ACADEMIC (1-BOARD OF STUDIES) SECTION

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Prasult vitapathajav sanctional vibyan v tanban vitipathakvelo padtagur stavaariyil pratham vachche CBS Pattern

Visarache amatyakram shrikanth vach 2019-20 padhun lagnu karyayavart.

Pariyak

Yaa pariyaan-vache sarv sapighbitama khandivipay manthe ko, dinak 08 june 2019 ravi sangh

Shalstha 440 M. Vithya pariyan Baakshithiil echeetana vipat 44 k9/44-2019 vch utarawanag prasult

Vitipathakalvya prasult vitipathajav sanctional vibyan v tanban vitipathakvelo padtagur stavaariyil pratham

Varchye Harkile vibyaan che C.B.C.S. (Choice Based Credit System) Pattern

Visarache amatyakram shrikanth vach 2019-20 padhun lagnu karyayavart.

1. Botany
2. Certificate Course in Industrial Safety, Health and Environmental Management (SHM)
3. Chemistry
4. Computer Application
5. Computer Network
6. Computer Science
7. Geophysics
8. Mathematics
9. M.C.A.
10. Microbiology
11. Physics
12. Zoology

Sadarit pariya v amatyakram prasult vitapathajav www.srtmun.ac.in yaa sankhyayav

Upadhyv Aahite. Tare sadarit bavhi sarv sapighbitama nidaranavas aasho chavvi.

Saadhin "parisar,
Vishnumur, Nanded - 431 606.

Ya.k.: shrikanth-1/pariyan/ sankhure/padtagur- sivashree

Amatyakram/ 2019-20/465


Prat Mahiti v pudhe kale karyavasannyav:
1) M. Kulasany, yaache karyaapathy, prasult vitapath.
2) M. Jashwanth, Pahushe v Muvdmavan Mandat yaanche karyaapathy, prasult vitapath.
3) M. Suresh, Sarv sapighbitam sankhure, vitapath parisar, prasult vitapath.
4) Sahastryak Kulasany, Padtagur Vibhag, Prasult Vitapath.
5) Upasantryak, Pavan Vibhag, Prasult Vitapath.
6) Sistem Ekalpare, Shreekanth Vibhag, Prasult Vitapath.
SWAMI RAMANAND TEERTH MARATHWADA UNIVERSITY, NANDED

SEMESTER PATTERN CURRICULUM UNDER

CHOICE BASED CREDIT SYSTEM (CBCS)

for

Post Graduate Program
Faculty of Science and Technology

SUBJECT: BOTANY

Program Code: SLS-S-BOT-PG

M. Sc. First Year

With Effect from June 2019..
Introduction:

The University Grants Commission (UGC) has initiated several measures to bring equity, efficiency and excellence in the Higher Education System of the country. The important measures taken to enhance academic standards and quality in higher education include innovation and improvements in the curriculum, teaching-learning process, examination and evaluation systems, besides governance and other matters.

Swami Ramanand Teerth Marathwada University has several initiatives towards academic excellence, quality improvement and administrative reforms. In view of this priority and in-keeping with Vision and Mission, process was already initiated towards introduction of semester system, grading system and credit system. University had implemented Choice Based Credit System (CBCS) pattern at PG level on Campus from the academic year 2014-2015 progressively. These regulations are called as Regulations on Swami Ramanand Teerth Marathwada University Choice Based Credit System 2014. Further, Revised Guidelines for implementation of CBCS in Campus and Sub Centre w.e.f. 2019-20 were also issued.

Revision and updating of the curriculum is the continuous process to provide an updated education to the students at large. In view of this priority and in-keeping with Vision and Mission, process of revision and updating the curriculum is initiated and implemented at PG level from the academic year 2019-2020 progressively. Presently there is wide diversity in the curriculum of different Indian Universities which inhibited mobility of students in other Schools of the Campus, Universities or States. To ensure uniform curriculum at PG level, curriculum of different Indian Universities, syllabus of NET, SET, MPSC, UPSC, Forest Services and the UGC model curriculum are referred to serve as a base in updating the same.

The CBCS provides choice for students to select from the prescribed courses. The choice based credit system provides a ‘cafeteria’ type approach in which the students can take courses of their choice, learn at their own pace, undergo additional courses and acquire more than the required credits, and adopt an interdisciplinary approach to learning. Our university has already introduced the choice based credit system. The semester system accelerates the teaching-learning process and enables vertical and horizontal mobility in learning.

Keeping in mind BOS in Botany prepared the curriculum to ensure up-to-date level of understanding of plant sciences. Studying plant sciences prepares the students for a career
working either in an educational institution or an industry in which they can be directly involved in the research and development and Knowledge of modern and applied plant science and excellent career prospects.

The study of Botany aims to expand and increase current knowledge about plants in order to solve problems in many fields including agriculture, ecology, medicine, biotechnology and horticulture are some of the objectives kept in mind during executing the syllabus.

