M.Sc- (Botony)

Sl. No.	Course Code	Title of the Course	CIA Max.	ESE Max.	TOT Max.	C Max.
FIRST YEAR						
I Semester						
1.	34611	**Plant Diversity**	25	75	100	4
2.	34612	**Plant Taxonomy**	25	75	100	4
3.	34613	**Biological Techniques in Botany**	25	75	100	4
4.	34614	**Practical – Lab I: Plant Diversity, Plant Taxonomy and Biological Techniques in Botany**	25	75	100	4
		Total	**100**	**300**	**400**	**16**
II Semester						
5.	34621	**Cell Biology, Genetics and Plant Breeding**	25	75	100	4
6.	34622	**Plant Anatomy and Embryology**	25	75	100	4
7.	34623	**Plant Physiology and Biochemistry**	25	75	100	4
8.	34624	**Practical – Lab II: Cell Biology, Genetics & Plant Breeding, Plant Anatomy & Embryology, Plant Physiology and Biochemistry**	25	75	100	4
		Total	**100**	**300**	**400**	**16**
SECOND YEAR						
III Semester						
9.	34631	**Microbiology and Plant Pathology**	25	75	100	4
10.	34632	**Ecology, Biodiversity Conservation and Economic Botany**	25	75	100	4
11.	34633	**Algal Technology and Mushroom Technology**	25	75	100	4
12.	34634	**Practical – Lab III: Microbiology & Plant Pathology, Ecology, Biodiversity Conservation, Economic Botany, Algal Technology and Mushroom Technology**	25	75	100	4
		Total	**100**	**300**	**400**	**16**
IV Semester						
13.	34641	**Plant Molecular Biology**	25	75	100	4
14.	34642	**Biostatistics, Biophysics and Bioinformatics**	25	75	100	4
15.	34643	**Horticulture and Plant Tissue Culture**	25	75	100	4
16	34644	**Practical - Lab IV: Plant Molecular Biology, Biostatistics, Biophysics and Bioinformatics, Horticulture and Plant Tissue Culture**	25	75	100	4
		Total	**100**	**300**	**400**	**16**
		Grand Total	**400**	**1200**	**1600**	**64**

***e.* 2. Detailed Syllabi:**

FIRST SEMESTER

Course Code	Title of the Course
34611	**Plant Diversity**

Objectives:

- To understand diversity of algae, fungi, lichens and bryophytes.
- To define and characterize diversity of lower vascular plants.
- To understand the dynamics of diversity
- To realize the significance of diversity.

Possible Outcomes of the course:

- The course will enrich the knowledge on algae, fungi, lichens and bryophytes.
- The course will impart the adequate knowledge about lower vascular plants.
- The course will help the students to have an insight on evolutionary approach with the plant kingdom.
- The course will help the students to answer the questions in competitive exams viz., SET, NET, GATE, etc. successfully.

Block 1: **Algae:**

Unit-1: Definitions and concepts of plant diversity- Thallus organization in Algae.

Unit -2: Reproduction and life cycle patterns in algae- Classification of algae (Smith).

Unit-3: Reproduction and life cycles in *Cyanophyceae, Chlorophyceae, Phaeophyceae* and *Rhodophyceae* (Comparative study only).

Block 2: Fungi; Lichens:

Unit-4: Classification of fungi (Alexopoulos and Mims, 1979).

Unit-5: Thallus organization and Reproductive pattern in fungi.

Unit-6: Life cycle patterns in fungi (Phycomycetes to Deuteromycetes) - Spores and spore dispersal mechanisms exhibited by fungi.

Unit-7: General account on Lichen- Classification of lichens (Miller, 1984) - Structure and reproduction of lichen.

Block 3: Bryophytes:

Unit-8: Classification of bryophytes (Watson, 1964).

Unit-9: Structural variations in the gametophytes and sporophytes of *Marchantiales, Sphaerocarpales, Jungermanniales*, and *Calobryales* (Comparative study only).

Unit-10: Structural variations in the gametophytes and sporophytes of *Anthocerotales, Sphagnales, Andreales* and *Bryales* (Comparative study only).

Block 4: The Lower Vascular Plants (Pteridophytes and Gymnosperms) :

Unit- 11: Classification of Pteridophytes (Reiner's).

Unit- 12: General characteristics and life cycle patterns in *Psilopsida, Lycopsida, Sphenopsida* and *Pteropsida.*- Study of fossils in Pteridophytes (*Sphenophyllum, Lepidodendron*).
Unit- 13: Classification (K.R.Sporne, 1967) of Gymnosperms.

Unit- 14: General characteristics of *Cycadales*, *Ginkgoales*, *Coniferales* and *Gnetales* (Comparative study only). - Study of fossil gymnosperms (*Medullosa, Cycadeoidea* and *Caytonia).*

Reference Books:

1. Robert Edwardlee, 2008, Phycology, 4th Edition, Cambridge University Press, London, ISBN: 0521682770.
2. O. P. Sharma, 2011, Algae, 1st Edition, Cambridge University Press, Mcgraw Hill Education, ISBN: 0070681945.
3. Steven L. Stephenson, 2010, The Kingdom Fungi: An Introduction to Mushrooms, Molds and Lichens, 1st Edition, Timber Press, ISBN: 0881928917.
4. Himanshu Rai, Dalip K. Upreti, 2014, Terricolous Lichens in India: Volume 2: Morphotaxonomic Studies, Springer NY, ISBN: 1493903594
5. W.B Schofield, 2001, Introduction to Bryology, 1st Edition, The Blackburn Press, ISBN: 1930665261.
6. S. S. Sambamurty, 2005, A Text Book of Bryophytes, Pteridophytes, Gymnosperms and Palobotany, I K International Publishing House Pvt. Ltd, ISBN: 8188237450.
7. Pteridophytes and Gymnosperms, 2010, 1st edition, Springer, ISBN: 3642080804.
8. C. J. Alexopoulos C. W. Mims M. Blackwell, 2002, Introductory Mycology, Wiley India Pvt Ltd. ISBN: 9788126511082.
9. K. R. Sporne, 2014, The Morphology of Pteridophytes; The Structure of Ferns and Allied Plants - Primary Source Edition, Nabu Press, ISBN: 9781294843078.

Course Code	Title of the Course
34612	**Plant Taxonomy**

Objectives:

- To acquire the fundamental knowledge of plant systematics.
- To know about the basic concepts and principles of plant systematics.
- To know how to identify the plants.
- To create awareness of the f taxonomic relationships in plant systematic studies.

