) – Economic Botany, McGraw Hill Pub.

Course Code: LPS.516.
Course Title: Fundamentals of Plant Biology Credits:

L	T	P	Cr
2	0	0	2

Learning Outcomes
To learn fundamentals of plant organization their functions, metabolism organ structure their functions and development

Unit I: **8 Hours**
Organization and function of the plant body: cells and tissues differentiation, meristem, primary and secondary growth and wood formation

Unit II: **10 Hours**
Plant metabolism: Glycolysis, photosynthesis, photorespiration, C4 and CAM photosynthesis, Secondary plant chemistry and Plant defenses

Unit III: **9 Hours**
Organ structure and function: leaves, shoots and roots, l

Unit IV: **9 Hours**
Plant development and morphogenesis: life history strategies, organogenesis and hormones, plant reproduction, seed formation, seed germination

Suggested readings:

1. Ray F Evert and Susan E Eichhorn, Esau,s. (2006). Plant Anatomy: Meristems, Cells, and Tissues of the plant body: Their structure, function and development. Wiley Publishers,
2. Charles B. Back (2010). An Introduction to Plant Structure and Development: Plant Anatomy for the Twenty-First Century. CAMBRIDGE
3. Bob B. Buchanan, (2000). Biochemistry and molecular Biology of Plants. Author: Wiley Blackwell,
4. David L. Nelson and Michael Cox. (2017). Lehninger Principles of Biochemistry: International Edition.
5. Ottoline Leyser and Stephen Day (2002) Mechanisms in Plant Development.

***More practicals may be added/modified from time to time depending on available faculties/facilities.**

Semester II

L	T	P	Cr
2	1	0	3

Course Code: LPS.521:
Course Title: Molecular Biology

Learning outcomes
The course is focused on the Central Dogma of life where we will try to understand the regulation of genes in response to different conditions. The overall aim of the course is enhance the understanding of various processes happening in the living world at molecular level. The students will be expected to gain knowledge in the gene regulation, Genomics and Transcriptomics.

Unit: I **14 Hours**

Structure, Conformation, Denaturation, Renaturation of Nucleic acids: Carrier of genetic information, Chemical structure of DNA and base composition, Watson-Crick model, Supercoiled DNA, Different forms of RNA: mRNA, tRNA, rRNA and other Types of RNA. Organelle DNA: mitochondria and chloroplast DNA. Chromosome Structure, Chromatin and the Nucleosome: Genome Sequence and Chromosome Diversity, Chromosome Duplication and segregation, The nucleosome, Chromatin structure: euchromatin, heterochromatin, Constitutive and facultative heterochromatin, Regulation of chromatin structure and nucleosome assembly, Nucleolus.

Unit: II **10 Hours**

Gene & Genome organization: Split genes, Overlapping genes, Transposons & retrotransposons, Gene clusters, Histones, Non-histones, Nucleosome, Chromatin, Chromosome structure in prokaryotes & eukaryotes. Basic Processes, Replication of DNA: Prokaryotic and eukaryotic DNA replication, Mechanism of DNA replication, Enzymes and accessory proteins involved in DNA replication, Replication errors, DNA damage and their repair.

Unit: III **11 Hours**

Transcription and mRNA processing: Prokaryotic &, eukaryotic transcription, general and specific transcription factors, Regulatory elements and mechanisms of transcription regulation, Transcriptional and posttranscriptional gene silencing: Initiation, Elongation & Termination of transcription, Capping, Polyadenylation, Splicing, editing, mRNA stability, RNA interference, Microarray.

Unit: IV **10 Hours**

Translation: Genetic code, Prokaryotic & eukaryotic translation, the translation machinery, mechanisms of chain initiation, elongation and termination, regulation of translation, co-and post- translational modifications of proteins, Epigenetics.

Suggested Reading:

1. Fasman, G.D. (1989). *Practical Handbook of Biochemistry and Molecular Biology*. CRC Press, Taylor and Francis Group, UK.
2. Gupta, P.K. (2005). *Cell and Molecular Biology*. Rastogi publications, Meerut, India.
3. James, D.W., Baker, T.A., Bell, S.P., Gann, A. (2009). *Molecular Biology of the Gene*. Benjamin Cummings, USA.
4. Jocelyn, E.K., Elliott, S.G., Stephen, T.K. (2009). *Lewin's Genes X*. Jones & Bartlett Publishers, USA.
5. Johnson, A., Lewis, J., Raff, M. (2007). *Molecular Biology of the Cell*. Garland Science, USA.
6. Lodish, H., Berk, A., Chris, A.K. and Krieger, M. (2008). *Molecular Cell Biology*. W.H. Freeman, USA.
7. Sambrook, J., Fritish, E.F., Maniatis, T. (2000). *Molecular cloning: A laboratory manual*. Cold Spring Harbor Laboratory Press, New York.

Course Code: LSS.522:
Course Title: Molecular Biology -Practical

L	T	P	Cr
0	0	2	1

Learning outcomes

To learn about practical applications of molecular biology

- Isolation of genomic DNA from bacteria (*E.coli*) and human blood, Quantification of DNA using spectrophotometric method.
- RNA isolation, cDNA synthesis, RT-PCR.
- Isolation of plasmid DNA from bacteria.
- Transformation of bacteria using CaCl2 heat shock method-Competent cell preparation.
- Digestion of DNA using restriction endonucleases, Resolution and molecular weight estimation of fragmented DNA using agarose gel electrophoresis.
- Construction of restriction map by single and double digestion, Designing DNA probe, Southern blot hybridization (demonstration only).
- Amplification of known DNA sequences by Polymerase Chain Reaction.

Course Code: LPS.523
Course Title: Plant Physiology

L	T	P	Cr
3	1	0	4

Learning outcomes

To learn about basic plant processes and their functioning aspects, transport systems, nutrition and primary and secondary metabolism.