The addition of Discipline Specific Elective Courses which includes Skill Enhancement Courses aims to develop skills in plant sciences and practical experience in the students.

At the end of the curriculum, the students should have increased: an aptitude towards science and nature and also undertake the fundamental and applied research in plant science in the benefit of the human and nature.

At last comments, suggestions are welcome from all the teachers, stakeholders and students for the upbringing the curriculum.

**Salient Features:**

The syllabus of M Sc Botany has been framed to meet the requirement of Choice Based Credit System. The courses offered here in will train and orient the students in the specific fields of Botany.

Apart from the Fundamental and applied Core Courses, the Discipline Specific Elective Courses deals with Pharmacognosy, Phytochemistry and Phytotherapy, Biodiversity and Conservation and Fungal Biotechnology. Skill Development Courses deals with Communication Skills in English and Foreign Language-French or Spanish.

Open Elective Courses provides an option to learn courses of their own choice across the Discipline from the Other Schools of the Campus or any other Institute. It also provides the option to learn online Courses of their choice like MOOC-NPTEL-SWAYAM.

The Discipline Specific Elective Courses which includes Skill Enhancement Courses like Technology of Fruit and Vegetable Processing and Technology of Biofertilizer Production offered during this program are designed with the aim of imparting specific skills to the students which will lead to the self employability through development of their own enterprises.

This would help students to lay a strong foundation in the field of Botany.
Overall after completion of this course, students will also acquire fundamental knowledge in Plant Science and also understand that Botany is an integral part of the human life and developments.

**Utility of Program**

This program will train and orient the students in the field of diversity of different plant life forms, Biochemistry, Cell Biology, Genetics and Molecular Biology, Plant Development and Reproduction, Bioinstrumentation, r-DNA Technology, Plant Physiology and Metabolism, Taxonomy of Angiosperms and Systematics, Plant Biotechnology, Biostatistics and Bioinformatics, Mycology and Plant Pathology, Phytochemistry and Phytotherapy, Pharmacognosy, Biodiversity and Conservation, Fungal Biotechnology in relation to Environment and Agriculture as well as Biotechnological, Pharmaceutical and Herbal Industries. This will help the students for their career development.

Skill Enhancement Courses being offered during this program like Technology of Fruit and Vegetable Processing and Technology of Biofertilizer Production will provide job opportunities and additional specific skills to the students for self employability through the development of their own enterprises.

Skill Development Courses like Communication Skills in English or Foreign Language-French or Spanish shall help the students to develop the skills in the respective language.

Open Elective Courses of their own choice from the Other Schools of the Campus or any other Institute or from online Courses like MOOC-NPTEL-SWAYAM will help the students to protect their interest across the Discipline.

**Learning Objectives:**

**The Objective of this program are:**

1. To provide an updated education to the students at large in order to know the importance and scope of the discipline and to provide mobility to students from one School or University or State to other.

2. To update curriculum by introducing recent advances in the subject and enable the students to face NET, SET, UPSC and other competitive examinations successfully.

3. To expose themselves to the diversity amongst life forms.
4. To develop a scientific attitude to make students open minded, critical and curious.

5. To develop an ability to work on their own and to make them fit for the society.

6. To develop skill in practical work, experiments, equipments and laboratory use along with collection and interpretation of plant materials and data.

7. To make aware of natural resources and environment and the importance of conserving the same.

8. To develop ability for the application of the acquired knowledge in the fields of life so as to make our country self reliant and self sufficient.

9. To appreciate and apply ethical principles to plant science research and studies.

**Prerequisite:**

The optional courses are offered to the students registered for post-graduate programs. Such students should have the basic knowledge of Plant Science and willing to gain additional knowledge in the field of Botany.

The students who passed B. Sc. with Botany as one of the optional subjects with 24 Credits OR B Sc Botany are eligible to take admission for this PG course.
### Class: M. Sc. First and Second Year