Possible Outcomes of the course:

- The course will nurture the knowledge on classification of plants.
- The course will give an expertise in understanding characteristic features of various plant families.

Block-1: Scope and Applications of Plant Taxonomy:

Unit-1: Scope and applications- Species concept, Biotype, Ecad, Ecotype-Binomial System of Nomenclature.

Unit-2: Theories of Biological Classification- Structural, Biological and Molecular systematics.

Unit -3: Historical Background, Plant classification- Plant classification systems: Bentham and Hooker, Engler and Prantl, Takhtajan and Hutchinson.

Block-2: Taxonomic Structure:

Unit-4: Taxonomic structure: Biosystematics, Chemotaxonomy, Numerical taxonomy-. Modern inter-disciplinary approaches to Taxonomy.

Unit -5: Botanical Nomenclature- Need for scientific names- Principles of ICBN. Type method, author citation, Publication of names, rejection of names.

Unit-6: Principle of priority, limitations, conservation of names of species-Draft Biocode.

Block-3: Salient features of plant families:

Unit-7: Study of the Monocotyledons: *Hydrocharitaceae* and *Dioscoreaceae*

Unit-8*:* Study of the Monocotyledons: *Arecaceae* and *Cyperaceae.*

Unit-9: Study of the Monochlamydeae families*: Polygonaceae* and *Amaranthaceae.*

Unit-10*:* Study of the Monochlamydeae families: *Aristolochiaceae* and *Loranthaceae.*

Block- 4: Salient features of plant families:

Unit-11: Study of the Gamopetalae families: *Sapotaceae, Rubiaceae, Asteraceae, Apocynaceae.*

Unit-12: Study of the Gamopetalae families: *Convolvulaceae, Bignoniaceae, Scrophulariaceae* and *Verbenaceae.*

Unit-13: Study of the Polypetalae families: *Magnoliaceae, Menispermaceae, Papaveraceae, Polygalaceae, and Tiliaceae.*

Unit-14: Study of the Polypetalae families: *Geramiaceae, Mimosaceae, Myrtaceae, Meliaceae* and *Sapindaceae*.

Reference Books:

1. Anupam Dikshit, M.O. Siddiqui, Ashutosh Pathak, 2016, Taxonomy of Angiosperms: Basic Concepts, Molecular Aspects & Future Prospects, 1st Edition, Studera Press, ISBN: 9385883070
2. O. P. Sharma, 2012, Plant Taxonomy, 2nd Edition, Mcgraw Hill Education, ISBN: 0070141592
3. Yilma Dessalegn, Getachew Mekonnen, 2012, Plant Taxonomy and Systematics, LAP Lambert Academic Publishing, ISBN: 3659164739.
4. Jones and Luchsinger, 1987, Plant Systematics, 2nd Edition, McGraw Hill International Editions. New York.
5. Neeru Mathur, 2012, Taxonomy of Angiosperms, Sonali Publications, ISBN: 8184114494.
6. K.V. Krishnamurthy, 2004, An Advanced Text Book on Biodiversity – Principles and Practice, Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi. ISBN: 9788120416062.

Course Code	Title of the Course
34613	Biological Techniques in Botany

Objectives:

- To acquire the knowledge about biological techniques.
- To know about the basic concepts, principles and significance of various analytical and molecular techniques.
- To understand the various anatomical techniques.

Possible Outcomes of the course:

- The course will nurture the knowledge on biological samples especially plant samples.
- The course will give an expertise in understanding the various important biological techniques to be employed in the field of botany.

Block-1: Microscopy:

Unit-1: Principles, image formation and applications of Light, Polarizing Microscpy.

Unit-2: Transmission and Scanning electron microscopes - Confocal Microscopy, Phase Contrast Microscopy. Photomicrography- Digital imaging.

Unit-3: Microscopic measurements- Micrometers – Ocular, Stage, Haemocytometer and Camera lucida.

Block-2: Microtomy:

Unit-4: Microtomes- Rocking, Rotary, Sledge and Ultra microtomes and their uses.

Unit-5: Material preparation techniques for microtome sectioning - fixatives, dehydrating agents, killing, fixing methods.

Unit-6: Stains and their uses and staining of plant tissues- Clearing, Mounting and mountants.

Block-3: Histochemical studies:

Unit-7: Histochemical techniques – staining of Proteins, Carbohydrates, Lipids and enzymes.

Unit-8: Microslide preparation—Whole mounts, Smears, Squashes.

Unit-9: Sectioning of Biological specimens- Free hand, Hand microtome, sludge and rotary microtome sectioning, Embedding methods.

Unit-10: Dewaxing and staining of the sections, fixing coverslips and ringing.

Block-4: Maceration, Separation Tracer and Blotting Techniques:

Unit-11: Maceration technique- PAGE, SDS – PAGE and Agarose gel electrophoresis. Isoelectric focusing. 2D Electrophoresis.

Unit-12: Separation technique -Ultracentrifugation- TLC, HPLC, HPTLC, FPLC, GC, MS, MALDI Tof.

Unit-13: Tracer techniques- Principles and applications of radioactive isotopes, Autoradiography and Liquid scintillation spectrometry.

Unit-14: Blotting techniques -Principles and techniques of Southern, Northern and Western blotting techniques and hybridization. Principles and applications of PCR, RFLP, RAPD, AFLP and DNA fingerprinting.

Reference Books

1. D.K. Singh, 2013, Principles and Techniques in Histology, Microscopy and Photomicrography, CBS Publishers.
   ISBN: 9788123909509.
2. R. Mortin, 1996, Gel Electrophoresis: Nucleic Acids (Introduction to Biotechniques), Garland/ BIOS Scientific Publishers. ISBN: 9781872748283.
3. A. S. Sameer, 2011, Molecular Biology and Biotechniques, VDM Verlag, ISBN: 9783639324990.
4. S.K. Dewab, 2012, Organic Spectrosopy (NMR IR MASS and UV), CBS Publishers, ISBN: 9788123919065.

