



**B. Sc., BOTANY**  
**SYLLABUS**  
**(WITH EFFECTIVE FROM 2021)**

**B. Sc. BOTANY PROGRAMME – Course Structure under CBCS Pattern**

(For the candidates admitted from the academic year 2021 onwards)

Sl. No	Sem	Paper	Hrs/Week	Credit	Exam Hrs.	Marks		
						Internal	External	Total
1	I	Part - I	6	3	3	25	75	100
2	I	Part - II	6	3	3	25	75	100
3	I	CCI - I – Plant Diversity – I (Algae, Fungi and Lichen)	6	5	3	25	75	100
	I	Allied Paper – I ( Botany for Zoology Students)	3		3	25	75	100
	I	Allied Practical – II * ( Botany for Zoology Students)	2					
4	I	Environmental Studies	2	2	3	25	75	100
5	II	Part - I	6	3	3	25	75	100
6	II	Part - II	6	3	3	25	75	100
7	II	CC -II- Plant Diversity – II (Bryophytes, Pteridophytes, Gymnosperms and Paleobotany)	6	5	3	25	75	100
8	II	CC -III - Practical - I* - Paper – I & II	3	4	3	40	60	100
9	II	Allied Paper – I ( Bot for Zoology Students)	3	5	3	25	75	100
10	II	Allied Practical – II * ( Bot for Zoology Students)	2	5		40	60	100
11	II	Value Education	2	2	3	25	75	100
12	II	Soft Skill Paper – I	2	4	3	25	75	100
13	III	Part - I	6	3	3	25	75	100
14	III	Part - II	6	3	3	25	75	100
15	III	CC IV - Cytology, Anatomy and Embryology	5	4	3	25	75	100
	III	Allied Paper – III*(Bot for Chemistry Students)	3					
	III	Allied Practical – IV* (Bot for Chemistry Students)	3					
16	III	Non Major Elective Paper – I Pharmacognosy( Botany Students)	7	5	3	25	75	100
17	IV	Part - I	6	3	3	25	75	100
18	IV	Part - II	6	3	3	25	75	100
19	IV	CC VI - Genetics, Plant breeding and Evolution	5	4	3	25	75	100
20	IV	CC V - Major Practical – II*	3	4	3	40	60	100
21	IV	Allied Paper – III* (Bot for Chemistry Students)	3	5	3	25	75	100
22	IV	Allied Practical – IV* (Bot for Chemistry Students)	3	5	3	40	60	100
23	IV	Soft Skill Paper – II	4	4	3	25	75	100
24	V	Major Paper – VII - Morphology and Taxonomy of Angiosperms	4	4	3	25	75	100
25	V	CC VIII - Plant Ecology and Biostatistics	4	4	3	25	75	100
26	V	CC IX – Microbiology and Plant Pathology	5	4	3	25	75	100
	V	Major Practical – III*	3					
	V	Major Practical – IV*	3					
27	V	Elective Paper – I –Seed and Nursery Technology	5	5	3	25	75	100
	V	Elective Paper – I – Mushroom Technology	5	5	3	25	75	100
	V	Elective Paper – I – Applied Algalogy	5	5	3	25	75	100
28	V	Non Major Elective Paper – II –Forestry For Zoology Students	2	2	3	25	75	100
29	V	Soft Skill Paper – III	4	4	3	25	75	100
30	VI	Major Paper – X – Horticulture and Gardening	5	5	3	25	75	100
31	VI	Major Paper – XI- Plant Physiology, Biochemistry and Biophysics	5	5	3	25	75	100
32	VI	Major Paper – XII -Plant Biotechnology and Tissue culture	4	4	3	25	75	100
33	VI	Major Practical – III*	3	4	3	40	60	100
34	VI	Major Practical – IV*	3	4	3	40	60	100
35	VI	Elective Paper – II- Nanobiotechnology	5	5	3	25	75	100
	VI	Elective Paper – II- Natural Products and Human Welfare	5	5	3	25	75	100
	VI	Elective Paper - III - Plant Tissue Culture	5	5	3	25	75	100
36	VI	Elective Paper - III-Biotechniques	4	4	3	25	75	100
	VI	Elective Paper - III - Organic Farming	4	4	3	25	75	100
	VI	Elective Paper - III - Biofertilizers and Biopesticide	4	4	3	25	75	100
37	VI	Gender Studies	1	1	3	25	75	100
		Extension Activities		1				
			180	140				
		* Exams will be held at the end of even semester						3700

<b>Program outcome:</b>
1. Students can grasp the knowledge on diversity and their role in environment. They can understand internal organization of cells, tissues and functions of life forms.
2. Students can also acquire knowledge on the applied sciences like horticulture and gardening and microbes.
3. Students can pursue either an academic career in institutions as lecturers and professors or a scientific career in various scientific positions such as Plant Scientists, Weed Scientists etc.
4. They can also go and work as researchers and as administrators.
5. They have also the option in Botanical Survey of India and other Government departments by competitive examinations such as UPSC, TNPSC etc.
<b>Program Specific Outcome:</b>
1. Students will have the capability to demonstrate proficiency in the experimental techniques and methods of analysis appropriate for botany.
2. Students will be able to explain how organisms function at that level of the gene, genome, cell, tissue, organ and organ –system. Drawing upon this knowledge, they will be able to give specific examples of the physiological adaptations, development, reproduction and behavior of different forms of life.
3. Students will be able to identify the major groups of organisms with an emphasis on plants and be able to classify them within a phylogenetic framework. Students will be able to compare and contrast the characteristics of plants, algae and fungi that differentiate them from each other and from other forms of life.
4. Students will have excellent research skills (field, laboratory, plant growth facilities and library).
5. Students can be able to know Communications skills to discuss and analyze problems using oral and written communication skills.
6. Students will acquire the knowledge about the cultivation of medicinal and aromatic plants

## Semester I

Course Code: 21UBT1	CORE COURSE - I
PLANT DIVERSITY - I (Algae, Fungi and Lichen)	Syllabus version 2020 - 2021

**Objectives:**

1. To understand the salient features of Algae and Fungi
2. To study the structure and reproduction of various genera mentioned in the syllabus.
3. To know the economic utility of organisms.

**Course specific outcome:**

1. Students studied about Ultra - structure of Prokaryotic and Eukaryotic cells and their composition.
2. They understood the general features distribution and mode of nutrition of fungi.
3. They understood about thallus organizations, vegetative and sexual reproduction.
4. They understood the importance lichen as an indicator of pollution.
5. Imparting knowledge on economic values of algae.

**UNIT - I : GENERAL FEATURES AND ECONOMIC IMPORTANCE OF ALGAE**

Introduction - General Characters of algae - Cell structure of Prokaryotic and eukaryotic cell. Habit and Habitat - Range of thallus organization (Unicellular forms, Coccoid forms, Colonial forms, Palmelloid forms and Filamentous forms) - Pigmentation - Classification of algae by Smith (1955) - Methods in Reproduction: Vegetative (Frgamentation and Hormogone) Asexual (Zoospore, Aplanospore, Akinetes) and Sexual (Isogamous, Anisogamous, Oogamous) - Economic uses - Industry (Agar-agar, Algin, Carrageenin, Diatomite), Agriculture (Nitrogen fixation, Land reclamation, Manurial importance of seaweeds).

**UNIT - II: STRUCTURE AND LIFE CYCLE OF ALGAL SPECIES**

Salient features of the major groups with reference to the structure, reproduction and life cycle of the types given below (excluding developmental studies), Myxophyceae - *Oscillatoria*, *Nostac*; Chlorophyceae - *Oedogonium*, *Ulva*; Phaeophyceae - *Sargassum*; Rhodophyceae - *Polysiphonia*.

**UNIT - III: GENERAL FEATURES AND ECONOMIC IMPORTANCE OF FUNGI**

Introduction - General characters - Occurrence and distribution - Hypha - Modifications of hypha (Appressoria, Rhizomorph, Haustoria) - Nutrition of fungi - Classification of Fungi by Alexopoulos and Mims- Structure of fungal cell - Economic uses - Industry (Production of alcohol, enzymes, organic acids, hormones, making bread), Agriculture, Medicine and Food.

**UNIT - IV: STRUCTURE AND LIFE CYCLE OF FUNGAL SPECIES**

Salient features of the major groups with reference to the structure, reproduction and life cycle of the following types (excluding developmental studies), Ascomycotina - *Saccharomyces*, *Peziza*; Basidiomycotina - *Puccinia*, *Polyporus*; Deuteromycotina - *Cercospora*.

**UNIT - V: TYPES, STRUCTURE AND REPRODUCTION OF LICHENS**

Introduction - Common features - Occurrence and distribution - Classification - Types, structure External and internal structure of Crustose, Foliose, Fruticose lichens - Reproduction -Vegetative and sexual (with reference to Usnea)- Economic uses - Ecological importance, Food, Medicine and chemical uses.

<b>Text Book:</b>
1. Pandey, BP. 2005. Simplified course in Botany, S. Chand and Company Ltd., New Delhi.
<b>References:</b>
2. Sharma, OP. 1992. Text Book of Algae. Tata Mc Graw Hill, New Delhi.
3. Gangulee, HC. & Kar, AK.1989. College Botany, Vol-II, Books & Allied Pvt. Ltd., Calcutta.
4. Singh V, Pande PC & Jain OK. A text book of Botany, Rastogi Publications, Meerut.
5. Smith, GM. 1955. Cryptogamic Botany Vol-1&II, McGraw Hill, New York.
6. Hale, ME Jr. 1983. The biology of Lichens, New Age International publishers, New Delhi.
<b>Related online contents:</b>
1. <a href="https://www.schandpublishing.com/books/higher-education/commerce-management/public-finance/9789352710805/#.Wwz_pUiFPIU">https://www.schandpublishing.com/books/higher-education/commerce-management/public-finance/9789352710805/#.Wwz_pUiFPIU</a>
2. <a href="https://www.abebooks.com/book-search/title/introduction-to-the-algae-structure-and-reproduction/">https://www.abebooks.com/book-search/title/introduction-to-the-algae-structure-and-reproduction/</a>

<b>Mapping with programme outcomes</b>					
<b>COs</b>	<b>P01</b>	<b>P02</b>	<b>P03</b>	<b>P04</b>	<b>P05</b>
<b>C01</b>	S	S	S	M	S
<b>C02</b>	M	S	S	S	M
<b>C03</b>	S	S	M	S	S
<b>C04</b>	S	S	S	S	S
<b>C05</b>	S	S	S	S	M

\*S- STRONG, M- MEDIUM, L- LOW

## Semester II

Course Code: 21UBT3	CORE COURSE - III
PLANT DIVERSITY - II (Bryophytes, Pteridophytes, Gymnosperms and Paleobotany)	Syllabus version 2020 - 2021

<b>Objectives:</b>
1.To study the salient features of plants belonging to Bryophytes, Pteridophytes and Gymnosperms.
2.To study the fossilization process and formation of different types of fossils.
<b>Course specific outcome:</b>
1. Students understood the general features distribution and economic importance of Bryophytes, Pteridophytes and Gymnosperms.
2. They understood about external, internal and development of reproductive structures in Bryophytes, Pteridophytes and Gymnosperms.
3. Students understood the evolutionary aspects of fossils found in Pteridophytes and Gymnosperms.
4. Understanding fossils and their values in evolution study
5. Getting knowledge on Process of fossilization.

**UNIT I: STRUCTURE AND LIFECYCLE OF BRYOPHYTES**

General characteristics. Classification [Rothmaler, 1951], Morphological, anatomical and reproductive characters of major classes. Economical importance of Bryophytes. Ecology of Bryophytes. Detailed study of the following genera: occurrence, distribution, common species, morphology, anatomy and reproduction of, *Marchantia*, *Anthoceros* and *Funaria*.

**UNIT II: CLASSIFICATION AND IMPORTANCE OF PTERIDOPHYTES**

General characteristics: Classification [ K. R. Sporne ]. Salient features of major classes. Stellar evolution and economical importance of Pteridophytes.

**UNIT III LIFECYCLE OF PTERIDOPHYTES**

Occurrence, distribution, common species, morphology, anatomy and reproduction of *Lycopodium*, *Selaginella* and *Marsilea*.

**UNIT IV: STRUCTURE AND REPRODUCTION OF GYMNOSPERMS**

General characteristics, Classification of Gymnosperms .[ K. R. Sporne]. General characteristics of major classes. Economical Importance. Morphology , Anatomy and Reproduction of *Cycas* , *Pinus* and *Gnetum*.

**UNIT V: PALEOBOTANY**

Importance of Paleobotany. Geological Time scale. Process of fossilization, types of fossilization. Brief study of the following fossil plants: Rhynia, Lepidocarpon, Lepidodendron, Calamites, Calamostachys and Williamsonia.

<b>Text Books:</b>
1. Vasishta PC, Sinha AK & Anilkumar. 2005. Botany for degree students, Gymnosperms. S Chand And Company Ltd., New Delhi.
2. Pandey, BP. 1998. A text book of Botany Vol. II. S. Chand & Co. Ltd. New Delhi.

<b>Reference:</b>
1. Rashid, A. 1976. An Introduction to Pteridophytes. Vikas Publishing House, New Delhi.
2. Sporne, KR.1967. The Morphology of Gymnosperms, Hutchinson & Co., London.
3. Sporne, KR.1975. The Morphology of Pteridophytes, Hutchinson & Co., London.
4. Arnold, C.R. 1947 (Rep. 1979). An Introduction to Paleobotany. Mc Graw Hill Publishing Co. Ltd., New Delhi.
<b>Related online contents:</b>
1. <a href="https://www.schandpublishing.com/books/higher-education/commerce-management/public-finance/9789352710805/#.Wwz_pUiFPIU">https://www.schandpublishing.com/books/higher-education/commerce-management/public-finance/9789352710805/#.Wwz_pUiFPIU</a>
2. <a href="https://www.abebooks.com/book-search/title/introduction-to-the-algae-structure-and-reproduction/">https://www.abebooks.com/book-search/title/introduction-to-the-algae-structure-and-reproduction/</a>
3. <a href="https://www.schandpublishing.com/books/higher-education/biology/college-botany-volume-ii/9788121906012/#.W0LrB9IzbiU">https://www.schandpublishing.com/books/higher-education/biology/college-botany-volume-ii/9788121906012/#.W0LrB9IzbiU</a>

Mapping with programme outcomes					
COs	PO1	PO2	PO3	PO4	PO5
C01	S	S	S	S	S
C02	M	S	S	M	M
C03	S	S	S	S	S
C04	M	M	M	S	S
C05	S	M	S	M	M

\*S- STRONG, M- MEDIUM, L- LOW

Semester I & II	
Course Code: 21UBT2P	CORE COURSE - II
PRACTICAL - I	
PLANT DIVERSITY I & II (Algae, Fungi, Lichen, Bryophytes, Pteridophytes, Gymnosperms and Paleobotany)	Syllabus version 2020 - 2021

Course Objectives:
1. To get practical on morphological and anatomical features of algal and fungal, Pteridophytes, and Gymnosperm species
2. To understand the reproductive system of algal and fungal, Pteridophytes, and Gymnosperm species.
Course outcomes:
1. Experiencing in handling specimens and preservation of algae, fungi etc.
2. Imparting knowledge on identification characters of algae and fungi
3. Acquiring knowledge on diversity of pteridophyte and gymnosperms.
4. Understanding symbiotic relationship of algae and fungi in lichen
5. Acquiring knowledge on fossil evidence for studying primitive plants.