Unit I **18 Hours**

Photosynthesis, Respiration and Photorespiration: Light harvesting complexes, Mechanisms of electron transport, Photoprotective mechanisms, CO_2 fixation, C3, C4 and CAM pathways. Citric acid cycle. Plant mitochondrial electron transport and ATP synthesis, Alternate oxidase, Photo-respiratory pathway. **Nitrogen metabolism:** Nitrate and ammonium assimilation, Amino acid biosynthesis.

Unit II **15 Hours**

Water relations, Solute transport and photoassimilate translocation: Properties of water, Properties of solutions, Cell water potential, Soil -plant -atmosphere continuum. Uptake, transport and translocation of water, ions, Solutes and macromolecules from soil, through cells, across membranes, through xylem and phloem, Transpiration, Mechanisms of loading and unloading of photoassimilates, WUE.

Unit III **15 Hours**

Phytohormones: biosynthesis, storage, breakdown and transport, physiological effects and mechanisms of action. **Sensory photobiology:** Structure, function and mechanisms of action of phytochromes, cryptochromes and phototropins, Photoperiodism and Biological clocks.

Unit IV **12 Hours**

Secondary metabolism: Biosynthesis of terpenes, Phenols and nitrogenous compounds and their roles. Growth, development and Programmed cell death: Apoptosis, Caspases, Importance and role of PCD in plant development.

Suggested Reading:

1. Buchanan, B.B. and Gruissem, W. (2015). *Biochemistry and molecular biology of plants.* Willy Blackwell ASPB USA.
2. Campbell, M.K. and Farrell, S.O. (2007). *Biochemistry.* Thomson Brooks/cole, USA.
3. Dey, P.M. and Harborne, J.B. (2000). *Plant biochemistry*. Academic Press, UK.
4. Goodwin, T.W. and Mercer, E.I. (2003). *Introduction to plant biochemistry*. CBS Publishers & Distributors, New Delhi, India.
5. Ross and Salisbury. (2009). *Plant Physiology.* Cengage Learning (Thompson), New Delhi, India.
6. Segel, I.H. and Segel, E. (1993). *Enzyme kinetics: Behavior and analysis of rapid equilibrium and steady-state enzyme systems.* Wiley-Interscience, USA.
7. Taiz, L., Zeiger, E. Mollar, I. M. and Murphy, A. (2015). Plant physiology and Development 6th edition. . Sinauer Associates Inc., USA.

Course Code: LPS.524
Course Title: Plant Physiology – Practical

L	T	P	Cr
0	0	2	1

Learning Outcomes
To learn about various aspects of physiological process and their measurements

- Osmosis, Plasmolysis, Relative leaf water content, Imbibition.
- Growth Parameters: CGR, RGR. LAR, PAR etc.
- Quantitative estimation of chlorophyll a, b, carotenoids and anthocyanins.
- Measurement of Photosynthesis (Pn).
- Membrane damage.
- Quantitative estimation of proteins, sugars and amino acids.
- Thin Layer Chromatography for separation of amino acids.
- Application of centrifugation in isolation of plant cell organelles.
- Assay and estimation of acid and alkaline phosphatases in plant seeds.
- Assay and estimation of amylases from different plant tissues.
- Principle and application of electrophoresis.
- Effect of auxin, cytokinin, gibberellic acid acid on plant growth.
- Stress measurement.

Course Code: LPS.525
Course Title: Plant Tissue and Organ Culture

L	T	P	Cr
2	1	0	3

Learning Outcomes
Students will learn tissue culture technique and its usage in conservation technology.

Unit I **11 Hours**

Overview: Historical developments**;** Disinfection and sterilization, Nutrient media; Tissue culture conditions; Role of phytohormones in plant development *in vitro*; Plant regeneration pathways - Organogenesis and Somatic embryogenesis.

Unit II **12 Hours**

Plant cell, tissue and organ Culturing: Organ culture, Root culture, Embryo culture - Embryo rescue, Breakdown of seed dormancy; Endosperm culture and triploid production; Anther and pollen culture, and production of haploid and doubled haploid plants; Callus culture; Protoplast culture and fusion, Somatic hybrids; Organelle transfer and cybrids.

Unit III **12 Hours**

Conservation techniques: *In-vitro* fertilization for production of novel hybrids; Micropropagation, Artificial seed and bioreactor technology, Virus-free plants by meristem culture; Use of somaclonal and gametoclonal variation for crop

improvement; *In-vitro* mutagenesis and mutant selection; Preservation of plant germplasm *in-vitro*, Genetic fidelity of culture systems and common problems.

Unit IV **10 Hours**

Transgenic Development: Plant transformation vectors - T-DNA and viral vectors, direct gene transfer vectors; Selectable marker and reporter genes, Plant transformation by *Agrobacterium* sp., non-*Agrobacterium* sp., and *in planta* transformation, Molecular mechanism of T-DNA transfer; Direct gene transfer methods in plants - gene gun and other methods; Chloroplast transformation. Transgene analysis, Mutant formation, Silencing and targeting; Marker-free and novel selection strategies;

Suggested Reading:

1. Plant Tissue Culture: Theory and Practice (1996), *Bhojwani S. S. & Razdan M. K.*, Elsevier.
2. Plant Biotechnology: The Genetic Manipulation of Plants (2008), *Slater A. Scott N. & Fowler M.*, Oxford University Press Inc.
3. Plants, Genes and Crop Biotechnology (2002), *Chrispeels M. J. & Sadava D. E. Jones*, Barlett Publishers.
4. Principles of Gene Manipulation and Genomics (2006), *Primrose S. B. & Twyman R. M.*, Blackwell Publishing.
5. Plant Cell, Tissue and Organ Culture: Fundamental Methods (1995), *Gamborg O. L & Phillips G. C.*, Springer-Verlag.
6. Plant Biotechnology (2011), *Singh B. D.*, Kalyani Publishers.

Course Code: LPS.526
Course Title: Plant Cell, Tissue and organ culture -Practical.