Course Code	Title of the Course
34614	**Practical – Lab I: Plant Diversity, Plant Taxonomy and Biological Techniques in Botany**

Suggested Laboratory Exercises:

1. Morphological study of representative member of Algae: *Microcystis, Oocystis, Pediastrum, Hydrodityon, Ulva, Pithophora, Stigeoclonium, Drapranaldiopsis, Closterium, Cosmarium, Chara.*
2. Morphological study of representative member of fungi: *Albugo, Mucor, Pilobolus, yeast, Polyporus, PeniCillium, Aspergillus, Colletotrichum.*
3. Identification of fungal cultures: *Rhizopus, Mucor, Aspergillus, Penicillium, Chaetomium, Curvularia, Fusarium.*
4. Study of morphological and internal structures of representative genera of fruticose, foliose, and crustose lichen.
5. Morphological study of representative member of bryophytes and pteridophytes: *Marchantia, Anthoceros, Polytrichum, Psilotum, Lycopodium, Selaginella, Equisetum, Ophioglossum, Isoates, Lygodium, Regnellidium* and *Marsilia*
6. Study of morphology, anatomy and reproductive structures *of* bryophytes.
7. Study of complex tissues *viz*. Xylem and Phloem, Tracheids, Vessels and Sieve tubes and Companion cells.
8. Comparative study of the wood anatomy and vegetative and reproductive parts of *Cycas, Ginkgo, Cedrus, Abies, Picea, Cupressus, Araucaria, Cryptomeria, Taxodium, Podocarpus, Agathis, Taxux, Ephedra* and *Gnetum*.
9. Study of the living gymnosperms in the botanical garden of the university.
10. Study of important fossil gymnosperms from prepared slides and specimens.
11. Monographic study of the living gymnopserms.
12. Description of a specimen from representative, locally available families.
13. Description of a species based on various specimens to study intraspecific variation a collective exercise.
14. Description of various species of a genus; location of key characters and preparation of keys at generic level.
15. Location of key characters and use of keys at family level.
16. Field trips; compilation of field notes and preparation of herbarium sheets.

17. Training in using floras and herbaria for identification of specimens described in the class.
18. Demonstration of the utility of secondary metabolites in the taxonomy of some appropriate genera.
19. Comparison of different species o*f* a genus and different genera of a family to calculate similarity coefficients and preparation of dendrograms.
20. Microscopic measurement practices using Micrometers, Haemocytometer and Camera lucida.
21. Microprepartaions of plant materials.
22. Microtomy, microslide preparations.
23. Staining for Proteins, Carbohydrates, Lipids and enzymes.
24. Demonstration of PAGE, Agarose gel electrophoresis.
25. Demonstration of PCR and blotting techniques.

SECOND SEMESTER

Course Code	Title of the Course
34621	Cell Biology, Genetics and Plant Breeding

Objectives:

To explore the cellular structure and inclusions of the cell.

- To understand about genetics and inheritance of traits.
- To realize the significance of plant breeding techniques in improving the plant productivity and strain improvement.

Possible Outcomes of the course:

- The course will impart the wisdom about structure and function of the cells, cell organelles.
- The course will give a detailed account on fundamentals and application of genetics
- The course will give a scientific approach to plant breeding techniques and their significances.

Block-1: The Cell:

Unit-1: Structure of Prokaryotic and Eukaryotic cell.

Unit-2: Structure and function of Nucleus, Endoplasmic Reticulum, Golgi complex, Mitochondria, Chloroplast and Lysosomes.

Unit-3: Architecture of Nucleus and nuclear transport.

Unit-4: Architecture and functions of Cytoskeleton networks (Microfilaments, Intermediate filaments and Microtubules).

Block-2: Assembly and Functions of Cellular Membranes:

Unit-5: Biological Membrane – Structure (lipid bilayer, membrane proteins) - Assembly and basic functions, Transport of ions and molecules across the membranes.

Unit-6: Protein sorting in mitochondria, chloroplast, endoplasmic reticulum and nucleus. **Unit-7**: Protein processing and trafficking from Endoplasmic reticulum to Golgi- Cell division and Cell cycle.

Block-3: Genetics:

Unit-8: Basic account on Mendelian Genetics and Gene interaction, Linkage, crossing over, Gene mapping.

Unit-9: Sex linkage, Cytoplasmic inheritance, male sterility, Origin, induction and applications of prions.

Unit-10: Polyploidy – Types, and their origin, Significance of polyploids.

Unit-11: Basic account on mutation (Causative agents, induction and types)- Basic account of population genetics (Hardey Weinberg's Law).

Block-4: Plant Breeding:

Unit-12: Objectives of plant breeding, Genetic variability and its role in plant breeding.

Unit-13: Breeding methods in self pollinated, cross pollinated, vegetatively propagated and apomictic plants.

Unit-14: Inbreeding depression theories- Hybrid vigour in plant breeding- Mutation breeding and breeding for disease resistance and stress tolerance.

Reference Books:

1. S. C. Rastogi, 2012, Cell Biology, 3rd Edition, New Age International, ISBN: 8122416888.
2. S. P. Vyas, A. Mehta, 2011, Cell and Molecular Biology, 1st Edition, CBS Publisher, ISBN: 8123919654.
3. P. S. Verma and A. K. Agarval, 2004, Cell Biology, Genetics, Molecular Biology, Evolution and Ecology, S. Chand Publishing, ISBN: 8121924421.
4. William S. Klug, Michael R. Cumming, Charlotte A. Spencer, Michael A. Palladino, 2016, Concepts of Genetics, 10th Edition, Pearson Education, ISBN: 9332577463.
5. J. E. Bradshaw, *et al.,* Root and Tuber Crops (Handbook of Plant Breeding), 2010, 1st Edition, Springer-verlag Gmbh, ISBN: 0387927646.
6. Mahabal Ram, 2014, Plant Breeding Methods, PHI Publishers, ISBN: 8120348508.
7. E.D.P. De Roberties and E. M. F. De Roberties Jr., 2010, Cell and Molecular Biology, Lippincot Williams & Wilkins, ISBN: 9788184734508.
8. J.E. Krebs, T. Kilpatrick, and E.S. Goldstein, 2014, Lewins Genes IX, Viva Books Pvt Ltd., ISBN: 9789380853710.

Course Code	Title of the Course
34622	**Plant Anatomy and Embryology**

Objectives of the Course:

- To study the plant anatomy which facilitate the process of understanding the internal structures of various plant parts and their significance.
- To study the development of male and female gametes, pollination and fertilization reveals the various steps involved in development of new plant.

Possible Outcomes of the Course:

- The course will illustrate anatomy of various plant parts.
- The course will make the learners understanding about various stages of development.

Block-1: Meristem, Connective tissues:

Unit-1: General account and theories of organization of meristems. Unit-2: Light and Electron microscopic structure of cell walls.

Unit-3: Structural diversity and phylogenetic specialization of xylem and phloem.