**ALGAE**

1. Microscopic observation of algal types and permanent slides included in the syllabus.
2. Section cutting of *Ulva*, *Sargassum* and, *Polysiphonia*
3. Identification of algal types in the algal mixture- oedogonium, Nostoc (only microscopic types).

**FUNGI**

1. Microscopic observation of slides of genera included in the syllabus.
2. Section cutting of, *Polyporus* and apothecium of *Peziza*, *Puccinia - uredo* and *teletospore*

**LICHEN**

1. Observation of different thalli - crustose, foliose, fruticose Lichens.
2. Microscopic observations of permanent slides of *Usnea*.

**BRYOPHYTES**

1. Section cutting of gametophytes of *Marchantia*, *Anthoceros* and *Funaria*.
2. Microscopic observation of slides of genera included in the syllabus.

**PTERIDOPHYTES**

1. A study of the morphology, anatomy of the vegetative and reproductive parts of the sporophyte and gametophytes (wherever available) of living genera included in the syllabus and analysis of their slides.

**GYMNOSPERMS**

2. A study of the morphology, anatomy of the vegetative and reproductive parts of the sporophyte and gametophytes (wherever available) of living genera included in the syllabus and analysis of their slides.

**PALEOBOTANY**

3. Observation of slides of fossil forms given in the syllabus

**One day tour/field visit to collect the living flora included in the syllabus within the Tamil nadu and submitted the specimens with detailed report.**



<b>Mapping with programme outcomes</b>					
<b>COs</b>	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>
<b>C01</b>	M	S	M	S	M
<b>C02</b>	S	M	S	S	M
<b>C03</b>	S	S	S	S	S
<b>C04</b>	S	S	S	M	S
<b>C05</b>	S	M	S	M	S

\*S- STRONG, M- MEDIUM, L- LOW

## Semester III

<b>Course Code: 21UBT4</b>	<b>CORE COURSE - IV</b>
<b>CYTOLOGY, ANATOMY AND EMBRYOLOGY</b>	<b>Syllabus version 2020 - 2021</b>

<b>Objectives:</b>
1. To study the progress made in the field of cell, cell organelles and their functions.
2. To impart knowledge about the various components and characters of wood.
3. To study the basic principles of embryo
<b>Course specific outcome:</b>
1. Students understood meristematic tissue.
2. They differentiated primary and secondary meristem and their function.
3. They understood the structure and function of vascular cambium.
4. They could the difference between dicot and monocot embryo.
5. Students knew the importance of polyembryony.

**UNIT I: ULTRA STRUCTURE OF PLANT CELL AND ITS ORGANELLES**

Ultra structure of Plant cell, cell wall, Plasma membrane, cell organelles – Mitochondria, Chloroplast, Endoplasmic reticulum, Golgi apparatus, Ribosome, Lysosome and Nucleus.

**UNIT II: CELL DIVISION**

Mitosis- Karyokinesis, Cytokinesis. Significance of mitosis. Meiosis- Meiosis I and Meiosis II. Difference between mitosis and meiosis.

**UNIT III: TISSUES**

Meristematic tissues and its types. Root and shoot apex and theories/ its organization. Simple tissues – Parenchyma, Collenchma, Sclerenchyma. Complex Tissues – Xylem and phloem- structure, types and their functions.

**UNIT IV: ANATOMY OF ROOT, STEM AND LEAF**

Primary structure of Root, Stem and leaf of Dicot and monocot. Anomalous secondary growth – *Nyctanthes*, *Boerhaavia*, *Achyranthes* - Types of Stomatal, Nodal anatomy- unilocular, Trilocular and multilocular.

**UNIT V: EMBRYOLOGY**

Microsporangium – microsporogenesis, development of male gametophyte. Megasporangium – megasporogenesis, ovule structure and types, development of female gametophyte [monosporic, bisporic, tetra sporic]. Fertilization. Embryo and Endosperm formation. Types of Endosperm, Apomixis- types and significance. Polyembryony and its significance.

<b>Text Books:</b>
1. Pandey B.P. 2007. Plant Anatomy, S. Chand & Co. De, New Delhi.
2. Bhojwani, SS. & Bhatnagar, SP. 1994. Embryology of Angiosperms, Vikas Publishing House (P) Ltd., New Delhi.
3. HP Brown, AJ Panshin & CC. Farsaith, 1981. Text book of Wood Technology, Mc Graw Hill Inc. New York.
4. Maheshwari, P. 1950. An introduction to the embryology of Angiosperms. McGraw Hill, New York.
<b>References:</b>
1. Cuttler, EG. 1969. Plant Anatomy - Part I Cells & Tissue. Edward Arnold Ltd., London.
2. Esau K. 1985. Plant Anatomy (2nd ed.) Wiley Eastern Ltd. New Delhi.

3. Maheshwari, P. (ed.) 1963. Recent advances in embryology. Intl. Soc. Pl. Morphol, New York.
4. Pullaiah, T., Lakshminarayana, K. and Hanumantha Rao, K. 2001. Text Book of Embryology of Angiosperms, Regency Publications, New Delhi.
5. Raghavan, V. 1979, Experimental embryogenesis of vascular plants.
6. Cambridge University Press, Cambridge. U.K.
<b>Related online contents:</b>
1. <a href="https://www.abebooks.co.uk/servlet/BookDetailsPL?bi=20569837712&amp;searchurl=tn%3Dhandbook%2Bof%2Bthe%2Bbritish%2Bflora%26sortby%3D17%26an%3Dbentham%2Bg&amp;cm_sp=snippet_-_srp1_-_title1">https://www.abebooks.co.uk/servlet/BookDetailsPL?bi=20569837712&amp;searchurl=tn%3Dhandbook%2Bof%2Bthe%2Bbritish%2Bflora%26sortby%3D17%26an%3Dbentham%2Bg&amp;cm_sp=snippet_-_srp1_-_title1</a>
2. <a href="https://trove.nla.gov.au/work/16054012">https://trove.nla.gov.au/work/16054012</a>
3. <a href="https://books.google.co.in/books/about/A_Text_Book_Ofbotany_Plant_Anatomy_and_E.ht ml?id=uMOglvnKUpQC&amp;redir_esc=y">https://books.google.co.in/books/about/A_Text_Book_Ofbotany_Plant_Anatomy_and_E.ht ml?id=uMOglvnKUpQC&amp;redir_esc=y</a>

Mapping with programme outcomes					
COs	P01	P02	P03	P04	P05
C01	S	S	S	S	S
C02	M	S	S	M	M
C03	S	S	S	S	S
C04	M	M	M	S	S
C05	S	M	S	M	M

\*S- STRONG, M- MEDIUM, L- LOW

## Semester III

Course Code: 21UBTN2	NON-MAJOR ELECTIVE - II
PHARMACOGNOY (1 Year) (For Zoology students)	Syllabus version 2020 - 2021

<b>Objectives:</b>
1. To study the different systems of Indian medicines and the bioactive principles.
2. To know the ethnopharmacological importance of medicinal plants.
<b>Course specific outcome:</b>
1. Students knew about history and relevance of herbal drugs in Indian system of medicine.
2. They learned the macroscopic and microscopic characters, chemical constituents, adulterants, therapeutical and pharmaceutical uses of medicinal plants
3. They understood the techniques for drug evaluation (Chemical, Physical and Biological), Phytochemical investigations, standardization and quality control of herbal drugs
4. Students knew the technique of medicinal gardening.
5. Experiencing in Cultivation practices, and preparation and marketing of herbal preparations.

**UNIT I HISTORY OF MEDICINAL AND AROMATIC PLANTS: -**

History of medicinal and aromatic plants - some important terms used in herbal medicine; Herbal industry; WTO Indian scenario- Prospects and constraints, export and import status; AAYUSH - Amchi (Tibetan), Ayurveda, Unani, Siddha and Homoeopathy;

**UNIT II CLASSIFICATION OF HERBAL DRUGS:** Classification of plant drugs, plant parts, chemical constituents, morphological, pharmacological, secondary metabolites on curative properties and uses - *Piper longum*, *Ficus bengalensis*, *Pandanus fascicularis*, *Emblica officinalis*, *Cyperus rotundus*, *Gmelina arborea*, *Oroxylum indicum* (bark and stem).

**UNIT III PREPARATION OF MEDICINES:** Preparation of herbal medicines for primary healthcare and their healing properties. Herbal preparations: powder, fresh juice, poultice, oils, ghee and syrups.

**UNIT IV ACTIVE PRINCIPLES:** Active principles of medicinal plants namely *Ocimum sanctum*, *Withania somnifera*, *Aloe vera*, *Asparagus racemosus*, *Adathodava sica*, *Terminalia arjuna*, *Terminalia bellerica* and *Tinospora cordifolia* (classification, active principle, extraction, preparation and safety and efficacy). Phytochemistry - Preliminary screening of secondary metabolites - Alkaloids, flavanoids, tannins and saponins.

**UNIT V EVALUATION OF CRUDE DRUGS**

organoleptic evaluation; microscopic evaluation - leaf constants, stomata, trichomes or plant hairs, calcium oxalate crystals, quantitative microscopy - *Lycopodium* spore method; chemical evaluation; physical evaluation - moisture content, viscosity, melting point, solubility, optical rotation, refractive index, ash values and extractives, volatile content, foreign organic matter; Biological evaluation; infrared spectroscopy (FTIR), microbiological assay - bacterial testing, mould and yeast testing;

<b>Text Books:</b>
1. James Green, 2000 Herbal Medicine-Maker's Handbook, Crossing Press, U.S.

2. Weiss, Rudolf Fritz 2000 Herbal Medicine, 2nd Edition Thieme Medical Publishers.
3. S. Somasundaram 1997. MaruthuvaThavaraiyal, IlangovanPadhippagam, Palayamkottai.
4. Kokate CK, Purokit AP and Gokahale, 2006. Pharmacognosy, NiraliPrakashan.
5. S. Anbazhakan, Plant systematic and Medical Botany
<b>References:</b>
1. Kumar NC <i>An Introduction to Medical Botany</i> . Emkay Publications, New Delhi.
2. Roberts <i>Pharmacognosy</i> K.M. Vergheese Co. Bombay.
3. Wallis TE <i>Text Book of Pharmacognosy</i> . R.S. Publishers, New Delhi.
4. Shah CS and Qudry JS <i>A text book of Pharmacognosy</i> . BS Shah Prakasm, Ahmedabad.
5. Afol CK and Kapur BM <i>Cultivation and utilization of Medicinal Plants</i> . CSIR, Jammu.
6. Jown SK <i>Glimpses of Ethnobotany</i> Oxford & IBH, New Delhi.
7. Hartman HT and Kester DE <i>Plant propagation - principles and practices</i> . Prentice Hall, New Delhi.
8. Bhattacharjee SK <i>Hand Book of Medicinal Plants</i> . Pointer Publications, Jaipur.
<b>Online Resources:</b>
1. <a href="http://www.gallowglass.org/jadwiga/herbs/preparations.html">http://www.gallowglass.org/jadwiga/herbs/preparations.html</a>
2. <a href="http://shawnacohen.tripod.com/thetribaltraditions/id51.html">http://shawnacohen.tripod.com/thetribaltraditions/id51.html</a>
3. <a href="http://www.vasundharaorissa.org/Research%20Reports/GlobalisationAndMedicinalplantsOfOrissa.pdf">http://www.vasundharaorissa.org/Research%20Reports/GlobalisationAndMedicinalplantsOfOrissa.pdf</a>
4. <a href="http://www.emea.europa.eu/docs/en_GB/document_library/Scientific_guideline/2009/09/WC500003393.pdf">http://www.emea.europa.eu/docs/en_GB/document_library/Scientific_guideline/2009/09/WC500003393.pdf</a>
5. <a href="http://www.bookganga.com/eBooks/Books?AID=5600445540161494332">http://www.bookganga.com/eBooks/Books?AID=5600445540161494332</a>

Mapping with programme outcomes					
COs	PO1	PO2	PO3	PO4	PO5
C01	M	M	S	S	M
C02	S	S	S	S	S
C03	S	S	S	M	M
C04	M	S	S	S	S
C05	S	S	M	S	S

\*S- STRONG, M- MEDIUM, L- LOW

## Semester - IV

<b>Course Code: 21UBT5</b>	<b>CORE COURSE - V</b>
<b>GENETICS, PLANT BREEDING AND EVOLUTION</b>	<b>Syllabus version 2020 - 2021</b>

**Objectives:**

1. To study the progress made in the field of cell, cell organelles and their functions.
2. To understand the principle, the hereditary mechanism, the structure and functions of genetic materials.

**Course specific outcome:**

1. Students studied the cell wall content of plant cell.
2. They understood the ultra-structure of various organelle.
3. Students learnt about Mendelian principles.
4. They knew about linkage and crossing over, mutation theories.
5. They familiarized about Evolution & Emergence of evolutionary thoughts.

**UNIT I: MENDELIAN GENETICS**

Mendelian genetics: Mendel's experiments, monohybrid and Dihybrid cross, Test cross, Back cross, genetic ratios. Mendelian inheritance, Law of Dominance, Law of Segregation and Law of Independent Assortment. Concepts of Gene- Allele, multiple allele, pseudoalleles, complementation tests. Extension of Mendelian Genetics- Codominance, Incomplete dominant, gene interactions, PLEIOTROPY, PENETRANCE, GENE EXPRESSIVITY, PHENOCOPY.

**UNIT II: LINKAGE AND CROSSING OVER**

Linkage and crossing over, Crossing over types. Sex determination in plants. Sex Linkage- Dominant and recessive sex linked genes, holandric genes. Sex linked Diseases- Haemophilia, Colourblindness.. Extra chromosomal inheritance- Cytoplasmic inheritance- kappa particles in Paramecium, Shell coiling in Snail, Plasmid inheritance, Maternal inheritance.

**UNIT III: DIFFERENTIATION IN GENE**

Gene pool, Gene bank, Estimation of allele and genotype frequency of dominant genes, Genetic equilibrium, Polymorphism. Population Genetics: Genetic drift, random drift, Eugenics, Euthenics, Hardy - Weinberg Law and its application.

**UNIT IV: MOLECULAR MAPPING AND MUTATION**

Molecular mapping- Methods, RFLP, Gene mapping, Walking and Jumping of Chromosome. Mutation-Chromosomal Aberration,- and its types, Mutation and its types, Mutagens, Lethal mutation. Loss and Gain of functions by mutation, Somatic mutants

**UNIT V: PRINCIPLES OF PLANT BREEDING**

Principles and importance of plant breeding in green revolution with reference to Wheat, Rice, Sugarcane, Cotton and Maize . Methods of Crop Improvements- Selection,- mass , clonal and pureline, Hybridization, - Heterosis - causes and effects. Ploidy Breeding, Mutation Breeding - Procedure, achievements. Disease Resistance Breeding - nature, causes, methods and its advantages.