L	T	P	Cr
0	0	2	1

Learning Outcomes

To impart basic training in plant cell and tissue culture

- Practical demonstration of media preparation
- Practical demonstration of plant regeneration form various explant
- Preparation of plant tissue culture media for different purposes
- Demonstration of sterilization techniques and prevention strategies to avoid contamination in plant tissue culture room/media.
- Demonstration of plant regeneration from adventitious shoot
- Demonstration of plant regeneration from callus culture
- Demonstration to show the best utilization of microscopic and photography techniques for plant tissue culture

Course Code: LPS.527
Course Title: Ecology, Environment and Biodiversity.

L	T	P	Cr
2	1		3

Learning Outcome
Students will learn basics of ecosystem and population ecology, an overview of biodiversity and various threats on biodiversity.

Unit I **15 Hours**
Ecosystem: Physical environment, biotic environment, biotic and abiotic interactions. Concept of habitat and niche, niche width and overlap, fundamental and realized niche, resource partitioning and character displacement, Structure and function, energy flow and mineral cycling (CNP), primary production and decomposition, Ecological succession, concept of climax. Nature of communities, community structure and attributes, edges and ecotones.

Unit II **15 Hours**
Population ecology: Characteristics of a population, population growth curves, population regulation, life history strategies (*r* and *K* selection), concept of metapopulation – demes and dispersal, interdemic extinctions, age structured populations. Types of interactions, interspecific competition, herbivory, carnivory, pollination and symbiosis.

Unit III **15 Hours**
Overview of Biodiversity: Importance of biodiversity: Bioprospecting, Biopiracy, Patterns of biodiversity, Endemism and hotspots, Continental drift and dispersal routes, Role of extinctions and additions, measuring biodiversity: Realism vs. Nominalism, Species richness, species evenness, Simpson's diversity index, Biodiversity acts, Conservation of biodiversity. Concept of biosphere reserves and current status.

Unit IV **15 Hours**
Threats to Biodiversity: Overview of HIPPO: Habitat Loss, Invasive Species, Pollution, Human Population, and Overharvesting, Climate Change, Climate Change mitigation, ozone depletion, Carbon credit, Kyoto Protocol and other International Environmental Agreements

Suggested Reading:

1. Odum, E. and Barrett, G.W. (2005). *Fundamentals of Ecology*. Brooks Cole, USA.
2. Prasanthrajan, M and Mahendran, P.P. (2008). *A Text Book on Ecology and Environmental Science*. Agrotech, India.
3. Sharma, P.D. (2005). *Ecology and Environment.* Rastogi Publications, Meerut, India.

4. Verma, P.S. Agarwal, V. K. (2000). *Environmental Biology: Principles of Ecology*. S. Chand, New Delhi, India.
5. Gupta, S. and Singh J. (2014) Environmental Science and Conservation. S, Chand Publishing, New Delhi

Course Code: LPS.528
Course Title: Ecology, Environment and Biodiversity – Practical.

L	T	P	Cr
2	1	0	3

Learning Outcomes
Practical demonstration of ecological methods and analytical strategy
Syllabus

- Ecosystem analysis: Quadrat method- Data collection Methods and species diversity estimations.
- Field and Laboratory Investigations: Biomes study.
- Biological Monitoring.
- Air, water and soil analysis.
- Isolation of xenobiotic degrading bacteria by selective enrichment technique.
- Test for the degradation of aromatic hydrocarbons by bacteria.
- Study on biogenic methane production in different habitats.
- Eco-modeling.
- TDS and Salinity measurement for water
- Vegetation sampling methods: Quadrats, Line, Random Number generation etc
- Usage of handheld GPS device and maps overlay
- Measurement of Biodiversity: Species Richness and Evenness, Various Indices

Semester III

Course Code: LPS.531
Course Title: Plant Systematics: Phanerogams

L	T	P	Cr
2	1	0	3

Learning Outcome
Students will learn in-depth taxonomy of gymnosperms, angiosperms with APG-IV system, economical importance of angiosperms and about DNA Taxonomy.

UNIT I **12 Hours**

Gymnosperms: Spermatophytes, Classification of gymnosperms, Phanerogamic way of reproduction in plants, General account of Glossopteridaceae, Comparative study of Coniferales (Pinaceae, Cupressaceae, Araucariaceae, Podocarpaceae, Cephalotaxaceae, Taxodiaceae), Taxales and Gnetales (Gnetaceae, Ephedraceae and Welwitschiaceae), Ginkgos, Cycads,

Phylogeny of gymnosperms, Ecological and economic importance of gymnosperms.

UNIT II **12 Hours**

Angiosperms: Angiosperms Apomorphies, Evolutionary trends in characters, Fossil angiosperms, Principles and outline of classification of Angiosperms: Takhtajan, Cronquist, merits and demerits, Angiosperm Phylogeny Group (APG)-III system, Basal Angiosperms: ANITA Grade and Magnolids, "Monocots", Eudicots, Basal Tricholpates, Caryophyllales, Santalales, Saxifragales, Rosids: Vitales, geraniales, Fabids, Malvids, Myrtales, Asterids: Cornales, Erycales, Lamids, Campanulids. Aquatic angiosperms including mangroves.

UNIT III **11 Hours**

Economic importance of angiosperms: Origin, evolution, botany, cultivation and uses - food (Wheat, rice, Potato and Sugarcane), forage and fodder crops (Sorgham, bajra, Gram), Fibre crops (Cotton, Jute Sunhemp), Medicinal and aromatic plants (*Atropha belladonna*, *Rauwolfia serpentina*, *Withania somifera* and *Phyllanthus amaraus*), vegetable oil yielding plants (Groundnut, Soybean, Safflower, mustard), Spices and condiments, Important fiber – wood and timber yielding plants, non-wood forest products- raw materials for paper making, gums, tannins, dyes, resins and fruits, Plants used for shade, pollution control and aesthetics.