**An Outline:**

<table>
<thead>
<tr>
<th>Semester</th>
<th>Course Code</th>
<th>Title of the Course</th>
<th>No. of Instructional hrs /week</th>
<th>Type of Course</th>
<th>Total Credits</th>
<th>Marks MSA</th>
<th>ESA</th>
<th>Total Marks</th>
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<td><strong>Semester I</strong>&lt;br&gt;THEORY</td>
<td>BOT-C101</td>
<td>Biochemistry</td>
<td>04</td>
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<td></td>
<td>BOT-C102</td>
<td>Cell Biology</td>
<td>04</td>
<td>CC</td>
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<td></td>
<td>BOT-C103</td>
<td>Biology and Diversity of Algae, Bryophytes, Pteridophytes and Gymnosperms</td>
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<td>CC</td>
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<td>*BOT-E101 OR E102</td>
<td>Technology of Fruit and Vegetable Processing OR Technology of Biofertilizer Production</td>
<td>04</td>
<td>DSE</td>
<td>04</td>
<td>50</td>
<td>50</td>
<td>100</td>
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<td><strong>Semester I</strong>&lt;br&gt;PRACTICAL</td>
<td>BOL-C101</td>
<td>Lab Course in Biochemistry</td>
<td>04</td>
<td>CC</td>
<td>02</td>
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<td></td>
<td>BOL-C102</td>
<td>Lab Course in Cell Biology</td>
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<td><strong>Semester II</strong>&lt;br&gt;THEORY</td>
<td>BOT-C201</td>
<td>Genetics and Molecular Biology</td>
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<td></td>
<td>BOT-C202</td>
<td>Ecology, Plant Development and Reproduction</td>
<td>04</td>
<td>CC</td>
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<td></td>
<td>BOT-C203</td>
<td>Bioinstrumentation</td>
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<td>CC</td>
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<td>*BOT-E201 OR E202</td>
<td>Pharmacognosy OR Biodiversity and Conservation</td>
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<td>BOL-</td>
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<td>C202</td>
<td>Development and Reproduction</td>
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<td>BOL-C203</td>
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<td>Lab Course in Pharmacognosy&lt;br&gt;<strong>OR</strong> Lab Course in Biodiversity and Conservation</td>
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**Semester III**

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<tr>
<td>BOT-C301</td>
<td>r-DNA Technology</td>
<td>04</td>
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<td>BOT-C302</td>
<td>Plant Physiology and Metabolism</td>
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<td>BOT-C303</td>
<td>Taxonomy of Angiosperms and Systematics</td>
<td>04</td>
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<td>***BOT-E301&lt;br&gt;<strong>OR</strong>&lt;br&gt;E302&lt;br&gt;<strong>OR</strong>&lt;br&gt;E303</td>
<td>Communication Skills in English&lt;br&gt;<strong>OR</strong> Foreign Language-French&lt;br&gt;<strong>OR</strong> Foreign Language-Spanish</td>
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**PRACTICAL**

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<th>Course Code</th>
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<th>Type</th>
<th>Credits</th>
<th>MSA</th>
<th>ESA</th>
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<tr>
<td>BOL-C301</td>
<td>Lab Course in r-DNA Technology</td>
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<td>BOL-C302</td>
<td>Lab Course in Plant Physiology and Metabolism</td>
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<td>BOL-C303</td>
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**Semester IV**

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<th>ESA</th>
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<td>BOT-C401</td>
<td>Plant Biotechnology</td>
<td>04</td>
<td>CC</td>
<td>04</td>
<td>50</td>
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<td>BOT-C402</td>
<td>Biostatistics and Bioinformatics</td>
<td>04</td>
<td>CC</td>
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<tr>
<td>BOT-C403</td>
<td>Mycology and Plant Pathology</td>
<td>04</td>
<td>CC</td>
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<tr>
<td>**BOL-E401&lt;br&gt;<strong>OR</strong>&lt;br&gt;E402</td>
<td>Phytochemistry and Phytotherapy&lt;br&gt;<strong>OR</strong> Fungal Biotechnology</td>
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<td>DSE</td>
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<td>OE</td>
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**PRACTICAL**

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<th>MSA</th>
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<td>BOL-C401</td>
<td>Lab Course in Plant Biotechnology</td>
<td>04</td>
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<tr>
<td>BOL-C402</td>
<td>Lab Course in Biostatistics and Bioinformatics and Mycology and Plant Pathology</td>
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<tr>
<td>BOL-C403</td>
<td>Project / Review Writing</td>
<td>04</td>
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CC: Core Course, OE: Open Elective Course, DSE: Discipline Specific Elective Course, SDC- Skill Development Course, MSA: Mid Semester Assessment, ESA: End Semester Assessment, Credits of four semesters = 100.
**Discipline Specific Elective**   **Open Elective / Skill Development Elective Course**

*indicates an Elective Course. Botany student, in a particular sem, can opt for either of these Courses OR a Course offered by Other Programs of the School.

**indicates an Open Elective Course. Botany student must opt for any Open Elective Course OR Skill Development Course offered by Other Schools of the Campus OR MOOC-SWAYAM-NPTEL Course.

***indicates Skill Development Elective Course

Total Credits / year = 50; Total Credits of All Four Semesters = 100; Total Marks of All Four Semesters = 2500; MSA: Two Internal Exams of 15 Marks each (based on MCQs), Home assignment of 10 Marks, Seminar of 10 Marks for each Course.