**Text Book:**

1. Verma, P.S. & V.K. Agarwal, 2003, Genetics. S. Chand & Co. Ltd., New Delhi.

**References:**

2. Freifelder, D. 1987. Essentials of Molecular Biology, Jones & Bartlett, Boston.

3. Gardner, E.J., Simmons, M.J. & Snustad, D. 1991. Principles of Genetics, John Wiley & Sons Inc., 8th Edn., New York.
4. Sinnott, E.W., Dunn, L.L. & Dobzhansky, T. 1997. Principles of Genetics, Tata Ma Graw Hill Publishing Co., New Delhi.
<b>Related online contents:</b>
1. <a href="https://onlinelibrary.wiley.com/doi/book/10.1002/9781118313718">https://onlinelibrary.wiley.com/doi/book/10.1002/9781118313718</a>
2. <a href="https://www.springer.com/in/book/9783642879302">https://www.springer.com/in/book/9783642879302</a>
3. <a href="https://trove.nla.gov.au/work/16054012?q&amp;sort=holdings+desc&amp;_id=1527503199193&amp;versionId=23683670">https://trove.nla.gov.au/work/16054012?q&amp;sort=holdings+desc&amp;_id=1527503199193&amp;versionId=23683670</a>
4. <a href="https://www.amazon.com/Chromosome-Atlas Flowering...Darlington/dp/B0014B1YJA">https://www.amazon.com/Chromosome-Atlas Flowering...Darlington/dp/B0014B1YJA</a>

Mapping with programme outcomes					
COs	P01	P02	P03	P04	P05
C01	M	S	S	M	S
C02	S	S	S	S	M
C03	S	M	M	S	M
C04	S	S	S	S	S
C05	S	S	M	M	S

\*S- STRONG, M- MEDIUM, L- LOW

## Semester IV

<b>Course Code: 21UBT6P</b>	<b>CORE PAPER - VI</b>
<b>PRACTICAL - II CYTOLOGY, ANATOMY, EMBRYOLOGY, GENETICS AND PLANT BREEDING</b>	<b>Syllabus version 2020 - 2021</b>

<b>Course Objectives:</b>
1. To get practical on morphological and anatomical features of Angiosperms.
2. To identify and classifying angiosperms by morphological features.
3. To understand the cytological features of plant cell.
4. to know the plant breeding techniques.
<b>Course outcomes:</b>
1. Experiencing in handling specimens and preservation of Angiosperms.
2. Imparting knowledge on plant anatomical characters.
3. Acquiring knowledge on Mendel's laws of genetic variations
4. Understanding embryonic development in angiosperms
5. Acquiring knowledge in plant breeding methods.

**ANATOMY**

1. Study of simple and complex tissues by using permanent slide
2. Study of primary structure of Dicot stem, root and leaf
3. Study of primary structure of Monocot stem, root and leaf
4. Normal secondary thickening in Dicot root and stem
5. Anomalous secondary growth in Boerhaavia, Bougainvillea, Nyctanthes
6. Stomatal types: Anomocytic, Anisocytic, Paracytic and Diacytic [peel out from leaf]

**EMBRYOLOGY OF ANGIOSPERMS**

1. Structure of Anther [young and mature from Datura or Cassia flower]
2. Types of ovules: Anotropous, Orthotropous, Circinotropous and Campylotropous
3. Stages in Microsporogenesis and Megasporogenesis [ permanent slides in Onion flower]
4. Structure of Male gametophyte and female gametophyte [permanent slide / photographs]
5. Dissection of embryo, observe the globular and heart shape using Tridax flower
6. Structure of endosperm. Nuclear [coconut], cellular [cucumber seed]

**CYTOLOGY**

1. To observe the plant cell structure with Onion epidermal peel out
2. Study the cell organelles using photographs
3. Starch grains [Potato], INULIN [ Potato], Raphides [Colocasia petiole] and cystolith [Ficus/ Momordica leaf peel out].
4. Study the Polytene and Lampbrush chromosome structure through photograph
5. Identification of different stages of mitosis by using Squash and smear technique using Onion root tip

**GENETICS**

1. Simple problem of Monohybrid and Dihybrid ratios and factor interaction
2. Construction of chromosome map - three point test cross

**PLANT BREEDING**

1. Emasculation technique



2. Bagging
3. Identification of Selection type -mass, clonal and pure line using photographs
4. Grafting - whip grafting, side grafting and approach grafting
5. Layering - simple, compound, air layering

<b>Mapping with programme outcomes</b>					
<b>COs</b>	<b>P01</b>	<b>P02</b>	<b>P03</b>	<b>P04</b>	<b>P05</b>
<b>C01</b>	S	M	S	S	S
<b>C02</b>	S	S	M	S	M
<b>C03</b>	M	S	S	M	S
<b>C04</b>	S	S	S	S	M
<b>C05</b>	S	M	S	M	S

\*S- STRONG, M- MEDIUM, L- LOW

## Semester V

<b>Course Code: 21UBT7</b>	<b>CORE COURSE -VII</b>
<b>MORPHOLOGY AND TAXONOMY OF ANGIOSPERMS</b>	<b>Syllabus version 2020 – 2021</b>

**Objectives:**

1. To observe the variations among plants, especially angiosperms.
2. To understand the way of description of a plant.
3. To study the floral characters with an aim to identify the taxa authentically.

**Course specific outcome:**

1. Students recognized morphological characters of vascular plants.
2. They gained proficiency in the use of keys and identification manuals for identifying any unknown plants to species level.
3. Experiencing in the identifying unknown plant.
4. Imparting knowledge on specific characters of plant families
5. Deep understanding the distribution of plant species different localities

**UNIT I: VEGETATIVE MORPHOLOGY**

Vegetative Morphology – Root- Morphology, types of root and its modification. Stem- aerial and underground. morphology of stem and its modification. Leaf – morphology, types of leaf, phyllotaxy and venation.

**UNIT II: REPRODUCTIVE MORPHOLOGY**

Reproductive morphology – Inflorescence- types – Raceme, Cyme, Mixed and Special. Flower – Arrangement of floral parts, types of aestivation, types of placentation, floral diagram and floral formula. Fruits – types and classification.

**UNIT III: CLASSIFICATION OF ANGIOSPERMS**

Binomial nomenclature, Systems of classification – Bentham and Hooker classification, Linnaeus classification, Engler and Prantl classification. Merits and demerits of natural system of classification. Preparation and advantages of Herbarium. Chemotaxonomy and Numerical Taxonomy.

**UNIT IV: FEATURES OF ANGIOSPERM FAMILIES**

Diagnostic characters and economical importance of the following families –**Polypetalae**- Annonaceae, Brassicaceae, Capparidaceae, Rutaceae, Anacardiaceae, Fabaceae, Moringaceae, Caesalpiniaceae, mimosoideae, Myrtaceae, Cucurbitaceae and Apiaceae.

**UNIT V: FEATURES OF ANGIOSPERM FAMILIES**

Diagnostic characters and economical importance of the following families **Gamopetalae** – Rubiaceae, Asteraceae, Asclepidaceae, Apocynaceae, Solanaceae, Acanthaceae, Verbinaceae and Convolvulaceae. **Monochlamydeae** – Chenopodiaceae, Amaranthaceae and Euphorbiaceae. Monocotyledonae: Lilliaceae and Poaceae. Economical importance of cereals , pulses, vegetables, fruits, timber, oil yielding plants, spices and condiments and ornamental plants any five plants in each.

**Text Books:**

1. Jeffrey, C. 1982. An Introduction to Plant Taxonomy, Cambridge University Press, UK.
2. Pandey, BP. 1999. Taxonomy of Angiosperms, S.Chand& Co. Ltd., New Delhi.
3. Gurcharan Singh, 2004. Plant Systematics: An Integrated Approach, Science Publishers Inc., New Hampshire, USA.

**References:**

1. Clive AS.1989. Plant Taxonomy and Biosystematics, Chapman and Hall Inc. New York.
2. Harborne, JB & Turner, BL. 1984. Plant Chemosystematics, Acad. Press, London.
3. Lawrence, GH. 1955. Taxonomy of Vascular Plants, MacMillan Co., USA.
4. Samuel, BJ & Arlene, EL. 1987. Plant Systematics, Mc Graw Hill Inc. New York.

**Related online contents:**

1. [https://www.abebooks.co.uk/servlet/BookDetailsPL?bi=20569837712&searchurl=tn%3Dhandbook%2Bof%2Bthe%2Bbritish%2Bflora%26sortby%3D17%26an%3Dbentham%2Bg&cm\\_sp=snippet\\_-\\_srp1\\_-\\_title1](https://www.abebooks.co.uk/servlet/BookDetailsPL?bi=20569837712&searchurl=tn%3Dhandbook%2Bof%2Bthe%2Bbritish%2Bflora%26sortby%3D17%26an%3Dbentham%2Bg&cm_sp=snippet_-_srp1_-_title1)
2. <https://trove.nla.gov.au/work/16054012>
3. [https://books.google.co.in/books/about/A\\_Text\\_Book\\_Ofbotany\\_Plant\\_Anatomy\\_and\\_E.html?id=uMOglvnKUpQC&redir\\_esc=y](https://books.google.co.in/books/about/A_Text_Book_Ofbotany_Plant_Anatomy_and_E.html?id=uMOglvnKUpQC&redir_esc=y)

**Mapping with programme outcomes**

COs	PO1	PO2	PO3	PO4	PO5
<b>C01</b>	M	S	M	S	M
<b>C02</b>	S	S	S	S	M
<b>C03</b>	S	S	S	M	S
<b>C04</b>	S	M	M	S	S
<b>C05</b>	M	S	S	S	S

\*S- STRONG, M- MEDIUM, L- LOW

## Semester V

<b>Course Code: 21UBT8</b>	<b>CORE COURSE - VIII</b>
<b>PLANT ECOLOGY AND BIOSTATISTICS</b>	<b>Syllabus version 2020 – 2021</b>

<b>Objectives:</b>
1. To understand the basic concepts of ecosystem and biodiversity.
2. To study the principle of sustainable utilization and management of bioresources.
3. To Construct knowledge about the various applications of Mathematics and Statistics to students.
<b>Course specific outcome:</b>
1. Students understood the ecological relationships between organisms and their Environment
2. Students obtained the knowledge on key concepts in evolutionary biology, the history of life on Earth, and phylogenetic relationships between organisms.
3. They understood the structure/function relationships in organisms.
4. Experiencing in mathematical and statistical problems with fellow class mates as well individually.
5. Improving ability in analyzing information based on mathematical data rather than accumulating memorizing it.

**UNIT I – PRINCIPLES OF ECOLOGY**

Approaches to the study of ecology – Autecology – Synecology – Population, Community. Climatic Factors (Light factor, Temperature factor, Wind factor). Edaphic Factors (Soil, Topography, Minerals).

**UNIT II – STRUCTURE AND FUNCTION OF ECOYSTEM**

Ecosystems - components, Types of Ecosystem – aquatic (Pond), terrestrial (Grass land and Forest)– Food chain, Food web, Ecological pyramid, Primary and Secondary production, Energy flow in Ecosystem, Morphological and Anatomical adaptation of Hydrophytes (Hydrilla), Mesophytes (Hibiscus) and Xerophytes (Cactus, **Nerium**), *Halophytes (Rhizophora)*, *Parasites (Cuscuta) and Epiphytes (Vanda)*. Pollution - Air, water, soil, thermal and radioactive pollution - control measures.

**UNIT III – PRINCIPLES OF PHYTOGEOGRAPHY AND PLANT DISTRIBUTION IN INDIA**

Phytogeography – Principles relating to distribution of plants, age and area hypothesis. Dispersal and migration, concept of Barriers, Continental drift, endemism, plant indicators. Vegetational types of India - Tropical Rain forest, shola and deciduous forest - sand dunes, mangroves and scrub jungle, Phytogeographical regions of India. Remote sensing for vegetation analysis.

**UNIT-IV BASICS OF BIOSTATISTICS**

Statistics : definition, history, applications and limitations : concept of biometry, population and samples. Data collection and tabulation, primary and secondary data, methods of collecting primary data. sources of secondary data, editing of primary and secondary data, rule of tabulation, parts and types of tables and role of tabulation of data. Frequency distribution : classification of data, histogram, frequency polygon, cumulative frequency curves, designs and limitations of graph. Measures of central tendency: arithmetic mean, median, mode: their merits and demerits.

**UNIT-V APPLICATION OF BIOSTATISTICS**

Measures of dispersion : standard deviation, standard error and coefficient of variation: Tests of significance : T-test, X<sup>2</sup> test and Anova. Binomial, Poisson and Normal distribution: Deviation, Properties and applications of normal distribution, Correlation: types, methods: Karl Pearson's coefficient and regression (linear) analysis and their uses.

<b>Text Book:</b>
1. Sharma P.D, 2009. Ecology and Environment, Rastogi Publications, Meerut.
<b>References:</b>
1. Odum, E.P., 1970. Fundamentals of Ecology, 3rd edn, W.B. Saunders Ltd., UK.
2. Melchias G 2001 Biodiversity and Conservation. Science Publishers Inc, NH USA.
3. Krishnamurthy K.V. 2003. An advanced text book on Biodiversity Principle and Practice. Oxford and IBH Publishing Co., New Delhi.
<b>Related online contents:</b>
1. <a href="http://rastogipublications.com/index.php?route=product/product&amp;product_id=216&amp;search=ecology&amp;category_id=20">http://rastogipublications.com/index.php?route=product/product&amp;product_id=216&amp;search=ecology&amp;category_id=20</a>
2. <a href="https://www.schandpublishing.com/books/higher-education/biology/a-textbook-plant-ecologyincluding-ethnobotany-soil-science/9788121905480/#.W0LsiNIzbIU">https://www.schandpublishing.com/books/higher-education/biology/a-textbook-plant-ecologyincluding-ethnobotany-soil-science/9788121905480/#.W0LsiNIzbIU</a>

<b>Mapping with programme outcomes</b>					
<b>COs</b>	<b>P01</b>	<b>P02</b>	<b>P03</b>	<b>P04</b>	<b>P05</b>
<b>C01</b>	S	S	S	M	S
<b>C02</b>	S	M	S	S	M
<b>C03</b>	M	S	M	S	S
<b>C04</b>	S	S	S	M	S
<b>C05</b>	M	S	M	S	S

\*S- STRONG, M- MEDIUM, L- LOW

## Semester V

<b>Course Code: 21UBT9</b>	<b>CORE COURSE - IX</b>
<b>MICROBIOLOGY AND PLANT PATHOLOGY</b>	<b>Syllabus version 2020 - 2021</b>

**Objectives:**

1. To study the different types of micro-organisms and their activities.
2. To understand and exploit their potentialities in agriculture, industry and other environmental aspects.
3. To study the etiology and control of various plant diseases.