Unit-4: Distribution, structure and significance of transfer cells, Vascular cambium – storied, non-storied and the mode of activity.

Block-2: Vascular Tissues:

Unit-5: Vascular differentiation in the primary body of stem, root and leaf.

Unit-6: Root stem transition- Molecular aspects of developing vegetative organs. Unit-7: Cambial variants and floral vasculature.

Block-3: The Wood:

Unit-8: Structure, identification, classification and uses of woods. Unit-9: Physical, chemical and mechanical properties of wood.

Unit-10: Natural defects, knots, reaction wood, compression wood tension wood.

Unit-11: Molecular aspects on wood differentiation, Commercial woods of South India.

Block-4: The Developmental Biology:

Unit-12: Anther development- Pollen morphology, Pollen stigma compatibility.

Unit-13: Megasporogenesis female gametopohyte- Nutrition of embryo sac-

Endosperm types.

Unit-14: Apomixis- Vegetative reproduction- Agamospermy and apospory- Exploitation of polyembryony and apomixis in plant improvement progrmmes- Molecular aspects of higher plant reproduction.

Reference Books:

1. Pandey, B.P. 2011. Plant Anatomy, 21st Edition. S. Chand & Company Ltd., New Delhi. ISBN 8121901456.
2. Katerine Esau. 2010. Anatomy of Seed Plants, 2nd Edition. Wiley India Pvt., Ltd., New Delhi. ISBN 8126508205
3. Bhojwani, S.S. and S.P. Bhatnagar 2010. The Embryology of Angiosperms, 5th Revised Edition. Vikas Publishing House Pvt Ltd. Noida. ISBN: 8125923466.
4. Sharma, H.P. 2009, Plant Embryology: Classical and Experimental. Narosa Book Distributors Pvt. Ltd., New Delhi. ISBN: 8173199698.

Course Code	Title of the Course
34623	**Plant Physiology and Biochemistry**

Objectives of the Course:

- To study the plant physiological processes.
- To study the bio-chemical architecture of various bio-materials and their synthesis.

Outcomes of the Course:

- The course will enlighten the students about various metabolic pathways of plants.
- The course will make the learners understanding about various enzymes and its kinetics.

Block-1: Plant-Water Relations:

Unit-1: Water transport process, diffusion, osmosis, water potential, Chemical potential,
Unit-2: Absorption of water, water transport through trachieds and xylem.
Unit-3: Transpiration and its significance, factors affecting transpiration, mechanism of stomatal movement- Water stress on crop production.

Block-2: Photosynthesis:

Unit-4: Ultra structure of photosynthetic apparatus.
Unit-5: Photochemical reaction- electron transport pathway in chloroplast membranes, photophosphorylation.
Unit-6: C4 carbon cycle- Crassulacean acid metabolism- Photorespiration.

Block-3: Respiration and Flow of Energy:

Unit-7: Glycolysis- TCA Cycle- electron transport in mitochondria.
Unit-8: Oxidative phosphorylation- pentose phosphate pathway- cyanide – resistant respiration.
Unit-9: Nutrient uptake and transport mechanism.

Unit-10: Biological nitrogen fixation, Nitrate and ammonia assimilation.

Block-4: Chemistry of Biomolecules

Unit-11: Carbohydrates- Classification, Structure of mono, di and polysaccharides, stereoisomers, enatiomers and epimers.
Unit-12: Amino acids and Proteins- Structure, characteristics and classification- aminoacid synthesis- peptide bond and polypeptide chain- primary, secondary, tertiary and quaternary structure of proteins.

Unit-13: Enzymes- General aspects (Classification and structure), allosteric

mechanism, regulatory and active sites, isoenzymes, enzymatic catalysis- Michaelis-Menton equation and its significance.

Unit-14: Lipids- Classification and structure, biosynthesis of fatty acids, Oxidation of fatty acids- Nucleic acids- Composition of nucleic acids and nucleotide synthesis.

Reference Books:

1. Salisbury and Ross. 2006. Plant Physiology. CBS Publications ISBN: 9788123910437.

2. Taiz and Zeiger, 2006, Plant Physiology, MAC Publishers, ISBN: 9780878938568.

3. S.N. Pandey and Sinha, 2005, Plant Physiology, Vikas Publishing House Pvt. Ltd.. ISBN: 9788125918790.

4 . David Hames and Nigel Hooper, 2008, Instant Notes on Biochemistry, Tylor & Francis, ISBN: 9780415367783.

5. David L. Nelson and Michael N. Cox, 2013, Lehninger Principles of Biochemistry, Macmillon, ISBN: 9781464109621.

Course Code	Title of the Course
34624	**Practical – Lab II: Cell Biology, Genetics & Plant Breeding, Plant Anatomy & Embryology, Plant Physiology and Biochemistry**

Suggested Laboratory Exercises:

1. Study of different types of chromosomes
2. Preparation of karyograms.
3. Study of different stages of mitotic cell division in suitable material.
4. Study of meiotic cell division.
5. Linear differentiation of chromosomes through banding techniques such as G-banding, C-banding and Q-banding.
6. Application of colchicines in genetics.
7. Studying pea plant as tool for investigating Laws of Inheritance.
8. Demonstration of Mendel's Law of segregation.
9. Demonstration of Mendel's Law of Independent Assortment.
10. Studying deviations from Mendel's laws and applying statistics.
11. Studying *Drosophila* as model organism.
12. Effect of chemicals on mutation.
13. Effect of radiations on mutation.
14. Isolation of DNA from different sources.
15. Study of cell structure from onion leaf peels; demonstration of staining and mounting methods.
16. Comparative study of cell structure in onion cells, *Hydrilla* and *spirogyra.*
17. Study of cyclosis in *Tradescantia* staminal hairs.
18. To study the permeability of plasma membrane using different concentrations of organic solvents.
19. To study the effect of temperature on permeability of plasma membrane.
20. To prepare the standard curve of protein and determine the protein content in unknown samples.
21. Separation of chloroplast pigments by solvent method.
22. Determining the osmotic potential of vacuolar sap by plasmolytic method.
23. Determining the water potential of any tuber.
24. Separation of amino acids in a mixture by paper chromatography and their identification by comparison with standards.

25. Comparison of the rate of respiration of various plant parts
26. Protein, carbohydrate estimation
27. Estimation of Nitrogenase activity.
28. Acid and alkaline acid phosphatase activity
29. Isolation and identification of Rhizobium from leguminous plants.
30. Separation of amino acid through paper and column chromatography.