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**LIST OF OPEN ELECTIVES IN BOTANY FOR OTHER SCHOOLS**

<table>
<thead>
<tr>
<th>Sr No</th>
<th>Course Code</th>
<th>Title of Open Elective Course</th>
<th>No of credits</th>
<th>Semester in which it is offered</th>
<th>Prerequisite of the student (Eligibility)</th>
<th>Course Instructor</th>
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</thead>
<tbody>
<tr>
<td>1.</td>
<td>BOT OE 101</td>
<td>Fundamentals of Plant Tissue Culture</td>
<td>02</td>
<td>I / III</td>
<td>Should have studied Biology at XII</td>
<td>Dr B S Surwase</td>
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<tr>
<td>2.</td>
<td>BOT OE 201</td>
<td>Basics of Plant Identification</td>
<td>02</td>
<td>II / IV</td>
<td>Should have studied Biology at XII</td>
<td>Dr B S Surwase</td>
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<tr>
<td>3.</td>
<td>BOT OE 301</td>
<td>Biofertilizers</td>
<td>02</td>
<td>I / III</td>
<td>Should have studied Biology at XII</td>
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<tr>
<td>4.</td>
<td>BOT OE 401</td>
<td>Herbal Botany</td>
<td>02</td>
<td>II / IV</td>
<td>Should have studied Biology at XII</td>
<td>Dr B S Surwase</td>
</tr>
</tbody>
</table>
Course Objectives: The Students will know how the collection of thousands of inanimate molecules that constitute living organisms interact each other to maintain and perpetuate life governed solely by the physical and chemical laws as applicable to the non-living things.

Learning Outcomes: Students will be able to
1. Know the chemical constituents of cells, the basic units of living organisms.
2. Explain various types of weak interactions between the biomolecules.
3. Know how the simple precursors give rise to large biomolecules such as proteins, carbohydrates, lipids and nucleic acids.
4. Correlate the structure-function relationship in various biomolecules
5. Know the role of biomolecules for orderly structures of the cells/tissues.

UNIT I

UNIT II
Amino acids and Proteins: Amino acids as building blocks of proteins, their structure, classification and chemical properties; non- protein organic amino acids; Structure of peptide bond, organizational levels of protein structure; alpha- helix, beta pleated sheet, Ramachandran Plot.

UNIT III

UNIT IV
Carbohydrates: Classification, monosaccharide – structures and function; reactions of monosaccharides- mutarotation, glycoside formation, reduction and oxidation, epimerization and Esterification , important monosaccharides and disaccharide; Polysaccharides –overview,
structure; important polysaccharide; plant polysaccharide; Glycosaminoglycans and Glycoproteins.

**Lipids:** Fatty acids as building blocks of most lipids, their structure and properties, classification of lipids, General structure and function of major lipid subclasses: Acylglycerols, Phosphoglyceride, Sphingolipids, glycosphingolipids, terpenes, steroids, Prostaglandins

**References:**


**BOL C101 Laboratory course in Biochemistry**

1. Calibration of instruments and verification of Lambert-Beer’s Law

2. Preparation of buffer solutions

3. Determination of pK values of amino acids

4. Estimation of reducing sugars

5. Estimation of total carbohydrates, amino acids and proteins

6. Estimation of amino acids

7. Estimation of proteins

8. Qualitative tests of carbohydrates

9. Quantitative analysis of lipids

10. Quantitative analysis of nucleic acids

11. Iodine number of given oil

12. Isolation of proteins from seeds

13. Determination of Achromatic point
Learning Objectives:
1. To provide understanding of the different microscopic techniques used to study the biology of cell.
2. To understand the structure and role of various cell organelles.
3. Acquire in-depth knowledge of the cellular components underlying mitotic and meiotic cell division and regulation of cell cycle.
4. To have a concrete knowledge about transport and cell to cell communication in animals as well as plants.
5. To provide wider perspective of cancer and its control.

Learning Outcomes: On completion of this course, the students shall:
1. Understand the structure and function of cell and its organelles. Also, acquire knowledge on cell cycle and its regulation.
2. Acquire the knowledge about transport and cell to cell communication in animals as well as plants.
3. Acquire knowledge about causes of cancer, tumour suppressor genes and control of cancer.

UNIT-I
Investigating the Cell: Cell theory, Microscope and its modifications: light, phase contrast, fluorescence, scanning and transmission electron microscopy.

Cell Organelles: Cell wall: Structure and functions; Plasma membrane: Molecular organization and functions; Vacuole: Tonoplast membrane, transporters, storage organelle; Glyoxysomes and peroxisomes: Structure, enzymes and functions: Golgi complex: Organization, role in storage and secretion; Cytoskeleton: Composition and organization of microtubules and microfilaments, role in cell division and mobility, intracellular motility; Lysozymes: Enzymes and role, Nucleus: structure, organization and regulation of nuclear pure complex, Role of Sarcoplasmic Reticulum in muscle contraction; Melanosomes, E/R etc.

UNIT-II
Transport across membrane: Cell and transport processes, simple diffusion, facilitated diffusion, Active transport, Sodium- potassium pump, proton pump, transport into prokaryotic cells, endocytosis and exocytose.

Cell Interactions: Extracellular matrix of animal cells, cell-cell recognition and adhesion, cell junctions.