**Course specific outcome:**

1. Students learned about classification, characteristics, ultra structure of Prokaryotic and Eukaryotic microbes
2. They applied an appropriate microbiology laboratory techniques, methodologies, instruments and equipment in accordance with current laboratory safety protocol.
3. Students knew about organisms and causal factor responsible for plant diseases & methods of studying plant diseases.
4. They familiarized with some common plant diseases of India
5. Students gained knowledge on Host parasite interaction process

**UNIT I – CLASSIFICATION OF MICROBES**

Microbiology: History and scope. classification of microorganisms – Whittaker's fivekingdom concept – Bergey's manual of systematic bacteriology – outline only-General features of mycoplasma, cyanobacteria, archaeobacteria, actinomycetes, fungi and protozoa.

**UNIT II – STRUCTURE AND GROWTH OF VIRUS AND BACTERIA**

Viruses – structure, classification and multiplication. Bacteria: Morphology, Ultra Structure, Nutrition, Respiration and Multiplication of Bacteria. Recombination of Bacteria - Transformation, Conjugation and Transduction.

**UNIT III – METHODS IN MICROBIOLOGY**

Methods in microbiology: Staining methods (simple, differential and special staining); methods of sterilization (physical and chemical); types of culture media; pure culture methods (streak plate, spread plate and pour plate); bacterial motility; methods for enumeration (direct and indirect); bacterial growth curve.

**UNIT IV – PRINCIPLES OF PATHOLOGY**

Plant Pathology: History and importance of plant pathology. General Symptoms of plant diseases, Identification of plant disease– Koch's postulates. Plant-parasite interactions– Mode of infection, Role of enzymes and toxins in disease development - Methods of Control of Plant disease-Cultural, Chemical and Biological methods. Integrated disease or pest management.

**UNIT V – PLANT DISEASES IN CROP PLANTS**

Plant Diseases – Definition. Study of plant diseases with respect to symptoms, causal organism, disease cycle and their management: Damping of seedlings, Root rot, Late blight of potato, Rust of wheat, Rice – blast disease; Red rot of sugarcane, Little leaf of Brinjal, Citrus – canker; Tikka disease of Groundnut – Root knot disease, Yellow vein mosaic of bhendi.

**Text Books:**

1. Pelczar, J., Chan, ECS & Krieg, R. 1999. Microbiology, Tata McGraw Hill, New Delhi.
2. Sullia, SB & Shantharam, S. 2005. General microbiology. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.

3. Mehrotra R.S., 1994, Plant pathology, Tata Mc Grew publishing company Ltd.
<b>References:</b>
1. Casida, LE.1989. Industrial microbiology, Wiley Eastern, New Delhi.
2. Dubey, RC & Maheshwari, DK. 2004, A text book of microbiology.
3. S. Chand & Company Ltd., New Delhi.
4. Frazier, NC.1974. Food Microbiology, II Edn., Tata McGraw Hill, New Delhi.
5. Martin Alexander. 1978. Introduction to Soil Microbiol, Wiley Eastern, New Delhi.
6. Rangasamy G. 1998. Diseases of crop plants in India. Prentice- Hall of India, New Delhi
7. Harsfall JG & Cowling E B. 1979. Plant Disease, an advanced Treatise. Academic Press, NY.
8. Mukherjee KG and Jayanti Bhasin, 1986. Plant diseases of India. Tata MacGraw-Hill Publishing Company Ltd. New Delhi.
<b>Related online contents:</b>
1. <a href="http://rastogipublications.com/index.php?route=product/product&amp;product_id=69&amp;mp;search=microbiology">http://rastogipublications.com/index.php?route=product/product&amp;product_id=69&amp;mp;search=microbiology</a>
2. <a href="https://www.schandpublishing.com/books/higher-education/biology/a-textbook-microbiology/9788121926201/#.W0LwytIzbiU">https://www.schandpublishing.com/books/higher-education/biology/a-textbook-microbiology/9788121926201/#.W0LwytIzbiU</a>

<b>Mapping with programme outcomes</b>					
<b>COs</b>	<b>P01</b>	<b>P02</b>	<b>P03</b>	<b>P04</b>	<b>P05</b>
<b>C01</b>	S	S	M	S	S
<b>C02</b>	M	S	S	S	S
<b>C03</b>	S	M	S	M	S
<b>C04</b>	S	S	S	M	S
<b>C05</b>	S	M	M	S	M

\*S- STRONG, M- MEDIUM, L- LOW

## Semester - V

<b>Course Code: 21UBTE1A</b>	<b>ELECTIVE COURSE - I</b>
<b>SEED AND NURSERY TECHNOLOGY</b>	<b>Syllabus version 2020 - 2021</b>

<b>Objectives:</b>
1. To prepare students for careers in the forest services.
2. To educate students to provide technical expertise to the establish nurseries.
<b>Course specific outcome:</b>
1. Students learned the forest types and their utilization
2. Students had ability to evaluate human dimensions of sustainable forest management, including the diverse universe of forest stakeholders, perspectives, and policies
3. They developed and implemented well-justified forest management strategies that address a diversity of objectives at spatial scales ranging from stands to the entire planet.
4. Students developed skills on the preparation of nursery bed and techniques.
5. Experiencing in nursery techniques

**UNIT I: INTRODUCTION TO SEED TECHNOLOGY**

Concept of seed technology, Role of seed technology, Goals of seed technology, Seed industry in India, Development of seed programmes.

**UNIT II: SEED PRODUCTION AND SEED PROCESSING**

General principle of seed production, Nucleus and Breeder's seed production, Seed production of cereals, pulses, oil seeds and vegetable crops, Seed processing, drying, cleaning and upgrading seed treatment, packing and handling. Seed storing.

**UNIT III: SEED TESTING AND SEED CERTIFICATION**

Seed testing, Seed sampling, determination of seed purity, seed germination, seed viability, seed Vigour testing. Seed health testing and seed moisture. Seed certification- seed certification standards. Field and seed inspection, seed legislation and seed Law Enforcement.

**UNIT IV: INTRODUCTION TO NURSERY TECHNOLOGY**

Planning and layout of nurseries, media for propagating and growing nursery plants. Care and handling nursery plants. Nutrition management for nursery plants. Pest and disease management of nursery plants. Irrigation management of nursery plants.

**UNIT V: NURSERY TECHNIQUES**

Procurement of polypots, manure, clay and sand. seed bed preparation saving of seeds in polypots and beds. Transplanting, potting, irrigation, weeding and mulching.

<b>Text Books:</b>
1. De Vere Burton L., 2000, Introduction to Forestry Science, Delmar publishers, N Y.
2. J.L. Bowyer, R. Shmulsky and J.G. 2007. Haygreen. Forest Products and Wood Science: An Introduction, Blackwell Publishing Professional.
<b>References:</b>
1. Negi, S.S., 1994, India's Forests, Forestry and Wildlife, Indus Publishing Com., New Delhi.
2. Jha, L.K., 1996. Forestry for rural development, APH Publishing Corporation, New Delhi. GopalswamyIyyangar, 1970. Complete gardening in India, Kalyan Printers, Bangalore.
<b>Related online contents:</b>



1. <https://www.amazon.com/Forest-Products-Science-Rubin-Shmulsky-ebook/dp/B0051BLT8A>

<b>Mapping with programme outcomes</b>					
<b>COs</b>	<b>P01</b>	<b>P02</b>	<b>P03</b>	<b>P04</b>	<b>P05</b>
<b>C01</b>	M	S	S	M	S
<b>C02</b>	S	M	S	M	M
<b>C03</b>	S	S	M	S	S
<b>C04</b>	M	S	S	S	S
<b>C05</b>	S	S	M	S	S

\*S- STRONG, M- MEDIUM, L- LOW

## Semester - V

<b>Course Code: 21UBTE1B</b>	<b>ELECTIVE COURSE - I</b>
<b>MUSHROOM TECHNOLOGY</b>	<b>Syllabus version 2020 – 2021</b>

<b>Objectives:</b>
1. To facilitate self-employment.
2. To know the nutrient value of mushroom.
<b>Course specific outcome:</b>
1. Students knew about nutritional and medicinal value of edible mushrooms & Poisonous Mushrooms
2. They learnt about the Cultivation techniques of White button mushroom and Oyster
3. Mushroom
4. They gained knowledge on the present status of mushroom industry in India.
5. Motivation to be become entrepreneur in mushroom business.

**UNIT I – IMPORTANCE OF MUSHROOMS**

Introduction, History and Scope - Mushroom cultivation in India. Edible and Poisonous Mushrooms - Mushroom morphology: Different parts of a typical mushroom & variations in mushroom morphology. Mushroom Classification Based on occurrence, Natural Habitats, Color of spores. Characters of vegetative and fruit body. Nutritional and medicinal value of mushrooms.

**UNIT II – TECHNIQUES IN MUSHROOM CULTIVATION**

Spawning techniques: Isolation and culture of spores, Preparation of culture media. Developing mother spawn, Facilities required for spawn preparation, Preparation of spawn substrate, preparation of pure culture, media used in raising pure culture, culture maintenance, storage of spawn.

**UNIT III – CULTIVATION OF MUSHROOMS**

Cultivation System and Farm design: Fundamentals of cultivation system- small village unit and larger commercial unit .Cultivation technology of button mushroom (*Agaricusbisporus*), milky mushroom (*Calocybe indica*), oyster mushroom (*Pleurotussajorcaju*) and paddy straw mushroom (*Volvariellavolvcea*).

**UNIT IV – STORAGE TECHNIQUES**

Mushroom farm and the lay out- culture room, harvesting room. Post-harvest and Storage methods - Short term and long term storage methods and marketing Storage and food preparation from mushrooms: Foods/recipes from mushrooms; Mushroom research centers/farms: National level and regional level.

**UNIT V – COMMERCIALIZATION OF EDIBLE MUSHROOMS**

Choice of mushrooms for the small grower; minimum resources needed to start production; Economics of cultivation: Cost economics – Permanent medium scale mushroom farm. capital outlay; retail expectations; profit margins; small business models.

<b>Text Book:</b>
1. Nita Bahl, Handbook on Mushrooms, S.Chand& Co. Ltd.
<b>Reference:</b>
2. Dubey, RC. A text book of biotechnology, S.Chand& Co. Ltd.
3. Alice, D., Muthusamy and Yesuraja, M. (1999). Mushroom Culture. Agricultural College, Research Institute Publications, Madurai.
4. Marimuthu, T. et al . (1991). Oster Mushroom. Department of Plant Pathology. Tamil Nadu Agricultural University, Coimbatore.
5. Nita Bhal. (2000). Handbook on Mushrooms. 2nd ed. Vol. I and II. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
6. Pathak, V. N. and Yadav, N. (1998). Mushroom Production and Processing Technology. Agrobios, Jodhpur.
7. TewariPankaj Kapoor, S. C. (1988). Mushroom Cultivation. Mittal Publication, New Delhi.
8. Tripathi, D. P. (2005). Mushroom Cultivation. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
<b>Related online contents:</b>
1. <a href="https://www.amazon.in/Mushroom-Production-Processing-Technology-IST/dp/8177540068?channel=dyn%7Bifmobile%3Amobile%7D%26placement%3D%7Bplacement%7D%26target%3D%7Btarget%7D%26campaignid%3D%7Bcampaignid%7D&amp;tag=googinremarketing54-21">https://www.amazon.in/Mushroom-Production-Processing-Technology-IST/dp/8177540068?channel=dyn%7Bifmobile%3Amobile%7D%26placement%3D%7Bplacement%7D%26target%3D%7Btarget%7D%26campaignid%3D%7Bcampaignid%7D&amp;tag=googinremarketing54-21</a>

<b>Mapping with programme outcomes</b>					
<b>COs</b>	<b>P01</b>	<b>P02</b>	<b>P03</b>	<b>P04</b>	<b>P05</b>
<b>C01</b>	S	S	M	S	M
<b>C02</b>	M	M	S	S	M
<b>C03</b>	S	S	S	S	S
<b>C04</b>	S	S	S	M	S
<b>C05</b>	S	M	M	S	M

\*S- STRONG, M- MEDIUM, L- LOW

## Semester V

Course Code: 21UBTE1C	ELECTIVE COURSE - I
APPLIED ALGALOGY	Syllabus version 2020 - 2021

<b>Objectives:</b>
1. To facilitate self-employment.
2. To gain the knowledge on the various applied aspects of algae.
<b>Course specific outcome:</b>
1. To understand the utility of algae to human beings.
2. Students understood the role of algae in medicine and food industry.
3. Students acquired the knowledge on the role of algae in the self-employment
4. Understanding importance of algae as indicators of water quality in fresh and marine environment
5. Imparting knowledge on commercial application of seaweed biotechnology

**UNIT I ALGAE AS BIO-FERTILIZER AND GREEN MANURE**

Symbiotic and non symbiotic algae in soil fertility and crop production, role of Anabaena and Nostoc in nitrogen fixation (aerobic and anaerobic); Algae in agriculture (Reclamation of usar soil and algalization)

**UNIT II ALGAE AS NUTRIENT SUPPLEMENT AND IN PHARMACY**

Nutrient supplements of Spirulina, Chlorella, Scenedesmus and Porphyridium; Importance of Botryococcusbraunii and Dunaliella; Value added products from microalgae and processes; Algae in pharmacy – iodine, carrageenan, agar, amino acids, vitamins, enzymes, antibiotics, vermifuge and sterols.

**UNIT III ALGAE AND ITS ROLE IN ASSESSMENT OF WATER QUALITY:**

Algae as indicators of water quality in fresh and marine environment (including algal blooms); Effect of algae in water supplies - taste, odour, filter and screen clogging, slime formation, coloration, corrosion, coagulation, toxicity and parasitic algae; Methods to control algae in water supplies, recreational waters and aquarium.

**UNIT IV CULTIVATION OF ALGAE**

Mass cultivation of algae with examples Spirulina, Chlorella, Dunaliella; Fermentation and its products from algae (methane and ethanol), Cultivation of agarophytes- methodology, requirements, harvest and processing of Porphyra, Eucheuma, Gelidium, Gracilaria and Laminaria.

**UNIT - V ALGAL BIOTECHNOLOGY AND TISSUE CULTURE OF SEaweEDS:**

General information about challenges in algal biotechnology; callus induction, protoplast culture and somatic hybridization; commercial application of seaweed biotechnology. Algal toxins – neurotoxins, hepatotoxins, effect of toxins, mode of action, problems and prospects. Biochemicals from algae – pigments, essential fatty acids, polysaccharides, wax, hydrocarbons, plant growth.

<b>Text Books:</b>
1. Singh, Pande and Jain. 1998.A text book of Botany, Rastogi Publication, Meerut.
2. Venkataraman, et al., 1974, Algae-Form & Function. Today and Tomorrow, Pub. Co.