UNIT IV **10 Hours**

Molecular Systematics: DNA Barcoding, Major Loci used in molecular systematics of plants, Selection of loci, Tortoise and Hare approach in molecular systematics, phylogenetic tree and tree thinking, Monophyly, Paraphyly, Polyphyly, Apomorphy Vs Plesiomorphy, Homoplasy, Introduction to phylogeny reconstruction, characters and character coding, Delimitation and identification of taxa, Barcode Gap analysis, Identification of species with DNA sequences.

Suggested Reading:

1. Hall, B.G. (2011). *Phylogenetic Trees Made Easy: A How-To Manual*. Sinauer Associates, Inc. USA.
2. Hennig, W., Dwight, D. and Zangerl, R. (1999). *Phylogenetic Systematics*. University of Illinois Press, USA.
3. Judd, W.S., Campbell, C.S., Kellogg, E.A., Stevens, P.F. and Donoghue, M.J. (2007). *Plant Systematics, A Phylogenetic Approach*. Sinauer Associates, Inc. USA.
4. Schuh, R.T. and Brower, A.V.Z. (2009). *Biological Systematics: Principles and Applications*. Comstock Pub Assoc.
5. Pandey, B.P., Angiosperms-Taxonomy, Emrbyology and Anatomy, S. Chand and Co., New Delhi

6. Bhojwani, S.S. and Bhatnagar, S.P., Embryology of Angiosperms, Vikash Publishing House, New Delhi
7. Sporne, K.R., Morphology of Gymnosperms, B.I. Publication, New Delhi
8. Singh, Gurucharan, Plant Systematics- Theory and Practices, Oxford and I.B.H. Publishing Co. New Delhi
9. Judd,W.S.,Christopher,S.,Campbell.,Kellogg,A.E.,Stevens,P.F.,1999.Plant Systematics: A Phylogenetic Approach. Sinauer Associates Inc. Publishers.
10. Simpson, M. G., 2006 Plant Systematics. Elsevier Academic Press.
11. Vashista, 1976, Gymnosperms, S. Chand & Co.
12. Lawrence.G.H.M, 1985 – An Introduction to Plant Taxonomy, Central Book Depot, Allahabad.
13. Porter.C.L., 1982 – Taxonomy of Flowering Plants, Eurasia Publications House, New Delhi
14. Pandey.B.P. (1987) – Economic Botany.
15. Verma. V (1984) – Economic Botany.
16. Hill.A.W. (1981) – Economic Botany, McGraw Hill Pub.

Course Code: LPS.532.
Course Title: Plant Systematics: Phanerogams- Practical.

L	T	P	Cr
0	0	2	1

Learning Outcomes
Practical demonstration of methods in angiosperm taxonomy and Practical training on molecular systematics

- **Gymnosperms:** External morphology and internal anatomy of the vegetative and reproductive organs of genera given in the theory.
- **Taxonomy:** Description of a species based on live specimens of the families mentioned in the theory as well as their herbarium preparation.
- **Molecular Systematics:** BLAST, Introduction to MEGA, Multiple Sequence Alignment, CLUSTALW, MUSCLE, Model Selection, Construction of Phylogenetic Trees
- Sample collection, preparation of herbarium, submission of report based on field trip.

Interdisciplinary Course:

Course Code: LPS.533
Course Title: Basic Plant physiology and biochemistry.

L	T	P	Cr
2	0	0	2

Learning Outcome
The students will understand basic plant processes and functions aspects of these processes.

Unit-I **8 Hours**

Basic plant physiology, processes and functions, Photosyntheisis

Unit-II **7 Hours**

Primary and Secondary Metabolism

Unit-III **7 Hours**

Plant Water Relations: Properties of water, Properties of solutions, Cell water potential, Soil -plant -atmosphere

Unit-IV **8 Hours**

Plant Growth regulators, Auxins . Gibberellins Cytokinins Ethyklene,Abscisic Acid, Growth and development

Suggested Readings

- Buchanan, B.B. and Gruissem, W. (2015). *Biochemistry and molecular biology of plants.* Willy Blackwell ASPB USA.
- Taiz, L. and Zeiger, E. (2010). *Plant physiology*. Sinauer Associates Inc., USA.
- Taiz, L., Zeiger, E. Mollar, I. M. and Murphy, A. (2015). Plant physiology and Development 6th edition. Sinauer Associates Inc., USA.

Course Code: LPS.534
Course Title: Evolution and Humanity

L	T	P	Cr
2	0	0	2

Learning Outcome

Students will learn the basics of theory of evolution and its implications, historical linguistics and how this field is influenced by Darwin's theory and about historical socio-politics and its connection with Darwinism.

Unit I **8 Hours**

Overview of theory of evolution: Pre-Darwinian concepts, Darwinism in detail, Artificial and Natural Selection, Adaptation, Molecular Evolution and Phylogeny

Unit II **7 Hours**

Cultural and Philosophical implications of Darwinism: Species concepts in biology, Philosophical realism Vs. Nominalism, nature of objective reality, ethics, aesthetics, post modernism, epistemology, metaphysics, cultural evolution, Memes and memetics, Spandrels, Inclusive Fitness, Extended Phenotype, Altruism and Sexual Cannibalism, Promiscuity

Unit III **8 Hours**

Evolutionary linguistics: Evolution of languages, Parallelism between organic evolution and linguistic evolution, cognates, comparative linguistics, major language families of the world and its evolution, evolutionary legacy of languages of Indian subcontinent, brief overview to the field of phylolinguistics

Unit IV **7 Hours**

Evolutionary socio-politics: Left-right political spectra and its evolution, Political philosophies contributing to Speciation Vs. Hybridization, Assortative mating and social stratification, Evolution and Indian caste system, socio-economical implications of evolution

Suggested Reading:

1. Dawkins, R. (1996). *The Blind Watchmaker*, W.W. Norton & Company Jones and Bartlett Publishers.
2. Futuyma, D.J. (2009). *Evolution*. Sinauer Associates Inc. USA.
3. Hake, S. and Wilt, F. (2003). *Principles of Developmental Biology*. W.W. Norton & Company, New York, USA.
4. Hall, B.K. and Hallgrimsson, B. (2007). *Strickberger's Evolution.* Jones and Bartlett Publishers, India.
5. Lewin, R. (2004). *Human Evolution - An Illustrated Introduction*. Wiley-Blackwell, USA.