Energy transaction: Role of mitochondria and chloroplast in energy transaction.
UNIT-III

Cell division and cell cycle: Mitosis, meiosis, their regulation, steps in cell cycle and control of cell cycle.

Cell Signalling: Hormones and their receptors, Cell surface receptors, Signalling through G-protein coupled and protein kinase associated receptors, Signal transduction pathways, Second messenger, Bacterial and plant two component signalling systems, Bacterial chemotaxis and quorum sensing, Signal transduction induced by auxins and GA in plants.

UNIT-IV

Cancer: Normal cells and cancer cells, Causes, Genetic arrangements in progenitor cells, Oncogenes, Tumour suppressor genes, Cancer and cell cycle, virus induced cancer, Metastasis, interaction of cancer cells with normal cells, Therapeutic interventions of uncontrolled cell growth.


References:
7. Lewis J. Kleinsmith, Principles of Cell and Molecular Biology
8. Philip Sheeler and Donald Bianeti, Cell and Molecular Biology by John Wiley and Sons

BOL -C102 Lab Course in Cell Biology
1. Microscopy
2. Demonstration of phenomenon of osmosis through a cell membrane.
3. Isolation of chloroplasts from spinach leaves.
4. Demonstration of Hill reaction to measure intactness of chloroplasts.
5. Isolation of mitochondria and mitochondrial swelling.
6. Isolation of mitochondria and activity of its marker enzyme, succinate dehydrogenase (SDH).
7. Fluorescence staining with FDA for cell viability and cell wall staining with calcofluor.
8. Study of mitosis.
11. Isolation of lysosomal fraction and estimation of acid phosphatase activity.
12. Study of Karyotyping and ideogram.
13. Orcein and feulgen staining of salivary gland chromosomes of chironomas and Drosophila.
14. WBC count.
15. Sub-cellular fractionation and marker enzymes.
Objectives
1. To understand diverse groups of organisms such as Algae, Bryophytes, Pteridophytes and Gymnosperms.
2. To impart detailed knowledge of diverse groups of organisms in the form of their habits and habitats, characters, classification and Economic/Ecological importance.

Outcomes:
This paper introduces several key markers to identify the Algae, Bryophytes, Pteridophytes and Gymnosperms.

UNIT I ALGAE
Algae in diversified habitats (Terrestrial, freshwater, marine), thallus organization, Cell structure, reproduction (Vegetative, asexual, sexual), pigments, reserve food, flagella, classification, salient features of Protochlorophyta, Chlorophyta, Charophyta, Xanthophyta, Bacillariophyta, Pheophyta and Rhodophyta, Algal blooms, Economic importance of algae-Algal biofertilizers, algae as food, feed and uses in industry.

UNIT II BRYOPHYTES
Distribution, morphology, structure, reproduction, life cycle, classification, Phylogeny, economic and ecological importance of Bryophytes, General account of Marchantials, Junger-manials, Anthocerotales, Sphagnales, Funariales and Polytrichales.

UNIT III PTERIDOPHYTES
Morphology, anatomy, reproduction, classification; evolution of Stele, heterosporry and origin of seed habit, general account of fossil pteridophytes, introduction of Psilopsida, Lycopsida, Sphenopsida and Pteropsida.

UNIT IV GYMNOSPERMS
References:

BOL-C103 Lab Course in Biology and diversity of Algae, Bryophytes, Pteridophytes & Gymnosperms

1. Microscopic and macroscopic observations with labelled sketches of the following types.
   a) Algae:- i) Cholorophyta:- Volvox, Chlorella, Oedogonium, Spirogyra, Zygnema etc.
      ii) Charophyta:- Chara, Nitella etc. iii) Cyanophyta:- Nostoc, Anabaena etc. iv) Pheophyta:-
      Ectocarpus v) Xanthophyta:- Voucheria vi) Rhodophyta:- Batrachospermum, Polysiphonia
      etc.
   b) Bryophyta:- Riccia, Marchantia, Anthoceros etc.
   c) Pteridophyta:- Psilotum, Lycopodium, Equisetum, Selaginella etc.
   d) Gymnosperm:- Cycus,Pinus, Gnetum, Araucaria, Ephedra etc.
2. Study of fossil specimens:-Compression, Impressions, Petrification.
4. Microscopic measurement of the algae.
5. Camera lucida drawings of some microscopic plants.
6. Collection, Preservation and Submission of material along with excursion/ field report.
Max Mark: 100           Periods: 60

Learning Objectives:
1. To impart knowledge of basic principles in fruit and vegetable processing.
2. To impart knowledge of different methods of fruits and vegetable processing.
3. To impart the knowledge about Food safety regulations like National Food Law (FSSA) and Other Food Laws.

Learning Outcomes: On completion of this course-
Students shall acquire training in processing technology of fruit and vegetable based products. Students shall also acquire knowledge about Food Safety Regulations. Over all, they will get opportunities in Food Technological Industries as well as they shall be able to start their own enterprises for self employment.