<b>Reference:</b>
1. Delevoryas, T., 1977, Plant Diversification. Holt, Rinehart & Wintson, New York.
2. Chapman, V.J. & Chapman, D.J. The Algae. ELBS & MacMillan, London
3. Srivastava, H.N., 1999, Fungi. Pradeep Publications, Jalandhar
4. Anderson, R.A. (2005) Algal Culturing Techniques. Physiological Society of America. Elsevier Academic Press. USA.
5. Fritsch, F.E. (1933-1945). The Structure and Reproduction of Algae Vols. Cambridge University Press. Cambridge. UK.
6. Fritsch, F.E. (1945). The structure and Reproduction of Algae. Vol. III. University Press, Cambridge. UK.
<b>E-Books:</b>
1. <a href="https://www.schandpublishing.com/books/higher-education/commerce-management/public-finance/9789352710805/#.Wwz_pUiFPIU">https://www.schandpublishing.com/books/higher-education/commerce-management/public-finance/9789352710805/#.Wwz_pUiFPIU</a>
2. <a href="https://www.abebooks.com/book-search/title/introduction-to-the-algae-structure-and-reproduction/">https://www.abebooks.com/book-search/title/introduction-to-the-algae-structure-and-reproduction/</a>
3. <a href="https://books.google.co.in/books?id=YsJs9eiNKdAC&amp;pg=PA138&amp;lpg=PA138&amp;dq=Bold,+H.C.+%26+Wynne,+M.J.+1985.+Introduction+to+the+Algae.+Prentice+Hall+of+India,+New+Delhi.&amp;source=bl&amp;ots=04B4qBMbX_&amp;sig=h2T109eo9zFlJ4Pc1YvPU5wFiyw&amp;hl=en&amp;sa=X&amp;ved=0ahUKEwih5TbsarbAhWHL08KHZH8A3oQ6AEIQzAG#v=onepage&amp;q=Bold%2C%20H.C.%20%26%20Wynne%2C%20M.J.%201985.%20Introduction%20to%20the%20Algae.%20Prentice%20Hall%20of%20India%2C%20New%20Delhi.&amp;f=false">https://books.google.co.in/books?id=YsJs9eiNKdAC&amp;pg=PA138&amp;lpg=PA138&amp;dq=Bold,+H.C.+%26+Wynne,+M.J.+1985.+Introduction+to+the+Algae.+Prentice+Hall+of+India,+New+Delhi.&amp;source=bl&amp;ots=04B4qBMbX_&amp;sig=h2T109eo9zFlJ4Pc1YvPU5wFiyw&amp;hl=en&amp;sa=X&amp;ved=0ahUKEwih5TbsarbAhWHL08KHZH8A3oQ6AEIQzAG#v=onepage&amp;q=Bold%2C%20H.C.%20%26%20Wynne%2C%20M.J.%201985.%20Introduction%20to%20the%20Algae.%20Prentice%20Hall%20of%20India%2C%20New%20Delhi.&amp;f=false</a>

<b>Mapping with programme outcomes</b>					
<b>COs</b>	<b>P01</b>	<b>P02</b>	<b>P03</b>	<b>P04</b>	<b>P05</b>
<b>C01</b>	S	S	M	M	S
<b>C02</b>	S	S	S	S	M
<b>C03</b>	S	M	S	S	S
<b>C04</b>	M	S	M	M	S
<b>C05</b>	S	M	S	S	S

\*S- STRONG, M- MEDIUM, L- LOW

**Semester - V**

<b>Course Code : 21UBTN2</b>	<b>NON MAJOR ELECTIVE- I</b>
<b>FORESTRY (For Zoology Students)</b>	<b>Syllabus version 2020 -2021</b>

**Objectives:**

1. To know about the forests and their types.
2. To understand the role of forest in the environment

**Course specific outcome:**

1. Students understood the forest types and their utilization
2. Students understand the forests nature and their situation
3. Students heard about the knowledge on various forms of forestry to conserve our Environment
4. Getting deep knowledge on Integrated Forest protection methods
5. Understanding the values of Social forestry and its components

**UNIT- I INTRODUCTION TO FORESTRY**

Definition of Forest, Forest cover, Importance of Forests – Types Forest in India. Silviculture – objectives – silviculture technique for some important species – Casuarina equisetifolia, Eucalyptus, Techtona grandis, Bamboo , and Azadirachta indica.

**UNIT- II PRINCIPLES OF FOREST**

Fundamental principles of Forests, Forest economics, Socio – economic analysis of forest. Forest productivity – forest valuation – role of ICFRE in research and education. Indian Forest Act. Principles of forest management, Utilization of Forest products.

**UNIT- III FOREST PROTECTION**

Role forest protection in Indian forestry - injuries caused by human beings – animals – insects – birds – adverse climate factors. Injuries caused by plants – forest fire. fire protection methods. Integrated pest management methods.

**UNIT- IV AGRO FORESTRY AND SOCIAL FORESTRY**

Definition – objectives of agro forestry – classification of agro forestry system – allelopathy – social forestry – its components and implementation at local and national level s- social attitude and community participation – choice of species of agro and social forestry.

**UNIT- V FOREST CONSERVATION**

Forest conservation- Importance, methods of forest conservation- Deforestation, reforestation and Afforestation. Forest Conservation awareness. Forest Conservation Acts in India.

<b>Text Books:</b>
<ul style="list-style-type: none"> <li>De Vere Burton L., 2000, Introduction to Forestry Science, Delmar publishers, N Y.</li> </ul>
<b>Reference:</b>
<ul style="list-style-type: none"> <li>Negi, S.S., 1994, India's Forests, Forestry and Wildlife, Indus Publishing Com., New Delhi.</li> <li>Jha, L.K., 1996. Forestry for rural development, APH Publishing Corporation, New Delhi.</li> </ul>
<b>E-Books:</b>
<a href="https://www.takealot.com/forest-products-and-wood-science-ebook/PLID37370116">https://www.takealot.com/forest-products-and-wood-science-ebook/PLID37370116</a>

<b>Mapping with programme outcomes</b>					
<b>COs</b>	<b>P01</b>	<b>P02</b>	<b>P03</b>	<b>P04</b>	<b>P05</b>
<b>C01</b>	S	S	S	S	S
<b>C02</b>	S	M	M	S	S
<b>C03</b>	S	M	S	M	S
<b>C04</b>	S	S	S	S	M
<b>C05</b>	M	S	M	S	S

\*S- STRONG, M- MEDIUM, L- LOW

## Semester - VI

<b>Course Code: 21UBT10</b>	<b>CORE COURSE - X</b>
<b>HORTICULTURE AND PLANT BREEDING</b>	<b>Syllabus version 2020 -2021</b>

**Objectives:**

1. This course is designed to provide theoretical knowledge about the gardening to enable them to be self reliant knowledge and self employment.
2. To study the importance of horticulture in Indian economy.
3. To understand the methodology of horticulture plantation.

**Course specific outcome:**

1. Students learned the importance of horticulture – career and occupational opportunities
2. They knew about hydroponics and its importance
3. They learned the techniques of irrigation and application of pesticides.
4. Students learned about kitchen garden - Cultivation of commercial flower crops
5. They understood the concept of post-harvest techniques.

**UNIT: I INTRODUCTION TO HORTICULTURE**

Importance and Scope of Horticulture – Divisions of Horticulture – Classification of Horticulture crops – fruits, vegetables, flower crops and plantation crops. Irrigation and manuring methods in Horticulture crops.

**UNIT: II PROPAGATION METHODS IN HORTICULTURE CROPS**

Propagation methods – Cutting, Layering, Budding and Grafting. Stock-Sion relationship in important horticultural crops. Role of plant growth regulators in horticulture crops. Induction of rooting, flowering, fruit setting and fruit development.

**UNIT: III PRODUCTION TECHNOLOGY**

Plan and Establishment of orchard. Selection of site – Soil, Climate. Selection of crops- Planting methods. Cultivation of following fruit crops- Mango, Sapota, Guava and Banana. Vegetable crops- Brinjal, Tomato, Cucurbits and Onion.

**UNIT: IV POST HARVEST TECHNOLOGY**

Methods of post harvest technology of following crops- Fruit crops- Mango, Sapota, Guava and Banana. Vegetable crops- Brinjal, Tomato, Cucurbits and Onion. Flowers- jasmine, rose, orchid. Storage and preservation methods of fruits and vegetables.

**UNIT: V GARDENING**

Types of gardens- indoor garden, kitchen garden and public garden, important Ornamentals- habit and types- garden components- lawn making, glass house, green house, rockery, water garden, hydroponics and aeroponics, terrace gardening topiarty and terrarium.



<b>Text Books:</b>
1. Kumar N., 1990, Introduction to Horticulture, Rohini agencies, Nagercoil.
2. Prasad, 2005, Principles of Horticulture, International Book Dept., Deharadun.
3. Gupta PK 2002 Cytology Genetics Evolution and Plant Breeding. Deep and Deep Publications, 2002
<b>Reference:</b>
1. Chauhan, D.V.S., 1968, Vegetable production in India, Ram Prasad, Agra.
2. Edmund J.B. Senn T.L Andrews F.S & Halforce R.G., 1990, Fundamentals of Horticulture 14th Edn., Tata McGraw Hill Co. Pvt., London.
3. Gopaldaswami Iyengar K.S., 1970, Complete Gardening in India, Kalyan Press, Bangalore.
4. Chandrasekaran & Parthasarathy, (1990). Cytogenetics and Plant Breeding.
5. Sinha, U. and Sinha, S., (1992). Cytogenetics, Plant Breeding and Evolution.
6. J. R. Sharma (1996) Principles and Practice of Plant Breeding.
7. Chaudhari, H.K., (1995) Revised Ed., Elementary Principles of Plant Breeding.
<b>Related online contents:</b>
1. <a href="https://www.amazon.in/Horticulture-Green-World-Gail-Lang-ebook/dp/B00E0EHY7K/ref=sr_1_7?s=digital-text&amp;ie=UTF8&amp;qid=1531113481&amp;sr=1-7&amp;keywords=horticulture">https://www.amazon.in/Horticulture-Green-World-Gail-Lang-ebook/dp/B00E0EHY7K/ref=sr_1_7?s=digital-text&amp;ie=UTF8&amp;qid=1531113481&amp;sr=1-7&amp;keywords=horticulture</a>
2. <a href="https://www.amazon.in/Gardening-Beginners-Perennial-Vegetables-Horticulture-ebook/dp/B01GF3UI9S/ref=sr_1_3?s=digital-text&amp;ie=UTF8&amp;qid=1531113444&amp;sr=1-3&amp;keywords=horticulture">https://www.amazon.in/Gardening-Beginners-Perennial-Vegetables-Horticulture-ebook/dp/B01GF3UI9S/ref=sr_1_3?s=digital-text&amp;ie=UTF8&amp;qid=1531113444&amp;sr=1-3&amp;keywords=horticulture</a>

<b>Mapping with programme outcomes</b>					
<b>COs</b>	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>
<b>CO1</b>	S	S	M	S	S
<b>CO2</b>	M	S	S	M	M
<b>CO3</b>	S	S	S	S	S
<b>CO4</b>	M	M	S	M	S
<b>CO5</b>	S	S	S	S	S

\*S- STRONG, M- MEDIUM, L- LOW

## Semester - VI

<b>Course Code: 21UBT11</b>	<b>CORE COURSE - XI</b>
<b>PLANT PHYSIOLOGY, BIOCHEMISTRY AND BIOPHYSICS</b>	<b>Syllabus version 2020-2021</b>

**Objectives:**

1. To study the recent aspects of various physiological processes in plants.
2. To understand the application of physiology in agriculture.
3. To fathom the chemical environment and the dynamics of the biological system.
4. To elucidate the interrelationships of the various pathways.

**Course specific outcome:**

1. Students knew about the mechanisms of mineral nutrition for plant growth.
2. They understood the process of Photosynthesis, Respiration and Nitrogen metabolism
3. They knew about the Plant Growth hormones.
4. Students understood the structure and functions of primary metabolites.
5. Deep understanding how physical principles are applied to biological system.

**UNIT I: RELATIONSHIP BETWEEN WATER AND PLANTS**

Introduction, water – types, physical and chemical properties, water potential and its components, Diffusion pressure deficit, Osmosis, Plasmolysis, Imbibition, Absorption- mechanism of absorption, active and passive absorption. Ascent of sap. Transpiration – types. Stomata- structure and mechanism of stomatal movement, Guttation. Stress physiology. Photoperiodism. Vernalization.

**UNIT II: MANUFACTURING OF ENERGY**

Photosynthesis: photosynthetic apparatus, Pigments, Action and Absorption spectrum,, Light reaction – Non – cyclic and cyclic photophosphorylation, Dark reaction – Calvin cycle, C4 cycle, Hatch and Slack pathway, CAM pathway – factors affecting photosynthesis.

**UNIT III: UTILIZATION OF ENERGY**

Respiration – Types of respiration, Mitochondria – Structure, Respiration substrates, Mechanism of respiration, Glycolysis, Krebs' cycle, Electron Transport pathway, Factors affecting respiration. Anaerobic respiration. Photorespiration. Plant growth regulators – structure and physiological role of Auxins. Gibberellins, Cytokinins, Ethylene and Abscissic acid.

**UNIT IV: PRIMARY METABOLITES**

Carbohydrates: Importance, classification, structure and properties. Proteins: Biological importance, classification and structure. Amino acids: properties, structure and classification. Lipids: Importance, structure, classification and properties. Enzyme: Nomenclature, classification, structure, properties and Mechanism of enzyme. Enzyme inhibitors. Factors affecting enzyme action.

**UNIT V: PRINCIPLES OF BIOPHYSICS**

Physical forces and chemical bonds – Hydrogen bond and covalent bond. Bioenergetics – Thermodynamics Laws – Nature of Light, Solar radiation – Absorption and emission of light by pigments.

**Text Books:**

1. Pandey, S.N. & Sinha, 2010, Plant Physiology, Vikas Publishing, New Delhi.
2. Stryer Lubert, 2005, Biochemistry, W.H. Freeman & Co., NY
3. Pranab Kumar Banerjee (2008) Introduction to Biophysics S. Chand, New Delhi.