Course Code: LPS.535
Course Title: Fundamentals of Plant Biotechnology

L	P	T	Cr
2	0	0	2

Learning Outcome:

Introduction to fundamentals of plant biotechnology course is an overview of plant tissue culture, application of tissue culture to plant breeding, gene cloning, gene transfer in plants, transgenics in crop improvement, and impact of recombinant DNA technology.

Unit I **6 Hours**

Introduction to plant biotechnology, Tissue culture media and preparation, Sterilisation techniques, In vitro Micropropagation, Application of tissue culture to plant breeding

Unit II **12 Hours**

Introduction to molecular biology, Basic molecular techniques, PCR based techniques, Genetic markers, Applications of molecular markers

Unit III **9 Hours**

Cloning vectors, cDNA and DNA libraries; Approaches for gene isolation, Analysis of cloned genes; Transient and stable gene transfer, Gene transfer methods, Agrobacterium mediated gene transfer

Unit IV **9 Hours**

Transgenic Development: Insect resistance, Virus and disease resistance, Resistance to abiotic stresses, Herbicide resistance, Transgenic for quality, Impact of recombinant DNA technology: Commercial transgenic crops: Ethical issues and impact on environment

Suggested Readings

1. Bhojwani SS, Razdan Mk (2009) Plant Tissue Culture: Theory and Practice, Volume 5, Elsevier Science
2. M.K. Razdan (2003) Introduction to Plant Tissue Culture, Science Publisher, Science
3. T A Brown (2016) Gene cloning and DNA analysis: An introduction, Seventh Edition, Wiley Blackwell
4. H Lorz and G. wenzel (2005) Molecular marker systems in Plant Breeding and crop improvement, Springer
5. Chittaranjan Kole, Charles H. Michler, Albert G. Abbott, Timothy C. (2010) HalTransgenic crop plant, volume 1: Principle and development, l, Springer
6. Ammann K, Jacot Y, Kjellsson Simonsen V, (1999) Methods for Risk Assessment of transgenic plants. Springer

Course Code: LPS.597
Course Title: Seminar-1

L	T	P	Cr
0	0	2	1

Learning outcomes

Ability to critically analyze the topic on emerging areas and enhancement of presentation skills of the students.

Course Code: LPS.553
Course Title: Recombinant DNA Technology

L	T	P	Cr
2	1	0	3

Learning Outcomes

Students will learn the basics of Genetic Engineering and understanding of various molecular tools needed for DNA manipulations. The overall aim of the course is enhance the understanding of various DNA manipulating tools and practical applications in Agriculture and different Industries.

Unit I **12 Hours**

Plasmid biology: Structural and functional organization of plasmids, Plasmid replication, stringent and relaxed plasmids, Incompatibility of plasmid maintenance. Biology of bacteriophage: lambda phage as a natural in vivo vector, *in vitro* construction of lambda vector, classes of vectors and their use.

Unit II **10 Hours**

Enzymes in genetic engineering: DNA polymerase, Polynucleotide kinase, T4 DNA ligase, Nick translation system, Terminal deoxynucleotidy1 transferase, Reverse transcriptase, Restriction endonucleases Type I & II.

Unit III **12 Hours**

Cloning vectors: Types of cloning vectors viz. plasmids, cosmids, ssDNA Phages, Yeast cloning vectors, animal viruses, Ti plasmids and Cauliflower Mosaic Virus. Cloning and subcloning strategies: Preparation of competent cell-Transformation, transfection – recombinant selection and screening; Isolation of genomic and nuclear DNA: DNA restriction and restriction fragment analysis, Genomic DNA and cDNA library[cDNA synthesis strategies – Linkers – Adapters – Homopolymer tailing], Making genomic and cDNA libraries in plasmids and phages, PCR product cloning (TA cloning), Cloning strategies in yeast, *Escherichia coli* and *Bacillus subtilis*. Sequencing by chemical, enzymatic and big-bye terminator methods.

Unit IV **11 Hours**

Selection of rDNA clones and their expression products: Direct and indirect methods, Drug resistance, Gene inactivation, DNA hybridization, colony hybridization and in-situ hybridization (Southern, Northern and Dot blots and immunological techniques Western blotting). Gene modification & application of recombinant DNA technology: Mutagenesis – Deletion mutagenesis, Oligonucletoide derived mutagenesis, Site directed mutagenesis – Its applications; Applications of rDNA technology in diagnostics; Pathogenesis; Genetic diversity; Therapeutic proteins-Vaccines, Molecular probes (Production, labelling and uses).

Suggested Reading:

1. Brown, T.A. (2010), *Gene Cloning and DNA analysis*.John Wiley & Sons.
2. Jocelyn, E.K., Elliott, S.G. and Stephen, T.K. (2009), *Lewin's Genes X.* Jones and Bartlett Publishers, LLC.
3. Primrose, S.B., Twyman, R.M and Old, R.W., (2001). *Principles of Gene manipulations*. Blackwell Science.

Course Code: LPS.554
Course Title: Recombinant DNA Technology-Practical.

L	T	P	Cr
0	0	2	1

Learning Outcomes
Practical demonstration and hands on training on various aspects of genetics as mentioned below

- Nucleic Acid Isolation: Genomic DNA isolation from Plant Cell, RNA isolation, Plasmid Isolation from Bacteria.
- Restriction Digestion:Genomic DNA restriction, Plasmid DNA restriction Digestion, Visualization of DNA restricted fragments.
- PCR amplification: RAPD PCR, Gene specific PCR, Sequencing PCR, Colony PCR.
- Cloning: Cloning of specific fragments, TA cloning.
- Sequencing: Sequencing of the inserted Fragments, Bioinformatic analysis of the sequence.