UNIT I INTRODUCTION
Importance of fruits and vegetables, Production and processing scenario of Fruits and vegetables in India and world, Scope of fruit and vegetable processing industry in India-present status, constraints and prospective. Principles and Methods of Preservation: Low temperature, High Temperature, Use of chemical preservatives, Irradiation, Drying/Dehydration, Removal of air etc

UNIT II FRUITS BEVERAGES, JAMS, JELLIES MARMALADES, CANDIES, TOFFEE AND BARS
FRUITS BEVERAGES: Introduction, Processing of fruit juices (selection, juice extraction, deaeration, straining, filtration and clarification), preservation of fruit juices (pasteurization, chemically preserved with sugars, freezing, drying, tetra-packing, carbonation), processing of squashes, cordials, nectars, concentrates and powder.
JAMS, JELLIES, MARMALADES, CANDIES, TOFFEE AND BARS

UNIT III PICKLES, CHUTNEYS AND SAUCES AND DEHYDRATUIN
PICKLES: Processing, Types, Causes of spoilage in pickling.

TOMATO PRODUCTS
Selection of tomatoes, pulping & processing of tomato juice, tomato puree, paste, ketchup, sauce and soup.

DEHYDRATION OF FOODS AND VEGETABLES
Sun drying & mechanical dehydration, process variation for fruits and vegetables, packing and Storage.

UNIT IV: FOOD SAFETY REGULATIONS

- National food law (FSSA), standards and regulations
  - Global Scenario
  - Other laws and standards related to food
- Food additives and contaminants
- Hygiene and sanitation
- HACCP

References:
9. M.G. Danthy .Fruit and Vegetable Processing .FAO, Rome

BOL-E101 Lab Course in Technology of Fruit and Vegetable Processing
1. Preparation of RTS beverage e.g. Amala, Mango and Pineapple etc
2. Preparation of jam/ jelly from selected fruit
3. Preparation of squash
4. Preparation of fruit candy
5. Preparation of fruit leather
6. Preparation of fruit toffee
7. Preparation of pickle
8. Preparation of banana and potato wafers
11. Estimation of Brix: acidity ratio
12. Estimation of ascorbic acid and effect of heat treatment on it.
13. Dehydration of fruits and vegetables.
14. Visit to fruit and vegetable processing units
Learning Objectives:
1. To impart knowledge about basic principles of Biofertilizer production.
2. To acquaint the students with knowledge on various methods of Biofertilizer application.

Learning Outcomes: On completion of this course, the students shall acquire knowledge in Biofertilizer production. They shall develop scientific skills in the field of Biofertilizers. Over all, they will get opportunities in Biofertilizer Industries as well as they shall be able to start their own enterprises for self employment.

UNIT I

UNIT II
Maintenance and Preparation of Biofertilizer: Culturing of microbes, preparation of inoculums, processing and preparation of carrier material, mass production, packaging and storage, Concept & its need in organic farming, treatment.

*Rhizobium* Biofertilizer: Characteristics, Host-*Rhizobium* interactions, *N₂* fixation in root-nodules, Production, Methods of application.

*Azotobacter* Biofertilizer: Characteristics, *N₂* fixation process, Production, Methods of application.

*Azospirillum* Biofertilizer: Characteristics, Association with plants, Production, Methods of application.

UNIT III
*Azolla* & BGA Bio fertilizers: *Azolla*: Characteristics, Production, Methods of application

BGA: Characteristics, *N₂* fixation process, Production, Methods of application

AM Biofertilizer: Characteristics & types of association, Production, Methods of application
UNIT IV
PSB Biofertilizer (Phosphate solubilising Bacteria) : Mechanism of phosphate solubilisation, Production , Methods of application
Quality control of Biofertilizers as per FCO (Fertilizer Control Order) : Introduction of FCO specifications for bio fertilizers , Sampling procedure , Methods of analysis, Standards of biofertilizers , Biostability of Biofertilizers.

References:
1. Soil Microbiology by Subbarao
2. Agriculture Microbiology by Rangaswamy.
5. Fertilizer Control Order–1985 amended up to June, 2011

BOL-E102 Lab Course in Technology of Biofertilizer Production
1. Isolation & preparation of bacterial fertilizer
   a) Azotobacter
   b) Azospirillum
2. Isolation and preparation of symbiotic biofertilizer: Rhizobium
3. Isolation of Phosphate solubilizing bacteria from soil.
4. Isolation and identification of AM fungi from soil and preparation of biofertilizer.
5. Determination of heterocyst frequency of blue-green bacteria.
6. Quality control of microbial inoculants
8. Determination of total nutrient content by spectrophotometric method
9. Evaluation of the P-solubilising capability of microorganism
10. Estimation of Nitrogenase activity by acetylene reduction assay
11. Colorimetric estimation of amino-N and nitrate-N.
13. Collection and preservation of root nodules in field trips
Learning Objectives:
1. Understanding Concept of Mendelian and post Mendelian of genetics.
2. Understanding Genome organization, Genome duplication and genome function in viruses, prokaryotes and Eukaryotes.