THIRD SEMESTER

Course Code	Title of the Course
34631	**Microbiology and Plant Pathology**

Objectives of the Course:

- To study microorganisms and scope of microbiology.
- To study about plant pathology and maintaining plant health.

Possible Outcomes of the Course:

- The course will give a detailed introduction of microorganisms and their classification.
- The course will make the learners understanding about which factor is lying behind the plant diseases and how to overcome that.

Block-1: Scope of Microbiology

Unit-1: Introduction to Microbiology – Scope of Microbiology – Evolution into science – Characterization of microorganisms.

Unit-2: Classification of microorganisms – Archea and bacteria – Characteristics of bacteria - Morphology – Ultrastructure.

Unit-3: Nutrition – Growth – Reproduction- Bacterial culture and culture characteristics – Economic importance of bacteria

Block-2: Virus and Mycoplasmas

Unit-4: Virology – General features – Classification of viruses – Characteristics – Ultrastructure

Unit-5: Virus- Isolation – Purification – Chemical nature – Replication – Transmission – Virions.

Unit-6: Prions – Phytoplasma (including mycoplasma).

Unit-7: Microbial products – Antibiotics – Enzymes – Human diseases caused by bacteria and viruses.

Block-3: Plant Pathology

Unit-8: Introduction to Plant Pathology – History - Causal agents responsible for plant diseases.

Unit-9: Types of plant diseases – Methods of studying plant diseases – Koch's postulates – Symptoms of plant diseases.

Unit-10: Etiology - Plant disease epidemics - Plant disease forecasting – Disease triangle – Disease cycle.

Block-4: Host-Pathogen Interactions and Plant Diseases:

Unit-11: Host-pathogen interactions – Defense mechanisms in plants.

Unit-12: Control measures – Cultural practices – Chemical control – Biological control - Integrated plant disease management.

Unit-13: Plant diseases- Tobacco mosaic virus – Bunchy top of banana –Blast and sheath blight of paddy – Citrus canker – Red rot of sugarcane – Downey mildew of grapes

Unit-14: Plant diseases – Late blight of potato – Leaf spot diseases of groundnut - Anthracnose of mango – Wilt of cotton – Rust of wheat.

Reference Books:

1. P. D. Sharma, 2012, Microbiology and Plant Pathology, 3rd Edition, Rastogi Publications, ISBN: 97881-7133-794-5.
2. Michael Pelczar, ECS Chan, R. Krieg, 2001, Microbiology, 5th Edition, Mcgraw Hill Education, ISBN: 074623206.
3. Allan Granoff, Robert G. Webster, 1999, Encyclopedia of Virology, 2nd Edition, Elsevier. ISBN: 0122270304.
4. H. C. Dube, 2007, A text Book of Fungi, Bacteria and Viruses, 3rd edition, Agrobios India, ISBN: 8188826383.
5. A. Bohra and A. Mishra, 2011, Plant Pathology - Disease and Management. AgroBios, Jodhpur, ISBN: 817754246X.
6. N. G. Ravi chandra, 2013, Fundamentals of Plant Pathology, Phi Learning, ISBN: 812034703X.
7. George N. Agrios, 2004, Plant Pathology, Elsevier, ISBN: 0120445654.

Course Code	Title of the Course
34632	Ecology, Biodiversity Conservation and Economic Botany

Course Objective:

To introduce various concepts in Ecology.

To introduce various components of biogeography

To create awareness on the biodiversity and importance of its conservation. To know about intellectual property rights.

To know about economically important plants.

Possible Outcomes of the Course:

- The course will give an introduction about ecosystem ecology and population ecology.
- The course will make the learners understanding about biodiversity and the necessity to conserve them.
- The course will introduce intellectual property rights and legal protection towards it.
- The course will make impart of knowledge about the economically important plants.

Block-1: Ecology:

Unit-1: Ecosystem Ecology- concept and dynamics – Abiotic and biotic components, energy input in ecosystem, Biomass, primary and secondary production.

Unit-2: Concept of food chain and food web – community organization – Concept of habitat, functional role and niche – ecotone – edge effect – ecological succession.

Unit-3: Population biology- Basic concepts –Gause's principle, survivorship curves – self- regulating mechanisms.

Unit-4: Species interaction - evolution of cooperation, inter-specific competition, competition coexistence- Negative interaction- predation, herbivory, parasitism - Positive interaction - commensalisms and mutualism.

Block-2: Biodiversity Conservation:

Unit-5: Introduction to biodiversity- Types of biodiversity, Biodiversity concepts, Centres of diversity, Agro biodiversity, Values and uses of biodiversity, Loss of biodiversity.

Unit-6: Phytogeographic zones, Vegetation types of India and Tamilnadu, Endemism, Red listed plants, Red Data Book, Threatened plants and animals of India.

Unit-7: Biodiversity act of India 2002 and 2004. General overview of plant conservation, Conservation of biodiversity - Wildlife Sanctuaries, National parks and Biosphere Reserves, Hotspot biodiversity areas in India- Sustainable use of plant genetic resources, Biotechnology assisted plant conservation (*in situ* and *ex situ* conservation).

Block-3: Intellectual Property Rights:

Unit-8: General Agreement on Trade and Tariff (GATT) and World Trade Organization, Establishment and functions of GATT and WTO, Physical and Intellectual Property.

Unit-9: Different types of intellectual property rights (IPR) - Patents, Trade mark, Trade secret and Copy right.

Unit-10: Plant biotechnological examples of patents, trademark, trade secret and copyright. Plant breeder's rights.

Unit-11: Flavr Savr™ tomato as a model case for GM food, Case studies on patents (Basmati rice, Neem and Turmeric,), General guidelines for research in transgenic plants.

Block-4: Economic Botany:

Unit-12: General account on economic botany Origin and History, Botanical description, Cultivation and uses of Spices and Condiments: Ginger, Pepper, Cardamom, Clove, Nut- Meg, Chilly, Coriandrum, Turmeric.

Unit-13: Origin and History, Botanical description, Harvesting, Extraction and uses of Fatty oils and Vegetable Fats: Sun flower, Soya bean, Peanut, Palm Oil, Coconut and Gingelly. Fibers and Timber: Cotton, Jute, Sun hemp, Teak, Rosewood, Ebony, Sal and Mahogany.

Unit-14: Ethnobotany -Origin and History, Botanical description, Cultivation, Processing and uses of - Medicinal Plants: Rauvolfia, Aconitum, Jatamansi, Sathavari, Goggul, Basil, Saraca and Neem.