Course Code: LPS.555
Course Title: Techniques in Life Sciences.

L	T	P	Cr
2	1	0	3

Learning Outcome
Students will learn basics of analytical methods used frequently in biological sciences, including microscopy, spectroscopy, nucleic acid techniques and flow cytometery.

Unit I **13 Hours**
Centrifugation: Principle and applications, Ultracentrifugation and their application in mass determination. Spectrometry: UV, IR, XRD, CD, NMR, atomic absorption and MS spectrophotometry. Chromatography: Principle, procedure and applications of paper & thin layer chromatography (TLC), gel filtration and ion exchange, affinity chromatography, GC (GLC & GSC), HPLC and FPLC.

Unit II **10 Hours**
Microscopy: Light microscopy, phase contrast microscopy, fluorescent microscopy, scanning electron microscopy (SEM/FESEM), transmission electron microscopy (TEM), micrometry and photomicrography, Histochemistry, Scanning-probe microscopy, Atomic force microscopy, CLSM.

Unit III **12 Hours**
Nucleic acids: Isolation, purification and analysis of nucleic acids. Electrophoresis: Principle of gel electrophoresis, polyacrylamide gel electrophoresis (PAGE and SDS-PAGE), agarose gel electrophoresis, pulse field gel electrophoresis (PFGE) and 2-Dimensional gel electrophoresis. Polymerase

chain reaction (PCR): Principle, types and applications, PCR based markers: RAPDs, SSRs, SNPs, ISSRs, and SCARs etc. Blotting techniques: Southern, Northern, Western, Dot blotting and hybridization, DNA fingerprinting.

Unit IV **10 Hours**

Flow cytometry: Cell sorting, Hybridoma technology/Production of antibodies, Developing Monoclonal and Polyclonal antibodies. Histochemical and Immuno-techniques, Immunochemical Techniques: Radioimmunoassay (RIA), Enzyme Linked Immunosorbent Assay (ELISA) and Autoradiography. Mutation Analyses Techniques: Restriction mapping, SSCP analyses.

Suggested Reading:

1. Brown, T.A. (2015). *Gene cloning and DNA analysis: An Introduction*. 6th Edition, Wiley-Blackwell Publisher, New York.
2. Goldsby, R.A., Kindt, T.J. and Osborne, B.A. (2008). *Kuby Immunology*. 6th Edition, W. H. Freeman & Company, San Francisco.
3. Gupta, P.K. (2005). *Elements of biotechnology*. Rastogi Publications, Meerut.
4. Gupta, S. (2005). *Research methodology and statistical techniques*, Deep & Deep Publications (P) Ltd. New Delhi.
5. Kothari, C.R. (2008.) *Research methodology(s)*. New Age International (P) Ltd., New Delhi
6. Lewin, B. (2010). *Genes X*, CBS Publishers & Distributors. New Delhi.
7. Mangal, S.K. (2007). *DNA Markers In Plant Improvement*. Daya Publishing House,New Delhi.
8. Nelson, D. and Cox, M.M. (2009). *Lehninger Principles of Biochemistry*. W.H. Freeman and Company, New York.
9. Primrose. S.B. and Twyman, R. (2006). *Principles of Gene Manipulation and Genomics*. Blackwell Publishing Professional, U.K.
10. Sambrook, J. (2006). *The Condensed Protocols from Molecular Cloning: A Laboratory Manual*. Cshl Press. New York.
11. Sambrook, J. and Russell, D.W. (2000). *Molecular Cloning: A Laboratory Manual* (3 Vol-set). 3rd Edition, CSHL Press, New York.
12. Sawhney, S.K. and Singh, R. (2005). *Introductory Practical Biochemistry*. Narosa Publishing House, New Delhi .
13. Slater, A., Scott, N.W. and Fowler, M.R. (2008). *Plant Biotechnology: The Genetic Manipulation of Plants*. Oxford University Press, USA.
14. Wilson, K. and Walker, J. (2006). *Principles and Techniques of Biochemistry and Molecular biology*. 6th Edition, Cambridge University Press India Pvt. Ltd., New Delhi.

Course Code: LPS.556
Course Title: Evolutionary Biology

L	T	P	Cr
2	1	0	3

Learning Outcome

Students will learn basics of Darwin's theory of evolution, evolutionary mechanisms and macroevolution, including punctuated equilibrium also about molecular evolution.

Unit I **7 Hours**

Darwinism and Microevolution: Pre-Darwinian developments, Darwin's theory of evolution, Artificial Selection: Intentional Vs. Unintentional, Natural Selection, Darwinian Fitness, Adaptation, Overproduction, Types of Selection: Purifying vs. Positive, Co-evolution, Nature of Natural Selection

Unit II **8 Hours**

Evolutionary Mechanisms and Population Genetics: Modern Evolutionary Synthesis, Variations, Hardy–Weinberg equilibrium, Selection Vs. Drift, Mutation, Gene Flow and Assortative Mating

Unit III **8 Hours**

Macroevolution: Concepts: Spandrel, Exaptation, Extended Phenotype, Inclusive Fitness, Kin Selection, Group Selection, Evolutionary Game Theory, Adaptations, Punctuated Equilibrium, Radiations and Extinctions, Evolutionary Time Scale and Dating, Fossils and Paleontology, Origin of life and pre-cambrian, Origin of multicellularity, plants and animals, Evolution of Homo sapiens

Unit IV **7 Hours**

Molecular Evolution: Concepts of neutral evolution, Molecular divergence and molecular clocks, Molecular tools in phylogeny, Sequence Alignments, Models of molecular evolution and model selection, distance based methods of phylogeny reconstruction: UPGMA, Minimum Evolution and Neighbour Joining, discrete-character based methods of phylogeny reconstruction: Maximum Likelihood, Maximum Parsimony and Bayesian Inference

Suggested Reading:

1. Darwin, C.R. (1911). *On the origin of species by means of natural Selection, or preservation of favoured races in the struggle for life*. Hurst Publishers, UK.
2. Dawkins, R. (1996). *The Blind Watchmaker*, W.W. Norton & Company Jones and Bartlett Publishers.
3. Futuyma, D.J. (2009). *Evolution*. Sinauer Associates Inc. USA.