Learning Outcomes: Students must know the
1. Fundamentals of Mendelian and post-Mendelian genetics.
2. Genome (viral, prokaryotic and eukaryotic) organization, duplication and function.

UNIT I  FUNDAMENTALS OF GENETICS
Review of basic terminologies (Allele, multiple alleles, pseudoallele, complementation tests) and principles of Mendelian (Dominance, segregation, independent assortment) and post Mendelian genetics (Codominance, incomplete dominance, gene interactions, pleiotropy), genomic imprinting, penetrance and expressivity, phenocopy, linkage and crossing over, sex linkage, sex limited and sex influenced characters. Maternal inheritance.
Overview of human genetics (Pedigree analysis, lod score for linkage testing, karyotypes, genetic disorders). Quantitative genetics. Population genetics.
Structural and numerical aberrations of chromosomes, linkage maps, tetrad analysis, recombination, sex determination.
Introduction to Microbial genetics (Transformation, Conjugation, Transduction). Mutation.
Focus of genetic studies as a platform for advances in molecular biology.

UNIT II  DNA STRUCTURE AND GENOME ORGANIZATION
DNA structure and topology. Physical properties of DNA : Tm, hypo and hyper chromicity, solubility, mutarotation and buoyancy. Organization of Viral, Prokaryotic and Eukaryotic genome (Structure of chromatin, nucleosome, chromatin organization, chromosome, centromere, telomere. General organization (size, banding, microsatellites, Gene distribution and density) of plant (rice) and animal (human) genome including their organelle genomes, Organization of genes: rRNA encoding Genes, mRNA encoding Genes, small nuclear RNA genes. Overlapping genes, genes within genes, gene families, pseudo genes, truncated genes

Techniques and Technology involved in genome mapping low and high resolution mapping; Strategies and milestones in mapping and sequencing of human genome approaches to physical and genetic mapping. Next generation sequencing: principles and platforms. Principles and strategies for identifying unknown disease or susceptibility genes. Major genomic databases, Glimpses and significance of the recently sequenced genomes of organisms.

UNIT III DNA REPLICATION AND REPAIR:
DNA Replication models, DNA replication mechanism (Prokaryotes/eukaryotes). RNA world and RNA Replication. DNA modifying enzymes: DNA polymerases: types and mechanism of action. DNA damage and repair and recombination: mechanisms and structure and functions of enzymes involved. RNA Polymerases and reverse transcriptase: structure and mechanisms of action. DNA methyl transferases, Topoisomerase, Gyrase, Nucleases etc. Types, mechanisms, and significance of mutations.

UNIT IV REGULATION OF GENE EXPRESSION

Transcription in pro and eukaryotic organisms and transcription factors. Regulation of gene expression at transcriptional level (Phages, viruses, prokaryotic and eukaryotic genes). RNA processing: capping, polyadenylation, splicing, editing and transport of RNA. Structure and functions of ribonucleoproteins. Translation in pro and eukaryotic organisms and its regulation. Genetic code and factors. Translational proofreading, translational inhibitors. PTM.

References:
5. Genes IX. Lewin B. (2008),
7. Molecular Biology by Weaver.
17. Vogel and Motulsky's Human Genetics.

**BOL-C201 Laboratory course in Genetics and Molecular Biology**

1. Use of Drosophila as a model system in genetics: Life history, morphology, mutants, culture, sexing pupae for setting up crosses etc.
2. Gene interactions
4. Sex linked lethal in Drosophila.
6. Human karyotype and chromosomal aberrations.
7. Ames test for genotoxins.
8. UV mutagenesis.
10. Bacterial transformation.
15. Isolation of genomic DNA from different sources viz. plant, animal, yeast and bacteria.
16. Restriction digestion of genomic DNA and analysis.
17. Thermal melting of DNA.
18. Agarose gel electrophoresis of DNA.
19. Isolation of organelle genome and restriction digestion.
Learning Objectives:
1. To acquaint the students with various aspects of Ecology
2. To understand the various aspects of plant development.
3. To understand sexual incompatibility and types of endosperms

Learning Outcomes:
After completion of this course, students shall be able to understand the each phase of development of seeds and different plant parts.

UNIT I
Principals of ecology:
Habitat and niche: Concept of Habitat and niche. Ecosystem Ecology: Ecosystem structure; ecosystem function; energy flow and mineral cycling (C, N, S and P); primary production and decomposition; structure and function of some Indian ecosystems: terrestrial (forest, grassland) and aquatic (fresh water, marine, estuarine).
Applied Ecology: Environmental pollution; global environmental change; biodiversity: status, monitoring and documentation; major drivers of biodiversity change; biodiversity management approaches

UNIT II
Fundamentals of development:
UNIT III

Shoot Development: Organization of Shoot apical meristem, tissue differentiation (Xylem and Phloem)

Root development: Organization of root apical meristem, vascular tissue differentiation.