**Reference:**

1. Noggle, G.R. and Fritz, G.J. 2001, Introductory Plant Physiology, Prentice - Hall, India.

2. Devlin, R.M., 2000, Plant Physiology, Affiliated East West Press Pvt. Ltd.
3. Epstein, E., 2000, Mineral Nutrition in Plants-Principles and Perspectives, Wiley.
4. Lincoln, T and Zeiger, Plant Physiology.2010 www.plantphys.net.
5. Apps et al., 1992, Biochemistry, ELBS.
6. Caret et al., 1993, Inorganic, Organic and Biological Chemistry, WMC Brown, USA.
7. Rawn, David, 1989, Biochemistry, Neil Patterson USA.
8. R.N. Roy A text book of biophysics. New Central Book Agency Pvt. Ltd, Calcutta.
9. Mohan Arora Biophysics. Himalaya Publishing House, Bangalore.
<b>Related online contents:</b>
1. <a href="http://www.divbiolchem.org">www.divbiolchem.org</a>
2. <a href="http://www.ercenzymes.com">www.ercenzymes.com</a>
3. <a href="http://rastogipublications.com/index.php?route=product/product&amp;product_id=113&amp;search=plant+physiology">http://rastogipublications.com/index.php?route=product/product&amp;product_id=113&amp;search=plant+physiology</a>
4. <a href="https://www.schandpublishing.com/books/highereducation/biology/fundamentals-plant-physiology/9789352533343/#.W0LymtIzBIU">https://www.schandpublishing.com/books/highereducation/biology/fundamentals-plant-physiology/9789352533343/#.W0LymtIzBIU</a>

Mapping with programme outcomes					
COs	PO1	PO2	PO3	PO4	PO5
<b>C01</b>	S	S	S	M	S
<b>C02</b>	S	S	M	S	S
<b>C03</b>	S	M	S	S	S
<b>C04</b>	S	S	S	M	M
<b>C05</b>	M	S	M	S	S

\*S- STRONG, M- MEDIUM, L- LOW

## Semester - VI

<b>Course Code: 21UBT12</b>	<b>CORE COURSE - XII</b>
<b>PLANT BIOTECHNOLOGY AND TISSUE CULTURE</b>	<b>Syllabus version 2020 -2021</b>

<b>Objectives:</b>
1. To study the emerging trends in biotechnology such as gene therapy, DNA finger printing and molecular cloning
2. To enumerate the role of 21st century science, biotechnology in increasing productivity of crop plants, to enhance the production of high value metabolites.
<b>Course specific outcome:</b>
1. Students learnt the techniques in biotechnology and plant tissue culture.
2. Students understood the process of somatic embryogenesis
3. They knew about the application of tissue culture in forestry, horticulture, agriculture and pharmaceutical industry.
4. They had the ability to explain the main techniques of in vitro culture of plant cells & tissues.
5. Students knew the patenting procedures for patenting biological products.

**UNIT I – TECHNIQUES IN BIOTECHNOLOGY**

Introduction: Definition, Scope and importance of Biotechnology, DNA structure – replication. Enzymes of biotechnology - Restriction endonucleases, exonuclease, DNA modifying enzymes - Polymerase, Transferase, Kinase and Ligase.

**UNIT II – GENETIC ENGINEERING**

Gene concept and Expression. Recombinant DNA Technology, Gene Cloning and cloning vehicles - Plasmids and cosmids. Transgenic plants, biofertilizer and single cell protein.

**UNIT III – TECHNIQUES OF TISSUE CULTURE**

Plant tissue culture Techniques- Sterilization techniques, preparation of culture media and methods of culturing plant tissues- Micropropagation, callus induction and regeneration *in-vitro* pollination and fertilization, embryogenesis and organogenesis, micropropagation, callus induction and regeneration haploids and their applications.

**UNIT IV – ENVIRONMENTAL BIOTECHNOLOGY AND DISEASE DIAGNOSIS.**

Waste management – Solid, liquid waste treatment, sewage, municipal waste Bioremediation. Bioleaching. Biodegradation. Domestic and Industrial effluent. Biogas production. Clinical diagnosis – Microscopy, Macroscopy, Biochemical, serological & Molecular diagnosis of diseases – PCR, RT – PCR, RAPD.

**UNIT V – APPLICATIONS OF BIOTECHNOLOGY**

Biotechnology and its applications – Agriculture- crop improvement, herbicide resistance, insect resistance, virus resistance, plants as bioreactors, Industry- production of Lactic acid and Alcohol. Medicine – Gene Therapy, DNA Finger printing. Intellectual property Rights (IPR) - Patents of Biological materials.

<b>Text Books:</b>
1. Anon. 1988. Animal cell Biotechnology, Academic Press, New York.
2. Bernard R Glick & Jack J Pasternak. 2001. Molecular biotechnology principles and applications of recombinant DNA, (2nd Edition), ASM Press, Washington, D.C.

**References:**

1. Butler, M. 1987. Animal cell technology, Principles and Products, Open University Press, New York.
2. Gamborg, OL &Phillips, GC. 1995. Plant cell, Tissue and Organ culture a Funtamental methods, Narosa publishing House, New Delhi.
3. George, EF & Sherrington, PD. 1984. Plant propagation by Tissue culture, Exegetics Limited, London.

**E. Books:**

1. <https://www.schandpublishing.com/books/higher-education/biology/a-textbook-biotechnology/9788121926089/>
2. [http://rastogipublications.com/index.php?route=product/product&product\\_id=57&search=biotechnology](http://rastogipublications.com/index.php?route=product/product&product_id=57&search=biotechnology)

**Mapping with programme outcomes**

<b>COs</b>	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>
<b>C01</b>	M	S	S	S	S
<b>C02</b>	S	M	S	S	M
<b>C03</b>	M	S	S	S	S
<b>C04</b>	S	S	M	M	S
<b>C05</b>	S	S	S	S	M

\*S- STRONG, M- MEDIUM, L- LOW

## Semester - VI

<b>Course Code: 21UBT13P</b>	<b>CORE COURSE - XIII</b>
<b>PRACTICAL - III</b> <b>MORPHOLOGY AND TAXONOMY OF ANGIOSPERMS,</b> <b>ECOLOGY AND PHYTOGEOGRAPHY AND</b> <b>MICROBIOLOGY AND PLANT PATHOLOGY</b>	<b>Syllabus version 2020 -2021</b>

**Course Objectives:**

1. To get practical on morphological features of Angiosperms.
2. To identify and classifying angiosperms by morphological features.
3. To understand the plant distribution.
4. To know the Microbiological procedure for studying pant disease.

**Course outcomes:**

1. Experiencing in handling specimens and preservation of Angiosperms.
2. Imparting knowledge on identification characters of Angiosperms.
3. Acquiring knowledge on developing taxonomy keys for plant identification.
4. Understanding microbiology techniques for culturing process.
5. Acquiring knowledge plant disease control and prevention methods.

**MORPHOLOGY AND TAXONOMY OF ANGIOSPERMS**

1. Describe the plant parts with suitable plants- Technical term habit, habitat form, types of leaves, with leaf shape, margin, texture, modification of leaf.
2. Study the Types and modification of root and stem with suitable example Identify the following inflorescence and fruits: a) Inflorescence - Simple raceme, Spike, Corymb, Head, simple cyme, Cyathium and Hypanthodium. b) Fruits - Simple: Berry, Drupe, Pepo, hesperidium. (Indehiscent) – Nut. Dry- Legume, capsule (loculicidal). Aggregate
3. Floral formula from floral description.
4. Identify the families mentioned in the syllabus by noting their vegetative and floral Characters.
5. Students must describe the floral parts, draw the L.S., floral diagram and write the floral formula of at least one flower from each family
6. Study the products of plants mentioned in the syllabus of economic importance with Special reference to the morphology, botanical name and family.
7. Prepare herbarium of 20 plants with field notes (internal assessment).
8. Conduct Botanical tour for a minimum of 3 to 5 days under the guidance of a teacher and Submit field report.

**ECOLOGY AND PHYTOGEOGRAPHY**

1. Study of morphological and anatomical adaptations of Hydrophytes, Xerophytes.
2. Diagrammatic presentation of Food chain, Food web, Ecological pyramids and Pond ecosystem.
3. Determination of BOD in different water samples
4. Determining frequency, density and abundance of different species in plant community of the quadrat
5. Phytogeographical regions of India.

<b>Mapping with programme outcomes</b>					
<b>Cos</b>	<b>P01</b>	<b>P02</b>	<b>P03</b>	<b>P04</b>	<b>P05</b>
<b>C01</b>	S	S	S	S	S
<b>C02</b>	M	S	M	S	M
<b>C03</b>	S	S	S	M	S
<b>C04</b>	S	S	M	S	S
<b>C05</b>	S	M	S	S	S

\*S- STRONG, M- MEDIUM, L- LOW

## Semester - VI

<b>Course Code : 21UBT14P</b>	<b>CORE COURSE - XIV</b>
<b>PRACTICAL - IV PLANT PHYSIOLOGY, BIOCHEMISTRY AND BIOPHYSICS, HORTICULTURE AND PLANT BREEDING AND BIOTECHNOLOGY</b>	<b>Syllabus version 2020 -2021</b>

<b>Course Objectives:</b>
1. To train on handling of laboratory equipment and analytical work.
2. To understand the chemistry of biological compounds.
3. To know the methods to study the biophysics, Biotechnology and Plant Physiology.
<b>Course outcomes:</b>
1. Experiencing in handling laboratory equipment and apparatus.
2. Imparting knowledge on experimental work in plant physiology.
3. Acquiring knowledge on practical demonstration of plant physiological activity.
4. Deep Understanding methods of qualitative and quantitatively study for biochemical compounds
5. Learning plant breeding and biotechnology tools.

**PLANT PHYSIOLOGY*****Experiments to be performed by each student***

1. Determination of osmotic potential of plant cell sap by plasmolytic method.
2. Calculation of stomatal index and stomatal frequency of a mesophyte and a xerophyte.
3. To study the effect of light intensity and bicarbonate concentration on O<sub>2</sub> evolution in photosynthesis.
4. Measurement of rate of transpiration using Ganong's photometer
5. Study of effect of wavelength of light on photosynthesis using Wilmott's bubbler
6. Study of the effect of varying concentration of CO<sub>2</sub> on photosynthesis
7. Separation of photosynthetically active pigments using paper chromatography

***Experiments for demonstration***

1. Ganong's respirometer
2. Anaerobic respiration
3. Clinostat

**BIOCHEMISTRY**

1. Estimation of starch by anthrone method
2. Colorimetric estimation of chlorophyll pigments
3. Estimation of oil in different oil seeds
4. Colorimetric estimation of proteins (Lowry / Bradford method)
5. Demonstration of the activity of peroxidase.

**BIOPHYSICS**

Principle and applications of:

1. pH meter.
2. Centrifuge.
3. Electrophoresis.
4. Spectrophotometer.



<b>Mapping with programme outcomes</b>					
<b>COs</b>	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>
<b>C01</b>	S	S	S	S	S
<b>C02</b>	S	S	S	M	S
<b>C03</b>	S	M	S	S	S
<b>C04</b>	M	S	S	S	S
<b>C05</b>	S	M	S	S	M

\*S- STRONG, M- MEDIUM, L- LOW

## Semester - VI

Course Code : 21UBTE2A	ELECTIVE COURSE - II
PLANT TISSUE CULTURE	Syllabus version 2020 -2021

**Objectives:**

1. To learn the basics of Tissue culture techniques
2. To understand the various methods of techniques for the production of plant.

**Course specific outcome:**

1. Students knew about applications of various tissue culture techniques
2. Students acquired the knowledge of the methods in tissue culture
3. They understood the importance of tissue culture
4. Deep understanding about Commercial application of tissue culture technology
5. Imparting knowledge on the applications of tissue culture in various fields.

**UNIT I BASICS OF PLANT TISSUE CULTURE**

History of Tissue Culture technique. Requirements for a plant tissue culture lab - Laminar air flow device; Totipotency of plant cells dedifferentiation and redifferentiation; Nutrient media: Composition of commonly used nutrient culture media with respect to their contents like inorganic chemicals, organic constituents, vitamins, amino acids etc; Plant growth regulators(PGR); Sterilisation of the media and culture.

**UNIT II METHODS IN PLANT TISSUE CULTURE**

Tissue development, simple and meristematic tissues; Culture of plant materials - explants selection and technique of culturing the same; Growth conditions; Methods of sub culturing and transfer of regenerated plants to the field.

**UNIT III: MICRO PROPAGATION**

Proliferation of axillary buds, induction of adventitious buds and bulbs, callus regeneration, somatic embryogenesis; Continuous culture, immobilized cultures, estimation of growth and artificial seeds; Biochemical and molecular basis of differentiation in plant tissue culture. Isolation of single cells, culturing of single cell- different methods, Cryopreservation, Freezing and storage, thawing, reculture.

**UNIT IV: METHODS FOR PRODUCTION OF HAPLOIDS**

Development of homozygous lines, Protoplast culture and regeneration of plants, isolation, merits and demerits. Somaclonal variations, isolation of somaclonal variants. Molecular basis of somaclonal variation and somatic hybridization.

**UNIT V: APPLICATIONS STUDY**

Applications of tissue culture in agriculture; improvement of hybrids; Production of encapsulated seeds, Production of disease resistant plants; Transgenic plants for crop improvement; virus and Insects resistance transgenic plants; Transfer of nif genes to eukaryotes; Applications in horticulture and forestry; Immunotherapeutic drugs.

**Text books**

1. Hartmann, H.T., Kester, D.E., Davies, F.T. and Geneve, R.L. Hartmann & Kester's Plant Propagation: Principles and Practices, Pearson, 2010.
2. Razdan, M. K. Introduction to Plant Tissue Culture. Oxford & IBH, 2005.
3. Gamborg, O. and Gregory, P. (Eds.) Plant Cell, Tissue and Organ Culture: Fundamental Methods, Springer, 1995. 4.

References
1. Chopra, V. L., Sharma, R. P. and Swaminathan, M. S. Agricultural Biotechnology: 2nd Asia Pacific Conference, Science Pub Inc., 1996
2. Kalyan Kumar, D. An Introduction to Plant Tissue Culture. New Central Book Agency, New Delhi, 1997.
3. Guptha, P.K. Elements of Biotechnology. Rastogi Publications, 2016
4. Slater, A., Scott, N. and Fowler, M. Plant Biotechnology: The Genetic Manipulation of Plants, Oxford, 2008.
5. Kung, De S., and Wu, R. Transgenic Plants: Engineering and Utilization, Academic Press, 2012.
6. Gresshoff, P.M. Plant Molecular Biology. CRC Press, 1994
7. Jogdand, S.N. Advances in Biotechnology. Himalaya Publishing House, 2007

Mapping with programme outcomes					
Cos	PO1	PO2	PO3	PO4	PO5
<b>C01</b>	M	S	S	S	S
<b>C02</b>	S	M	S	M	S
<b>C03</b>	S	S	M	S	M
<b>C04</b>	M	S	S	S	S
<b>C05</b>	S	S	S	M	S

\*S- STRONG, M- MEDIUM, L- LOW

## Semester - VI

<b>Course Code: 21UBTE2B</b>	<b>ELECTIVE COURSE - II</b>
<b>NATURAL PRODUCTS AND HUMAN WELFARE</b>	<b>Syllabus version 2020 -2021</b>

<b>Objectives:</b>
1. To know the natural products in our environment and their utilization
<b>Course specific outcome:</b>
1. Students knew about applications of micro organisms in industry - food, vitamins, enzymes, antibiotics and alcohol.
2. They understood the medicinal plants.
3. Bioactive components and their potential.
4. Learning the cultivation methods of common medicinal herbs
5. Understanding Traditional and economically important wood plants in India

**UNIT I - MICROBES IN INDUSTRY**

Application of micro organisms - algae, fungi in industry - food, vitamins, enzymes, antibiotics and alcohol. Role of algae in the production of agar, alginate and in soil fertility.