References Books:

1. James P. Kimmins, 2003, Forest Ecology 3rd edition Benjamin Cummings Publisher. ISBN: 0130662585.
2. Peter Stiling, 2001, Ecology – Theories and applications ISBN: 013091102X.
3. Jessica Gurevitch, 2006, The Ecology of Plants Sinauer Associates; 2 nd edition ISBN: 0878932941.
4. D.L. Hawskworth, 2009, Methods and Practice in Biodiversity Conservation,

Springer, ISBN: 9789048138487.

5. Biber-Klemm and T. Cottier, 2006, Rights to plant genetic resources and traditional knowledge: Basic issues and Prespectives, Cabi Publication, ISBN: 9780851990330.

6. Sammbamurthy, 2008,A Textbook of Modern Economic Botany, 1st edition, CAS publishers & Distributors Pvt, Ltd, ISBN: 8123906293.

7. Ashwin Dutt, 2008, Economic Botany, 1st edition, Aahyayan Publishers & Distributors, ISBN: 8184350694.

8. Gary W. Barrett, Murray Barrick and Eugene Odum, 2005, Fundamental of Ecology, Cengage Learning, ISBN: 9788131500200.

Course Code	Title of the Course
34633	Algal Technology and Mushroom Technology

Objectives:

- To give introduction about values of algae.
- To understand about micro and macro algal distribution, cultivation, and their economic importance.
- To reveal the importance and cultivation methods of mushroom.

Possible Outcomes of the course:

- The course will give a clear picture on distribution, availability and utilization of various kinds of algae belongs to both fresh water and marine habitats.
- The course will train the students to promote mass cultivation of algae and improve the livelihood of the fishermen community through providing alternative employment.
- The course will make the learners skilled in cultivation, harvesting and processing of mushroom.

Block-1: Algal Technology:

Unit-1: Economic importance of algae: Fresh water and marine algae – Macro and Micro algae – Occurrence – distribution - Cultivation – Importance of cultivation.

Unit-2: Mass cultivation techniques of microalgae- Upstream and downstream processes of algal cultivation - Spirulina, Dunaliella, Hematococcus and Botryococcus.

Unit-3: Single cell protein – bioactive compounds, industrial enzymes, biofuel and other bioproducts from algae.

Block-2: Micro and Macro Algae:

Unit-4:Micro algae used as biofertilizers – nitrogen fixing forms – free living and symbiotic nitrogen fixers – Azolla – Mass cultivation of blue green algae in field - Importance and selection of carrier materials – Immobilization technique.

Unit-5: Mass cultivation of macro algae: rope cultivation – culturing in the laboratory – Applications of seaweeds in biotechnology.

Unit-6: Seaweed liquid fertilizers preparation and their potential in agriculture and horticulture.

Unit-7: Genetics of algae – *nif* genes – strain improvement – transformation – protoplast fusion technique for macro algae.

Block-3: Mushroom Technology:

Unit-8: Introduction to mushroom cultivation – History – scope of edible

Mushroom – Types of edible mushroom available in India – Medicinal and other uses - Poisonous mushroom.

Unit-9: Pure culture – preparation of medium (PDA and Oatmeal Agar medium) Sterilization – preparation of test tube slants.

Unit-10: Spawn preparation: Spwan substrate, Mother spawn in saline bottle – Inoculation, incubation, storage and transportation of spawn – Quality of spawn and contaminants.

Unit-11: Preparation of compost and cultivation of white button mushroom (*Agaricus bisporus*)- Cultivation of paddy straw mushroom (*Volvariella volvacea*) and oyster mushroom (*Pleurotus spp.*) - Low cost mushroom farm design of production.

Block-4: Storage and Values of Mushroom:

Unit-12: -Factor affecting mushroom cultivation (Temperature, pH, air and water management) - Insects and pest attacking mushroom – fungal, bacterial, viral diseases.

Unit-13: Packing and preservation techniques for mushroom - Storage -short-term storages, long term storages, drying, storages in salt solution,

Unit-14: Nutrition- nutritive value – amino acids, mineral elements – carbohydrates, crude fiber – vitamins-Cost benefit ratio – Marketing in India and abroad, export value.

Reference Books:

1. Faizal, B. and Yusuf, C. 2016. Algal biotechnology: Products and processes. Springer. ISBN: 3319123335.
2. Sharma, O.P, 2011. Algae. McGraw Hill Education (India) Private Limited. ISBN: 0070681945.
3. Demirbas, 2010, Algae Energy, 1st Edition, Newnes Publisher, ISBN: 1849960496
4. Pathak. V. N, 2011. Mushroom Production and Processing Technology. 1st Edition. Agrobios (India). ISBN: 8177540068.
5. Suman, B.C, Sharma, V.P, 2007. Mushroom Cultivation in India. Daya Publishing House, ISBN: 817035479X.

Course Code	Title of the Course
34634	**Practical – Lab III: Microbiology & Plant Pathology, Ecology, Biodiversity Conservation, Economic Botany, Algal Technology and Mushroom Technology**

Suggested Laboratory Exercises:

1. Gram staining of bacteria.
2. Sterilization methods, preparation of media and stains.
3. Symptomology of some diseased specimens: White rust, downy mildew, powdery smuts, ergot, groundnut leaf spot, red rot of sugarcane, wilts, paddy blast, bacterial blight of paddy, angular leaf spot of cotton, tobacco mosaic, little leaf of brinjal, seasame phyllody, mango malformation (based on availability).
4. Preparation of different media for the isolation and culture of fungi from soil and diseased materials
5. Isolation of bacteria from diseased plant specimen.
6. Collection and study of the crop diseases from the local and out station fields.
7. Demonstration of the production of cell wall degrading enzymes.
8. Demonstration of the production of mycotoxins.
9. Culture and study of some common plant pathogenic fungi.
11. Study of minimal size of the quadrat by Species- Area Curve method for studying the forest and grassland vegetation.
12. To determine minimal number of quardats by Species –Area Curve method in forest and grassland.
13. Sampling of the grassland vegetation by quadrat method for determining the density, frequency and basal cover of different species.
14. To determine diversity indices (Shannon-Wiener, concentration of dominance, species richness, equitability and B-diversity) for protected and unprotected grassland stands.
15. To estimate IVI of the species in a woodland using point centred quarter method.
16. To determine gross and net phytoplankton productivity by light and dark bottle method.
17. To determine soil moisture content, porosity and bulk density of soils collected for varying depths at different locations.
18. To determine the water holding capacity of soils collected from different locations.
19. To determine percent organic carbon and organic matter in the soils of cropland, grassland and forest.