4. Hake, S. and Wilt, F. (2003). *Principles of Developmental Biology*. W.W. Norton & Company, New York, USA.
5. Hall, B.K. and Hallgrimsson, B. (2007). *Strickberger's Evolution.* Jones and Bartlett Publishers, India.
6. Lewin, R. (2004). *Human Evolution - An Illustrated Introduction*. Wiley-Blackwell, USA.

Course Code: LPS.561
Course Title: Physiology and Molecular Biology of stress.

L	T	P	Cr
2	1	0	3

Learning outcome
To learn about various environmental factors involved in normal growth and development of plants and how plants cope up under adverse conditions.

Unit I **12 Hours**
Environmental Stresses and stress factors: Definition, Significance, Types, Stress- as perceived by plants. **Responses of plants towards biotic factors:** Choice between fight or flight, acquired vs induced tolerance, Plant defense system, Genetic basis, understanding R genes, Systemic plant defense responses.

Unit II **12 Hours**
Responses towards abiotic factors: Stresses involving water deficit, High and low temperature stress, Salinity stress, Drought stress, Anoxia and Heavy metal stress, Role of osmotic adjustments towards tolerance, understanding of genetic basis.

Unit III **12 Hours**
Signaling under stress conditions: Perception, Transduction and response trigger, Induction of specific gene expression, Stress proteins, Convergence and divergence of signaling pathways, ABA as stress hormone, ABA the phenomenon of cross adaptation.

Unit IV **9 Hours**
Genetic engineering and production of plants for improved stress tolerance: Physiological approach, Mutant approach, Wild relatives approach, Contrasting genotypes approach, Getting clue from sub - relative approach, contrasting genotypes approach, Getting clue from sub-lethal stress application, Success of plant breeding vs modern genetic modifications, Raising of stress tolerant genotypes through genetic engineering. High throughput analysis techniques in stress biology

Suggested Reading:

1. Taiz, L., Zeiger, E. Mollar, I. M. and Murphy, A. (2015). *Plant physiology and Development*, 6th edition. Sinauer Associates Inc., USA.
2. Buchanan B. (2014). *Biochemistry and Molecular Biology of Plants*. American Society of Plant Physiologists, USA.
3. Hopkins, W.G. and Hüner, N.P.A. (2004). *Introduction to plant physiology*. J. Wiley, USA.
4. Orcutt, D.M. and Nilsen, E.T. (2000). *Physiology of Plants Under stress*. J. Wiley, USA.
5. Galun, E. and Breiman. (1997). *Transgenic Plants*. World scientific Publishing, Chennai, India.
6. Hopkins, W.G. (2007). *Plant Biotechnology*. Infobase Publications Inc.. USA.
7. Chrispeels, M.J. and Sadava, D.E. (2002). *Plant, Genes and Crop Biotechnology*. American Society of Plant Biologists, USA.

Course Code: LPS.562
Course Title: Physiology and Molecular Biology of stress (P)

L	T	P	Cr
2	1	0	3

Learning Outcomes

Practical demonstration and hands on training on various aspects of stress physiology

- Membrane Damage analysis (Electrolyte leakage, Lipid peroxidation etc.)
- TTC reduction and mitochondrial respiratory ability.
- Estimation of enzymatic and non enzymatic antioxidants.
- Native expression of enzymatic antioxidantsi.e. SOD, APX, CAT, POX, GR, Etc.
- DNA Damage due to stress.
- Reactive species localization.

***More practicals may be added/modified from time to time depending on available faculties/facilities.**

Course Code: LPS.599
Course Title: Project

L	T	P	Cr
0	0	6	6

Learning outcomes

Students's shall be exposed to formulate a small research problem and execute in real lab conditions. Students's / concern supervisor may opt for review writing also.

MOOC Courses (4 Credits)

Student shall be encouraged to take one or two online MOOC courses in place of discipline elective course.

Semester-IV

Course Code: LPS.571
Course Title: Metabolic Engineering

L	T	P	Cr
2	1	0	3

Learning Outcome
Student will learn how to engineer plants for specific metabolite production, and various metabolomics techniques

Unit I **10 Hours**
Cellular metabolism, Ecological significance of plant secondary metabolites; their effects on bacteria, insects and human health; Introduction to cellular and metabolic engineering. Major classes of secondary metabolites of plants, Regulation of specific pathways and secondary metabolism.

Unit II **13 Hours**
Building networks as assemblies of simpler control schemes, Metabolic flux analysis, Metabolic control analysis, Structure and flux analysis of metabolic networks,

Unit III **12 Hours**
Metabolomics, Techniques used in metabolomics, Metabolome informatics.

Unit IV **10 Hours**
E. coli: appropriate hosts for Metabolic Engineering. Production of secondary metabolites by plant cell and tissue cultures. Metabolic engineering to improve the content of bioactive secondary metabolism with applicable value in medicinal plants. Engineering of crop plants with altered nutrient content, improved photosynthesis efficiency, biofuel production and enhanced lignin content.

Suggested readings:

1. Bhojwani S. S. & Razdan M. K., (1996) Plant Tissue Culture: Theory and Practice, Elsevier.
2. Slater A. Scott N. & Fowler M., (2008) Plant Biotechnology: The Genetic Manipulation of Plants Oxford University Press Inc.
3. Chrispeels M. J. & Sadava D. E. Jones, (2002) Plants, Genes and Crop Biotechnology Barlett Publishers.
4. Primrose S. B. & Twyman R. M. (2006) Principles of Gene Manipulation and Genomics, Blackwell Publishing.
5. Gamborg O. L & Phillips G. C., (2004), Plant Cell, Tissue and Organ Culture: Fundamental Methods Springer-Verlag.
6. Singh B. D., (2014) Plant Biotechnology Kalyani Publishers, New Delhi.
7. C.D. Smolke, (2009) The Metabolic Pathway Engineering Handbook, CRC Press.
8. B.O. Palsson, (2011) Systems Biology, Cambridge University Press.