**UNIT II - MEDICINAL PRODUCTS FROM LOWER PLANTS AND HIGHER PLANTS**

Useful products of Algae (*Spirulina*), fungi (yeast), Gymnosperms- Wood (Pine), Drugs (Ephedrine), antioxidants, (*Green tea*). Drugs from Bryophytes, Pteridophytes

**UNIT III - ECONOMIC PRODUCTS FROM PLANTS**

Study of following plants and application of the following products: beverages (coffee), narcotics (poppy, tobacco), fiber (cotton), oil-seeds (sesame, Ground nut), latex (rubber, resin).

**UNIT IV - PLANTS AND THEIR ACTIONS**

Medicinal plants: Bioactive compounds from *Azadirachta*, *Withania*, *Rauwolfia*, and *Ocimum sanctum*, *Achyranthes aspera*, *Vitex negundo*- their pharmacological applications. Edible plants & their importance: Cereals (Wheat, Ragi), Beverages (tea), Spices (Clove, Saffron) fruits (Mango, Guava)

**UNIT V - ECONOMIC VALUES OF WOODY PLANTS**

Traditional and economically important wood plants in India: *Bambusa*, *Dalbergia*, *Tectona*, *Dalbergia*, Red sandal.

<b>Text Books:</b>
1. Hill AW <i>Economic Botany</i> . Tata McGraw Hill, New Delhi.
2. Puri GS <i>Indian Forest Ecology</i> . Oxford Books and Stationary & Co.,
3. Rama Rao SV <i>Soil Conservation in India</i> . ICAR, New Delhi.
<b>References:</b>
4. Dastur JF <i>Useful plants of India</i> . Tarapore.
5. Baker GS <i>Plants and Cultivation</i> . Mac Millan Co., London.
6. Sambamurthy AWS <i>Economic Botany</i> .
<b>Online Resources:</b>
1. <a href="http://shawnacohen.tripod.com/thetribaltraditions/id51.html">http://shawnacohen.tripod.com/thetribaltraditions/id51.html</a>
2. <a href="http://www.vasundharaorissa.org/Research%20Reports/GlobalisationAndMedicinalplantsOfOrissa.pdf">http://www.vasundharaorissa.org/Research%20Reports/GlobalisationAndMedicinalplantsOfOrissa.pdf</a>

3. <a href="http://www.emea.europa.eu/docs/en_GB/document_library/Scientific_guideline/2009/09/WC500003393.pdf">http://www.emea.europa.eu/docs/en_GB/document_library/Scientific_guideline/2009/09/WC500003393.pdf</a>
4. <a href="http://www.bookganga.com/eBooks/Books?AID=5600445540161494332">http://www.bookganga.com/eBooks/Books?AID=5600445540161494332</a>
5. <a href="http://www.gallowglass.org/jadwiga/herbs/preparations.html">http://www.gallowglass.org/jadwiga/herbs/preparations.html</a>

<b>Mapping with programme outcomes</b>					
<b>Cos</b>	<b>P01</b>	<b>P02</b>	<b>P03</b>	<b>P04</b>	<b>P05</b>
<b>C01</b>	S	S	S	S	M
<b>C02</b>	S	S	S	S	S
<b>C03</b>	M	S	M	S	S
<b>C04</b>	S	M	S	M	S
<b>C05</b>	S	S	M	S	S

\*S- STRONG, M- MEDIUM, L- LOW

## Semester VI

<b>Course Code : 21UBTE2C</b>	<b>ELECTIVE COURSE - II</b>
<b>NANOBIOTECHNOLOGY</b>	<b>Syllabus version 2020 -2021</b>

<b>Objectives:</b>
1. To know the importance and application of nanotechnology in biological sciences.
<b>Course specific outcome:</b>
1. After learning the course, the students should be able to: Develop a fundamental understanding of basic concepts of nano-biotechnology and its uses in the field of life sciences.
2. Students knew about Various applications of Nano-biotechnology.They understood the Nano bio- machines, chemistry and structure
3. Understanding Biomaterial nano-particle systems for bio-electronic and biosensing applications
4. Evaluate applications of various concepts & techniques of nano-biotechnology to facilitate biotechnological advancement and innovations.
5. Understanding current scenario of nanotechnology application in biology

**UNIT I: INTRODUCTION**

History and Applications, Various definitions and Concept of Nano-biotechnology and Historical background, Fundamental sciences and broad areas of Nanobiotechnology, Various applications of Nano-biotechnology, Cell – Nanostructure interactions

**UNIT II: PROTEIN-BASED NANOSTRUCTURES**

Nano bio- machines and Signalling, Overview, chemistry and structure, Genetics & Secondary cell-wall polymers, Self-assembly in suspension, Re-crystallization at solid supports, Formation of regularly arranged Nano-particles.

**UNIT III: MICROBIAL NANOPARTICLE PRODUCTION**

Overview and concept of microbial nano-particle production, Methods of microbial nano-particle production, Applications of microbial nano-particles, Bacteriorhodopsin and its potential in technical applications – overview, structure, photoelectric applications, photochromic applications and applications in energy.

**UNIT IV: DNA-PROTEIN NANOSTRUCTURES**

Overview and introduction, Oligonucleotide-Enzyme conjugates, DNA conjugates of binding proteins, Non-covalent DNA-Streptavidin conjugates, DNA-Protein conjugates in microarray technology.

**UNIT V: BIOMATERIALS AND BIO-ELECTRONICS**

Biomaterials- types, properties and applications, Biomaterial nano-particle systems for bio-electronic and biosensing applications, Biomaterial-based Nano-circuitry, Protein-based Nano-circuitry, DNA as functional template for Nano-circuitry.

<b>Text books</b>
1. Nanobiotechnology: Concepts, Applications and Perspectives, Christof M. Niemeyer (Editor), Chad A. Mirkin (Editor) , Wiley Publishers, April 2004.
2. Nanotechnology: A Gentle Introduction to Next Big Idea, Mark Ratner and Daniel Ratner, Low Price edition, Third Impression, Pearson Education.
<b>References:</b>
1. Nanotechnology, William Illsey Atkinson, JAICO Publishing House, Second Impression-2008.
2. Bio molecular computation for Bio nanotechnology, Liu and Shimohara, Artech House-London, 2007.
<b>Online Resources:</b>
1. <a href="https://en.wikipedia.org/wiki/Nanotechnology">https://en.wikipedia.org/wiki/Nanotechnology</a>
2. <a href="https://www.nanowerk.com/nanotechnology/introduction/introduction_to_nanotechnology_1.php">https://www.nanowerk.com/nanotechnology/introduction/introduction_to_nanotechnology_1.php</a>
3. <a href="https://www.nano.gov/nanotech-101/what/definition">https://www.nano.gov/nanotech-101/what/definition</a>
4. <a href="https://www.researchgate.net/publication/261638569_Biological_Applications_of_Nanobiotechnology">https://www.researchgate.net/publication/261638569_Biological_Applications_of_Nanobiotechnology</a>
5. <a href="http://www.ncabr.org/wp-content/uploads/2015/12/chapter_nanobiotechnology.pdf">http://www.ncabr.org/wp-content/uploads/2015/12/chapter_nanobiotechnology.pdf</a>

<b>Mapping with programme outcomes</b>					
<b>COs</b>	<b>P01</b>	<b>P02</b>	<b>P03</b>	<b>P04</b>	<b>P05</b>
<b>C01</b>	S	S	S	S	S
<b>C02</b>	S	S	M	S	M
<b>C03</b>	S	S	S	S	M
<b>C04</b>	S	S	S	M	S
<b>C05</b>	S	M	S	S	S

\*S- STRONG, M- MEDIUM, L- LOW

## Semester - VI

Course Code : 21UBTE3A	ELECTIVE COURSE - III
BIOTECHNIQUES	Syllabus version 2020 -2021

**Objectives:**

- 1.This course discusses basic and advanced methods used in instrumentation investigation focusing on biology applications and to provide ample opportunity for the students to specialize in instruments
- 2.To understand how physical principles are applied to biological system.
- 3.To know the principles and applications of instruments (centrifugation, chromatography, electrophoresis, spectroscopy).

**Course specific outcome:**

1. The student was able to check calibration on all instruments studied.
2. The student could identify the proper careful handling and precautions for all types of instruments.
3. The student understood that instruments must be intelligently used to minimize errors
4. The student identified various techniques and procedures needed with a particular instrument.
5. The student made calculations necessary with certain instruments.

**UNIT I – PRINCIPLES AND TYPES OF MICROSCOPY**

Microscopy: Basic principles of microscope – Parts of Compound microscope, bright and Dark field microscope, Phase contrast microscope, Fluorescent microscope, Electron microscope, TEM and SEM.

**UNIT II – SECTIONING AND STAINING TECHNIQUES**

Microtechnique– Preparation plant tissue for microscopic slides in light and Electron Microscope – Whole mount, Smears, Squash.

**Microtomy:** Fixation, Dehydration, Infiltration, Embedding, Sectioning. Stains and Staining techniques – Simple, double and compared staining.

**UNIT III – TECHNIQUES OF SEPARATION**

Centrifugation: Principles, components, mechanism and application of Centrifugation, Basic principles of sedimentation. Determination of molecular weight - sedimentation velocity and sedimentation equilibrium.

Types of centrifuges - Preparative, analytical, ultracentrifuge, differential and density gradient clinical, Refrigerated and ultracentrifuges.

**UNIT IV – PRINCIPLES OF CHROMATOGRAPHY**

Chromatography: Basic principles and application of chromatography, mobile and stationary phases, Rf Value.

Chromatography types – Paper, Column, Thin layer, HPLC, Ion Exchange Chromatography, Gas Chromatography, Gel Filtration Chromatography.

**UNIT V – ANALYSIS OF SPECTRA**

Principle and Application of pH meter, Colorimetry and Spectrophotometer. Beer- Lamberts Law and its limitations.

Types of Electrophoresis: Agarose Gel Electrophoresis, Poly Acrylamide Gel Electrophoresis, Electrophoresis (SDS–PAGE). Blotting techniques – Southern, Northern and Western Blotting.



<b>Text Books</b>
1.P.Palanivelu and M.Saliyu. 2009. Analytical Biochemistry and Separation Techniques. 4th Edition, MKU, Madurai.
2.Friefelder, D.M. 1983. Physical Biochemistry: Applications to Biochemistry and Molecular Biology. 2nd Revised edition. W. H. Freeman, USA.
<b>References:</b>
1. Patki L.R, Bhalchandra B.L, Jeevaji.H.(1987). An introduction to Microtechnique, S.Chand and company (Pvt)ltd, New Delhi
2. Marimuthu, R. (2008). Microscopy and Microtechnique. MJP Publishers,Chennai Wilson K, Walker, J. (1994 ). Principle and techniques of practical biochemistry,4th ed) Cambridge university press, Cambridge
3. Palanivelu P (2013). Analytical Biochemistry and Separation techniques , 20th century publications ,Palkalainage ,Madurai
4. Johansen, DA (1940). Plant Microtechnique, TATA McGraw Hill Book Co., Ins., New Delhi.
5. Peter Gray (1964). Hand book of Basic Microtechnique. McGraw hill publication, New York
6. Cooper.TG (1991).The Tools of Bio - chemistry, John Wiley & sons, London
7. Hammes, G. G. 2007. Physical Chemistry for the Biological Sciences, 1st Edition. Wiley-Inter science, USA.
8. Pavia, D.L., Lampman, G.M., Kriz , G.S. 2000. Introduction to Spectroscopy. 3rd Revised edition. Brooks Cole Publishing Company, USA.
9. Wilson and Walkar. 2000. A Biologist Guide to Principles and Techniques of Practical Biochemistry, 5th Edition, Cambridge University Press, UK.
10. Asokan P. 2003. Analytical Biochemistry. 2nd Edition. China publications.
<b>Related online contents:</b>
1. <a href="https://epdf.tips/biotechnology-a-laboratory-course.html">https://epdf.tips/biotechnology-a-laboratory-course.html</a>
2. <a href="https://www.amazon.in/Bioinstrumentation-Webster/dp/8126513691">https://www.amazon.in/Bioinstrumentation-Webster/dp/8126513691</a>

<b>Mapping with programme outcomes</b>					
<b>COs</b>	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>
<b>C01</b>	S	S	S	S	S
<b>C02</b>	S	S	M	S	M
<b>C03</b>	S	S	S	S	M
<b>C04</b>	S	S	S	M	S
<b>C05</b>	S	M	S	S	S

\*S- STRONG, M- MEDIUM, L- LOW

## Semester – VI

<b>Course Code : 21UBTE2B</b>	<b>ELECTIVE COURSE II</b>
<b>ORGANIC FARMING</b>	<b>Syllabus version 2020 -2021</b>

**Objectives:**

1. To Study of different bio input like biopesticides, bio-weedicides, Bio-organic fertilizers
2. To study the deficiency symptoms of nutrient deficiency inorganic farming.
3. To get knowledge on Preparation of organic Manure for sustainable farming.

**Course specific outcome:**

1. Imparting knowledge on composting methods.
2. Getting experience in Preparation of vermicompost.
3. Imparting knowledge on recycling of farm waste.
4. Getting familiarizing in methods of green manuring.
5. Motivation to become an organic farmer and consultant.

**UNIT-I INTRODUCTION TO ORGANIC FARMING**

Introduction, concept, relevance in present context; Scope of Organic Farming in India. Organic inputs, Hazards of Chemicals, World Organic food market, production requirements; Biological intensive nutrient management-organic manures.

**UNIT-II ORGANIC AGRICULTURE**

Eco-technologies, Traditional farming, organic manures, vermicomposting, green manuring, recycling of organic residues, biofertilizers; Soil improvement and amendments. Role of microorganisms in organic matter- decomposition. Growing Organic Vegetable at home.

**UNIT-III PEST AND DISEASE MANAGEMENT**

Integrated diseases and pest management in organic farming– use of biocontrol agents, biopesticides, pheromones, trap crops, bird perches. Weed management, Quality considerations, certification, labelling and accreditation processors, marketing, exports.

**UNIT-IV PROBLEMS AND PROSPECTS OF ORGANIC FARMING**

Organic agriculture: The realistic Alternative and sustainable farming, Government initiative, Corporate initiative, Prospects of growing spices, Medicinal and Aromatic Crops. Organic foods: Promotion and Quality Assurance. Current status of organic farming in India.

**UNIT-V PROMOTION OF ORGANIC FARMING**

Certification for organic farming, Government assistance for promoting organic farming-Paramparagat Krishi Vikas Yojana (PKVY), Mission Organic Value Chain Development for North Eastern Region (MOVCDNER), Capital Investment Subsidy Scheme (CISS) under Soil Health Management Scheme, National Mission on Oilseeds and Oil Palm (NMOOP), National Food Security Mission (NFSM).