20. To estimate the dissolved oxygen content in fresh waters by azide modification of Winkler's method.
21. To estimate rate of carbon dioxide evolution from different soils using soda lime or alkali absorption method.
22. Isolation and cultivation of fresh and marine water algae.
23. Cultivation of Spirulina, Azola.
24. Immobilization of algae and use of algae as biocarrier.
25. Preparation of seaweed liquid biofertilizers.
26. Survey of mushrooms.
27. Isolation and pure culture of edible mushrooms.
28. Spawn preparation for the growth of mushrooms.
29. Mass cultivation of edible mushrooms.
30. Value added food preparation from mushroom.

FOURTH SEMESTER

Course Code	Title of the Course
34641	**Plant Molecular Biology**

Objectives of the Course:

- To study about molecular aspects of plants.
- To study about manipulation at molecular level for the strain improvement of the plants.
- To study about molecular pharming.

Possible Outcomes of the Course:

- The course will give knowledge about plant genome organization.
- The course will make the learners understanding about various methods of molecular manipulation.
- The course will make the leaners understanding about the production of transgenic plants and molecular pharming.

Block-1: Plant Genome Organization:

Unit-1: Plant genome organization – Nucleus, Chloroplast and Mitochondria, Structural features of a typical plant gene- Chromatin organization in plants.

Unit-2: Nucleus-encoded and chloroplast-encoded genes for chloroplast proteins- Targeting of nuclear encoded cytoplasmic proteins to chloroplast compartments.

Unit-3: Mitochondrial genome and Cytoplasmic male sterility- Seed storage proteins – Classification and functions.

Unit-4: Regulation of gene expression in plant development- Plant hormones- Plant transposons.

Block-2: Plant Genetic Engineering:

Unit-5: Introduction to Plant Genetic Engineering- Tools of genetic engineering- General Methodology.

Unit-6: Selectable markers – Types and their role in plant transformation- Antibiotic sensitivity assay- Reporter genes – Types and role in optimizing transformation- Promoters used in plant vectors.

Unit-7: Plant transformation techniques – Direct (chemical, mechanical and electrical) and Indirect methods (Agrobacterium mediated)-Mechanism of T-DNA

transfer to plants-

Unit-8: Types of Ti-plasmid based vectors (Co integrate and binary vectors) for plant transformation, Agro infection, Symbiotic nitrogen fixation in legumes by Rhizobia.

Block- 3: Transgenic Plants

Unit-9: Plant genetic engineering for herbicide resistance- Abiotic stress tolerance.

Unit-10: Insect pest resistance (Bt and proteinase inhibitor)- Cytoplasmic male-sterility-Virus resistance (Antisense RNA approach, Cross protection Satellite RNA, Ribozymes and Coat protein mediated protection)- delays of fruit ripening and resistance to fungi and bacteria.

Unit-11: Case studies - Golden rice, Flavr Savr®, Chloroplast engineering and Transplastomic plants.

Block- 4: Molecular Markers; Molecular pharming:

Unit-12: Molecular markers – STS, Microsatellites, RAPD, SCAR (Sequence Characterized Amplified Region) and AFLP for genetic diversity.

Unit-13: Molecular pharming – Introduction, Transgenic plant derived products for commercial applications,

Unit-14: Bioremediation through plants. Tagging, mapping and cloning of plant genes.

Reference Books:

1. H. S. Chawla, 2009, Introduction to Plant Biotechnology, 3rd Edition, Oxford and IBH Publishing Co. Pvt. Ltd. ISBN: 978-81-204-1732-8.
2. Peter J. Lea, Richard. C. Leegood, 1999, Plant Biochemistry and Molecular Biology, 2nd Edition, John Wiley and Sons.
3. J. Hammond, P. McGarvey and V. Yusibov (Eds), 2000, Plant Biotechnology-New Products and Applications. Springer-Verlog, ISBN: 978-3-540-66265-5.
4. Maarten J. Chrispeels and David E. Sadava, 2000, Plants, Genes and Agriculture, Jones and Barlett Publishers. ISBN: 0763715967.
5. Adrian Slater, Nigel W. Scott and Mark R. Fowler, 2003, Plant Biotechnology: The Genetic Manipulation of Plants, Oxford University Press.

Course Code	Title of the Course
34642	**Biostatistics, Biophysics and Bioinformatics**

Objectives of the Course:

- To study about basics of statistics and utilization of statistical method in biology.
- To study about physical properties of biomaterials.
- To study about modern tools of bioinfromatics an inter-disciplinary subject to help the biologists in research perspectives.

Possible Outcomes of the Course:

- The course will give knowledge about data collection, processing and interpretation of biological samples through statistical methods.
- The course will make the learners understanding about basic physical property of biological materials.
- The course will give knowledge about modern tools of bioinformatics.

Block-1: Biostatistics:

Unit-1: Data collection and interpretation- Types of population - sample – non probability sampling techniques - random sampling techniques.

Unit-2: Choice of sampling methods-sampling and non-sampling errors-Diagrammatic and graphical representation of data.

Unit-3: Measures of central tendency: Mean - median - mode. Measures of dispersion: Range - mean deviation - standard deviation.

Unit-4: Test of significance: Null hypothesis - alternate hypothesis - confidence interval -level of significance - p value - S.E of mean - S.E of standard deviation - Z test - t test - chi square test.

Block-2: Biophysics

Unit-5: Bioenergetics- Energy and work- Laws of Thermodynamics-Energy transductions in biological systems.

Unit-6: Redox potential, Redox couples, ATP bioenergetics, Order of reactions.

Unit-7: Photobiology: Dual nature of light, characteristics of solar radiation, solar energy.

Unit-8: Efficiency of atoms - Absorption spectra in molecules, energy states, De-excitation.

Block-3: Bioinformatics-Data Retrieval:

Unit-9: Bioinformatics - introduction - biological data bases - nucleotide sequence data

bases, protein sequence data bases, specialized sequence data bases.

Unit-10: Data retrieval and analysis, sequence and retrieval system.

Unit-11: Sequence alignment - sequence similarity searches, amino acid substitution matrices,

Block-4: Data base search; Sequence alignment; Phylogenetic analysis:

Unit-12: Data base searches - FASTA, BLAST - PSI BLAST.