Course Code: LPS.572
Course Title: Anatomy and Developmental Biology of Plants.

L	T	P	Cr
2	1	0	3

Learning Outcome
Students will learn in-depth anomalies related to anatomy of stem and roots and in-depth Developmental biology of plants.

Unit I **12 Hours**
Male and female gametophyte: Microsporangium and Microsporogenesis, Megasporangium and Megasporogenesis, Gametophyte formation, Pollen development, Ovule development.

Unit II **10 Hours**
Pollen-pistil interaction and double fertilization: Pollen tube guidance; recognition and rejection, Embryo-sac development and double fertilization in plants, preferential fertilization; pistil activation and ovule penetration.

Unit III **11 Hours**
Seed development and dormancy: Embryogenesis, Embryo and endosperm development, Classification of typical dicot and monocot embryo, Seed maturation and dormancy, polyembryony, apomixes, apospory.

Unit IV **12 Hours**
Anatomy: Shoot development: organization of shoot apical meristem, Root development: organization of root apical meristem, Anatomy of **S**tems and roots with special reference to plants showing anomalies- *Nyctanthes, Bignonia, Strychnos, Salvadora, Boerhaavia, Dracaena* and *Tinospora*.

Suggested Reading:

1. Dawkins, R. (1996). *The Blind Watchmaker*, W.W. Norton & Company Jones and Bartlett Publishers.
2. Hake, S. and Wilt, F. (2003). *Principles of Developmental Biology*. W.W. Norton & Company, New York, USA.
3. Scott, F. and Gilbert, S.F. (2010). *Developmental Biology*. Sinauer Associates, Inc. USA.
4. Slack, J.M.W. (2005). *Essential Developmental Biology*, Wiley-Blackwell, USA.
5. Bhojwani, S.S. and Bhatnagar, S.P. (2016) Embryology of Angiosperms, Vikash Publishing House.
6. Maheshwari, P. (2015) An introduction to the embryology of angiosperms, Nabu Press or Tata McGraw Hill
7. Hake, S. and Wilt, F. (2003). Principles of Developmental Biology. W.W. Norton & Company, New York, USA.
8. Scott, F. and Gilbert, S.F. (2010). Developmental Biology. Sinauer Associates, Inc. USA.

9. Slack, J.M.W. (2005). Essential Developmental Biology, Wiley-Blackwell, USA.
10. B P Pandey (2014) Plant Anatomy, S. Chand Publications
11. Singh, Pande, Jain (2015) A Text Book of Botany, Rastogi Publications.

Course Code: LPS.573
Course Title: Anatomy and Developmental Biology of Plants,

L	T	P	Cr
0	0	2	1

Learning Outcomes
Students will learn about the structural aspects of developmental events

- Practical demonstration of various reproductive plant parts
- Practical demonstration of Stem and root anatomy of dicots and monocots
- Types of Ovules, mature embryo, endosperms
- Types of placentation – Axile, basal, free central, marginal, parietal, superficial
- Floral morphology
- Types of pollens, Anther, microsporogenesis
- Dicot and monocot stems
- Dicot and monocot roots

Course Code: LPS.574
Course Title: Life Sciences, A Revision

L	T	P	Cr
2	0	0	2

Learning outcome
This course is designed to sensitize the students' regarding competitive world and various options, and revision of important course contents.

Unit I **15 Hours**
This course shall focus on utility of life sciences in this competitive world, various career options as well as sensitization about higher education in India and abroad.

Unit II **15 Hours**
Subject related problems shall be addressed viz. revision of specific topics, mock tests of last year's CSIR NET exams. Evaluation shall be done based on the Mock tests conducted.

Course Code: LPS.575.
Course Title: Life Sciences, Communication

L	T	P	Cr
0	0	2	2

Learning outcome
This course is designed to enhance presentation and interpersonal skills.

Unit I **15 Hours**
The focus shall be give on communication and presentation skills.

Unit II **15 Hours**
Students' presentations on specific topics. The evaluation shall be done based on the presentation.

XXX.xxx. Elective Foundation/ Value based course- I
XXX.xxx. Elective Foundation/ Value based course- II

List of Value Added Courses
The list of Value added courses, choose any two courses in a programme.

(i) Ethics for Science
(ii) Professional Ethics
(iii) Academic Writing
(iv) Value Education
(v) Stress Management
(vi) Personality Development through Life Skills
(vii) Physical & Mental Well Being
(viii) Pedagogical Studies
(ix) Data Analysis using spread sheet
(x) Soft Skill Training
(xi) Leadership
(xii) Personal Management
(xiii) Wealth Management
(xiv) Reasoning Ability
(xv) MS office Specialist
(xvi) Practical Taxation
(xvii) Ethical Issues & Legal Awareness
(xviii) Disaster Management
(xix) Nutrition and Specialty Foods
(xx) Shorthand & Typing
(xxi) SPSS

Course Code: LPS.598
Course Title: Research Seminar

L	T	P	Cr
0	0	1	1

Course Code: LPS 599
Course Title: Master's Research Project/Dissertation –

L	T	P	Cr
0	0	6	6

- The Synopsis and Master's Project Research shall be evaluated by a three member committee consisting of
  a. Head of the Department
  b. Supervisor or Co-supervisor
  c. Vice Chancellor's Nominee (One Senior faculty of the department)

Evaluation Criterion	**Max percentage**
Literature survey/background information	20
Organization of content	5
Physical presentation	15
Question and Answer	10
Report evaluation	50
Total	100