**Text Books:**

1. Arun. K. Sharma. 2011. *Handbook of Organic farming*. Agrobios (India), Jodhpur.
2. H.M.Gupta.2005. *Organic farming and Sustainable Agriculture*. ABD Publishers, Jaipur(India).
3. S.P. Palaniappan and K.Annadurai. 2010. *Organic farming – Theory and Practice*.

Scientific Publishers. Jodhpur.
4. A.K.Dahama. 2007. <i>Organic farming for sustainable agriculture</i> . Agrobios (India), Jodhpur.
<b>References:</b>
1. U.Thapa and P. Tripathy. 2006. <i>Organic farming in India- Problems and Prospects</i> . Agrotech publishing agency, Udaipur.
2. G.K.Veeresh. 2006. <i>Organic farming</i> . Foundation Books. New Delhi.
3. Purshit,S.S.2006. <i>Trends in Organic Farming in India</i> . AgrosBios(INDIA), Jodhpur.
4. Thampan,P.K.1995. <i>Organic Agriculture</i> . Peckay tree Crops Development Foundation Cochin, Kerala.
<b>Related online contents:</b>
1. <a href="https://www.downtoearth.org.in/blog/agriculture/how-indian-states-are-promoting-organic-natural-farming-73306">https://www.downtoearth.org.in/blog/agriculture/how-indian-states-are-promoting-organic-natural-farming-73306</a>
2. <a href="https://agriculturepost.com/5-govt-schemes-promoting-organic-farming-in-india/">https://agriculturepost.com/5-govt-schemes-promoting-organic-farming-in-india/</a>
3. <a href="https://www.conserve-energy-future.com/organic-farming-benefits.php">https://www.conserve-energy-future.com/organic-farming-benefits.php</a>
4. <a href="https://ofrf.org/research/organic-faqs/">https://ofrf.org/research/organic-faqs/</a>

Mapping with programme outcomes					
COs	PO1	PO2	PO3	PO4	PO5
C01	S	S	S	M	S
C02	M	S	S	S	M
C03	S	S	M	S	S
C04	S	S	S	S	S
C05	S	S	S	S	M

\*S- STRONG, M- MEDIUM, L- LOW

## Semester - VI

Course Code : 21UBTE3C	ELECTIVE COURSE - III
BIOFERTILIZERS AND BIOPESTICIDES	Syllabus version 2020 -2021

**Objectives:**

1. Completion of the course will give an overview of relevance use of microbial biofertilisers and biopesticides.
2. To discuss on the impact of products of biological based agriculture.
3. To discuss on the importance of sustainable agriculture.

**Course specific outcome:**

1. Students had familiar with the vast reserves of available microbial biodiversity that provide abundant opportunities to harness the ability of micro -organisms.
2. Understanding chemical constituents, to sustainably minimize damage from pests or increase agricultural productivity and production.
3. Getting knowledge on importance of biopesticides in agriculture.
4. Understanding the values of biofertilizers and biopesticides in organic agriculture
5. Students became on entrepreneur in biofertilizers production.

**UNIT I- GENERAL INTRODUCTION**

Biofertilizers - Introduction, scope. A general account of Biofertilizers organisms, characteristic features of bacterial biofertilizers. Mechanism of phosphate solubilization and phosphate mobilization, K solubilization, Blue Green Algal biofertilizers- *Azolla* as a biofertilizer - Isolation, Characterization, Mass cultivation and field application.

**UNIT II – BACTERIAL BIOFERTILIZERS**

Bacterial biofertilizers - Introduction, types, Isolation, Characterization, *plant growth-promoting Rhizobacteria*, *Biological nitrogen fixation*, Mass production and field application of *Azospirillum*, *Azotobacter*, *Rhizobium* and *Phosphobacteria*.

**UNIT III –MYCORRHIZAL AS BIOFERTILIZERS**

Mycorrhizal fungi - Introduction, scope. A general account of Ecto, Endo and Arbuscularmycorrhizae - Isolation, characterization and mass multiplication of Arbuscularmycorrhizae and its field application.

**UNIT IV –BIOPESTICIDES**

History and concept of biopesticides. Importance, scope and potential of biopesticide. Definitions, concepts and classification of biopesticides-virus, bacteria and fungi- advantages, isolation, characterization, mechanism of action and application. Mass production technology of biopesticides. Virulence, pathogenicity and symptoms of entomopathogenic pathogens and nematodes.

**UNIT V –COMMERCIALIZATION OF BIOPESTICIDES**

Minimum Infrastructure Required for the Manufacturing of Biopesticides. Large scale production of biopesticides – NPV, *Trichoderma viride*, *Beauveria bassiana*, *Pseudomonas fluorescens* and *Bacillus thuringiensis*. Government Policies and Regulations in Biopesticides Market in India-General Overview, Insecticides Act, 1968, Mandatory Registration of Biopesticides.

<b>Text Book:</b>
1. Sharma, A.K., 2003. Biofertilizers for sustainable agriculture, Agrobios.
<b>Reference:</b>
2. NIIR Board, 2004. The Complete Technology Book on Biofertilizer and Organic Farming, National Institute of Industrial Research.
3. Subba Rao, N.S. 2000 Soil Microbiology. Oxford and IBH Publishing Co. Ltd.
4. Verma A and Hock B. 1995. Mycorrhiza. ISBN
5. Yaacovokan, 1994 -Azospirillum, CBC press.
6. Wicklow, D.T. and B.E. Soderstrom. 1997, Environmental and microbial relationships. Springer ISBN.
<b>Related online contents:</b>
1. <a href="http://ec.europa.eu/agriculture/organic/organic-farming/what-organic_en">http://ec.europa.eu/agriculture/organic/organic-farming/what-organic_en</a>
2. <a href="http://attra.ncat.org/organic.html#list">http://attra.ncat.org/organic.html#list</a>
3. <a href="http://www.epa.gov/agriculture/tbio.html">http://www.epa.gov/agriculture/tbio.html</a>

Mapping with programme outcomes					
COs	P01	P02	P03	P04	P05
C01	S	S	S	S	S
C02	S	M	S	S	S
C03	S	S	M	S	S
C04	S	M	S	S	M
C05	M	S	S	M	S

\*S- STRONG, M- MEDIUM, L- LOW

## Semester I &amp; II

<b>Course Code: 21UZOA1</b>	<b>ALLIED COURSE - I - BOTANY</b>
<b>Plant Diversity, Taxonomy, Morphology, Anatomy, Embryology, Plant Physiology, Biochemistry, Plant pathology, Cytology, Genetics, Molecular biology, Ecology and Evolution(For Zoology Students)</b>	<b>Syllabus version (2020 -2021)</b>

<b>Objectives:</b>
1. To understand the plant organization, their structure and function
2. To observe the variations among plants, especially angiosperms.
3. To understand the external and internal metabolism of plants
4. To understand the various physiological processes in plants
5. To study the progress made in the field of cell, cell organelles and their functions.
6. To understand the basic concepts of ecosystem and biodiversity.
<b>Expected Course Outcomes</b>
1. Understand the importance of Bio resources
2. Describe the characters of families with their economic importance
3. Get a good knowledge about descriptive terms used in Taxonomy and classification
4. Know about the plant diseases
5. Get an overview about the Algae, Fungi, Bryophytes, Pteridophytes and Gymnosperms.

**UNIT I – PLANT DIVERSITY AND TAXONOMY**

Plant diversity: General characters of algae, lichen, fungi, bryophytes, pteridophytes and gymnosperms - Structure and life history of the following genera -, Chlamydomonas, Fruticose, Polyporus, Funaria, lycopodium and Pinus - Economic importance of algae and fungi.

Taxonomy: Plant nomenclature – ICBN - Bentham & Hooker system of classification - Systematic floral characters and their economic importance of Caesalpiniaceae, Rubiaceae, Apocynaceae, Annonaceae, Malvaceae, Amaranthaceae and Cucurbitaceae.

**UNIT II – MORPHOLOGY, ANATOMY, EMBRYOLOGY**

Morphology: The plant body of - root, stem, leaf, flower, fruit and seed.

Anatomy: Meristems – General account and Classification - Organization of shoot and root apical meristems - Tissue (Simple and Complex) - Anatomical structure monocot root and stem, Dicot - Root and Stem.

Embryology: Structure of mature anther and ovule - Microsporogenesis and Megasporogenesis - Present concept of fertilization.

**UNIT III – PLANT PHYSIOLOGY, BIOCHEMISTRY AND PLANT PATHOLOGY**

Physiology: Osmosis, Absorption water and minerals - transpiration - Plant mineral relationships – General characteristics of Photosynthesis and Respiration (Glycolysis – Kreb’s cycle) - Phytohormones: Auxins, gibberellins, cytokinins, ethylene and abscisic acid - Tropic movements - (Phototropism, geotropism and Chemotropism) - Photoperiodism and Vernalization.

Biochemistry: General characteristics of carbohydrates, protein and lipid.

Plant pathology: Importance of plant diseases - Scope and objective of plant pathology – Bacterial disease of citrus canker - fungal disease of - Tikka disease of Ground nut and sugarcane - Red Rot.

#### UNIT IV – CYTOGENETICS AND MOLECULAR BIOLOGY

Cytology: (Ultrastructure of plant cell) - cell wall, mitochondria, chloroplast, nucleus, endoplasmic reticulum, golgi complex - Chromosomes and its types – Cell division – Mitosis and Meiosis. Genetics: Mendel's law of monohybrid and dihybrid - linkage and crossing over - concepts of gene – Cistron, Mutton and recon.

Molecular biology – Nucleic acids as genetic material – Types of Nucleic acids – Replication of DNA – Methods and models in DNA repair mechanism.

#### UNIT V – ECOLOGY AND EVOLUTION

Ecology: Scope of plant ecology - Structure and function of ecosystem - Environmental impact and assessment in India (EIA).

Evolution: Origin and evolution of life - Theories of evolution: Lamarkism, Darwinism and principles of Hugo de Vries. Population genetics - Methods of studying population structure.

<b>Text Books:</b>
1. Pandey, S.N., S.P. Misra and P.S. Trivedi. 2002. A Textbook of Botany. Volume II. Vikas Publishing House Pvt Ltd, New Delhi.
2. Heywood, V.H., 1967, Plant Taxonomy. English Language Book Society, London.
3. Esau, K., (1953) Plant Anatomy. Jon Willey & Sons Inc, New York.
4. Maheshwari, P.,(1988) An Introduction to the Embryology of Angiosperms, McGraw-Hill.
<b>References:</b>
1. Noggle, G.R. and Fritz, G.J. 2001, Introductory Plant Physiology, Prentice Hall, India.
2. Devlin, R.M., 2000, Plant Physiology, Affiliated East West Press Pvt. Ltd.
3. Pandey, S.N. & Sinha, 2010, Plant Physiology, Vikas Publishing, New Delhi.
4. Mehrotra R.S., 1994, Plant pathology, Tata Mc Graw publishing company Ltd.
5. Verma P.S and Agarwal V.K. 2006. Cell Biology, Genetics, Molecular Biology, Evolution and Ecology. S. Chand & Company Ltd
<b>Related Online Contents</b>
1. <a href="https://swayam.gov.in/nd2_cec20_bt11/preview">https://swayam.gov.in/nd2_cec20_bt11/preview</a>
2. <a href="https://www.swayamprabha.gov.in/index.php/program/archive/9">https://www.swayamprabha.gov.in/index.php/program/archive/9</a>
3. <a href="https://swayam.gov.in/NPTEL">https://swayam.gov.in/NPTEL</a>
4. <a href="https://swayam.gov.in/nc_details/NPTEL">https://swayam.gov.in/nc_details/NPTEL</a>

<b>Mapping with programme outcomes</b>					
<b>COs</b>	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>
<b>CO1</b>	S	S	S	S	S
<b>CO2</b>	S	M	S	S	S
<b>CO3</b>	S	S	M	S	S
<b>CO4</b>	S	M	S	S	M
<b>CO5</b>	M	S	S	M	S

\*S- STRONG, M- MEDIUM, L- LOW

## Semester I &amp; II

Course Code : 21UA02P	ALLIED PRACTICAL – BOTANY
Plant Diversity, Taxonomy, Morphology, Anatomy, Embryology, Plant Physiology, Biochemistry, Plant pathology, Cytology, Genetics, Molecular biology, Ecology and Evolution (For Zoology Students)	Syllabus version 2020 -2021

<b>Course Objectives:</b>
1. To get practical on morphological and anatomical features of algal and fungal, Pteridophytes, and Gymnosperm species
2. To understand the physiological process of plants.
<b>Course outcomes:</b>
1. Experiencing in handling specimens and preservation of different group of plants species.
2. Imparting knowledge on morphology, taxonomy and biochemistry of plants
3. Acquiring knowledge on diversity of pteridophyte and gymnosperms.
4. Understanding ecological relationship in plants.
5. Acquiring knowledge on cyto-genetics, evolution and molecular aspect in plant growth and development.

**ALGAE, FUNGI AND LICHEN**

Microscopic observations of algal and fungal types and their slides included in the syllabus  
Section cutting of *polyporus* fruit body and lichen

**BRYOPHYTES**

Microscopic observation of slides of genera included in the syllabus.

**PTERIDOPHYTES**

A study of the morphology, anatomy and structure of the vegetative and reproductive parts of the sporophytes and gametophytes (wherever available of *lycopodium* and *marselia*).

**GYMNOSPERM**

Preparation of transverse section of the rachis and leaflet of *Pinus* observe and record the internal structure.

**TAXONOMY**

Training in dissection, observation, identification, sketching of floral parts, construction of floral formula and sketching of floral diagram of plants belonging to the families mentioned in the theory syllabus.

Description of the plants in technical terms.

**MORPHOLOGY**

Study of Root, stem, Leaf, Fruit and Seed.

Inflorescence : Study of types included in the theory syllabus

**ANATOMY**

Preparation of transverse section of the following plant parts to Observe and record the internal structure.

Primary structure of monocots stem and root

Primary structure of monocot stem and root

**EMBRYOLOGY**

Study of permanent slides showing T.S of anther and ovule types



**PLANT PHYSIOLOGY, BIOCHEMISTRY AND PLANT PATHOLOGY**

Experiments included in the syllabus – demonstration only

**CYTOLOGY, GENETICS AND MOLECULAR BIOLOGY**

Study of the cell structure of plants and its organelles using electron micro-graphs from standard publication.

Study of mitosis stages using photographs.

Study of Mendal's monohybrid cross, Dihybrid cross using photographs.

Study of DNA and RNA

**ECOLOGY AND EVOLUTION**

Demonstration of the following: Food chain, food web and ecological pyramid.

Evolution - Demonstration only (mentioned in the theory syllabus).

<b>Mapping with programme outcomes</b>					
<b>COs</b>	<b>P01</b>	<b>P02</b>	<b>P03</b>	<b>P04</b>	<b>P05</b>
<b>C01</b>	S	S	M	S	S
<b>C02</b>	M	S	S	M	M
<b>C03</b>	S	S	S	S	S
<b>C04</b>	M	M	S	M	S
<b>C05</b>	S	S	S	S	S

\*S- STRONG, M- MEDIUM, L- LOW