Unit-13: Mutiple sequence alignment – Clustered W:

Unit-14: Phylogenetic analysis, PHYLODRAW- Phylogenetic tree.

Reference Books:

1. Bernard Rosner, 2010, Fundamentals of Biostatistics, 7th Edition, Cengage Learning, Inc, ISBN: 0538733497.
2. Rodney Cotterill, 2014, Biophysics: An Introduction, Wiley India Private Limited, ISBN: 8126551607.
3. Rastogi, 2008, Bioinformatics: Methods and Applications : Genomics, Proteomics and Drug Discovery, 4th eition, PHI Learning Private Limited, New Delhi, ISBN: 8120347854.
4. Pranav Kumar, 2014, Biophysics and Molecular Biology, Patnfinder Publisher, ISBN: 938047315X.
5. R. Perl, 2014, Building Bioinformatics Solutions, 2nd edition, Oxford university, ISBN: 9780199658558.

Course Code	Title of the Course
34643	Horticulture and Plant Tissue Culture

Objectives of the Course:

- To learn about horticulture.
- To acquire the fundamental of plant tissue culture techniques.
- To know about the basic concepts and principles of plant tissue culture.
- To learn about various types of gardening and maintenance of the same.

Possible Outcomes of the Course:

- The study of horticulture gives knowledge about the art, science, technology and business of growing plants.
- The course will make the learners knowing about micro propagation technique towards development of disease-free plants.

Block-1: Horticulture:

Unit-1: Scope of horticulture - relation to agriculture, agronomy and forestry - Divisions of horticulture.

Unit-2: Climate, soil and nutritional needs- Importance of macro and micronutrients,- different types of soil- Sterile soil mixtures (vermiculite, perlite, etc.).

Unit-3: Different types of organic manure's and inorganic fertilizers - Water irrigation; advanced irrigation system such as drip, microtube and sprinkler systems.

Block-2: Biological Components of Horticulture:

Unit-4: Growth and Development- Seed dormancy, viability and germination-Vegetative and reproductive growth of plants.

Unit-5: Native and synthetic hormones and other growth regulators- their importance in horticulture, gardening and landscaping.

Unit-6: Vegetative propagation using stem, leaf and root cuttings- Propagation by division and layering, bulbs, corms, tubers and rhizomes-budding and grafting.

Unit-7: Production of seeds, their certification, storage and germplasm collection.

Block- 3: Gardening:

Unit-8: Outdoor Gardening: Principles and methods of designing outdoor garden - hedges, edges, fences, trees, climbers, rockeries, arches, terrace garden - Lawn making and maintenance.

Unit-9: Water garden - cultivation of water plants- Layout for a model college garden.

Unit-10: Indoor gardening: Foliage plants, flowering plants, hanging basket, Bonsai plants - Training and pruning.

Block-4: Plant Tissue Culture:

Unit-11: Introduction to plant cell and tissue culture- Totipotency- Sterilization techniques- Nutrient media composition and preparation of solid and liquid cultures- Establishment and maintenance of callus and suspension cultures from representative monocot and dicot plants. **Unit-12**: Micropropagation – Introduction, stages and types of explants for commercial propagation- Virus elimination-mmercial mportance and applications of micropropagation.

Unit-13: Plant regeneration-Organogenesis and Somatic embryogenesis. Role of hormones in regeneration- Artificial seeds-Principle and method involved in the production- Somoclonal variations-Significance, mechanism and applications.

Unit-14: Protoplast isolation - Principles and protocols, protoplast culture and fusion- Importance of protoplast fusion and applications- In vitro production of secondary plant products.

Reference Books:

1. Chadha, K. L. 2012. Hand Book of Horticulture. ICAR, New Delhi. ISBN: 89171640065.
2. Simson, S. P., and M. C. Straus 2009. Basics of Horticulture, Oxford Book Company, New Delhi. ISBN: 9380179189
3. Misra, Kumar, K and R. Kumar, 2014. Fundamentals of Horticulture, Biotech, New Delhi. ISBN: 9380179189.
4. S. S. Bhojwani and M. K. Razdan, 2004, Plant Tissue Culture: Theory and Practice, Elsevier, ISBN: 0444-816232.
5. O. L. Gamborg and G. C. Philips, 2013, Plant Cell, Tissue and Organ Culture, Springer. ISBN: 9783642489747.
6. H. S. Chawla, 2009, Introduction to Plant Biotechnology, 3rd Edition, Oxford and IBH Publishing Co. Pvt. Ltd. ISBN: 9788120417328.

Course Code	Title of the Course
34644	**Practical - Lab IV: Plant Molecular Biology, Biostatistics, Biophysics and Bioinformatics, Horticulture and Plant Tissue Culture.**

Suggested Laboratory Exercises:

1. Isolation of plant genomic DNA.
2. Isolation of total RNA.
3. Isolation of plasmid DNA from bacteria.
4. Quantification of DNA.
5. Examples of positive and negative control of gene expression.
6. Restriction and modification of DNA by using restriction enzymes and ligases.
7. Cloning vectors - pBR322, pUC18 and Col E1.
8. Biology and molecular basis of *Agrobacterium* mediated plant transformation and its applications.
9. Gene transfer methods – Biolistics ®, PEG and Electroporation.
10. Genetic Markers – RFLP and ISSR.
11. Blotting techniques: Southern, Northern and Western blotting.
12. PCR- Types of PCR- DNA foot printing, finger printing.
13. Genetically Engineered Foods.
14. Sampling of biological data.
15. Measures of central tendency.
16. Test of significance- Chi square, T-test
17. FASTA, BLAST - PSI BLAST.
18. Clustered W, PHYLODRAW
19. Sterilization of Plant Tissue Culture Media/Glassware with the help of autoclave and hot air oven.
20. Media components and composition of important culture media (MS medium).
21. Micropropagation of given plant materials – shoot and root formation.
22. Plant Growth Regulators – IAA, IBA, NAA, GA_3, 2, 4-D.
23. Somatic embryogenesis – Embryo development.
24. Another culture, pollen culture, ovule and ovary culture.
25. Cryopreservation technique.
26. Importance of macro and micro nutrients in horticulture.

27. Types of irrigation methods – drip, microtube and sprinkler systems.
28. Seed dormancy.
29. Seed viability test by Tetrazolium chloride.
30. Role of growth hormones on horticultural propagating plant.
31. Propagation methods – Layering, budding and grafting.
32. Bonsai plants.