Floral Development: Floral development in Antirrhinum

Development of male gametophyte: Structure of anthers, microsporogenesis, role of tapetum, pollen development, pollen tube development and guidance.

Development of female gametophyte: Ovule development, megasporogenesis, organization of embryo sac and its types (mono, bi, tetra etc.).

Pollination and seed development: Pollination mechanism and vectors, Mechanism of pollen stigma interactions (self-incompatibility)

UNIT IV

Double fertilization and triple fusion, role of synergids, endosperm development and imprinting. Seed formation and germination: Seed formation, cotyledon, endosperm and seed coat development. Seed dormancy and germination, seedling development

Embryogenesis: Basic layout of dicot and monocot embryos, stages of embryo development, embryonic axis, cell division and pattern formation in embryo, genetic and hormonal regulation of embryo development, cell polarity in embryo, Embryogenesis mutants.

References:

23. Essentials of Ecology and Environmental Science by S.V S. Rana

**BOL-C202 Lab Course in Ecology, Plant Development and Reproduction**

1. Random sampling to measure the abundance of various different species on an area of grassland.
2. To study communities by quadrat method and to determine % Frequency, Density and Abundance.
3. To determine the basal cover, or vegetational cover of one herbaceous community by quadrat method.
4. To determine diversity indices (richness, Simpson, Shannon-Wiener) in grazed and protected grassland.
5. To determine transparency or turbidity of different water bodies.
6. To measure amount of dissolved oxygen content in polluted and unpolluted water bodies.
7. Study of vascular tissues.
8. Comparative anatomy of dicot and monocot stem.
9. Study of types of trichomes, stomata and hairs.
10. Microtomy.
12. *In vivo* germination of pollen grains on stigma.
13. Study and types of pollen grains
14. Pollen viability (Tetrazolium test) and Germination: Calculation of percentage germination in different media using hanging drop method
15. Study and types of Embryo sacs
17. Megasporogenesis
19. Educational tour to Sanctuaries and National park.
Learning Objectives:
1. To impart knowledge about basic principles of Bioinstrumentation.
2. To acquaint the students with knowledge on various techniques and methods of biochemical analysis.

Learning Outcomes: On completion of this course, the students shall:
1. Demonstrate the knowledge about the techniques of Bioinstrumention.
2. Acquire knowledge in biochemical analysis.
3. Shall develop scientific skills to analyze the structure of biomolecules and their functions.

UNIT I: SEPARATION TECHNIQUES, CHROMATOGRAPHY AND CENTRIFUGATION
General principles, classification, separation, mechanisms, Thin layer, Paper, affinity, gel permeation, ion exchange, GLC, HPLC, HPTLC, Preparative and analytical centrifugations and their applications.

Unit II: ELECTROPHORETIC TECHNIQUES
Basic principles of electrophoresis, factors affecting electrophoresis, Electrophoretic mobility, paper and gel electrophoresis, Native and denaturing PAGE, iso-electric focusing, purse field gel electrophoresis.

Unit III: SPECIAL TECHNIQUES
Theory and applications of ultra violet and visible spectroscopy, Infrared (IR), Nuclear magnetic resonance (NMR), AAS, Mass(MS) Raman, Fluorescence and X-ray spectroscopy and applications.

Unit IV: RADIATION AND NON-RADIOACTIVE TECHNIQUES
Tracer Technology, dose response relationship, radioisotopes in diagnostic and biotechnology. Geiger Muller Counter, Scintillation counter, Metabolic tracer techniques, non-radioactive labels, labelling and detection methods using florescent molecules.

References:
5. Gel Electrophoresis of Proteins- A Practical Approach – Hanes
7. Analytical Biochemistry – Holme
9. Spectroscopy- B. P. Straughan and S. Walker
11. Gel Chromatography – Tibor Kremmery, wiley Publications

**BOL-C203 Lab Course in Bioinstrumentation**

1. Separation of Lipids by thin layer chromatography
2. Gel filtration
3. Separation of blue dextran and cobalt chloride on Sephadex G25
4. The separation of proteins by ion exchange chromatography
5. The separation of serum proteins by electrophoresis on cellulose acetate
6. Separation of sub cellular organelles by differential centrifugation
7. Separation of amino acids by paper chromatography.
8. Separation and identification of plant pigments by Thin Layer Chromatography.
9. Demonstration of HPTLC
11. Demonstration of Giger Muller Counter (GMC)
Course Objective:
1. To know the crude drugs and their chemical nature
2. To carry out the pharmacognostic evaluation of crude drugs
3. To know the cultivation and marketing of crude drugs.

Course Outcomes:
Upon completion of the course, the student shall be able to know different crude drugs, their evaluation, cultivation techniques, production and regulation of crude drugs.

UNIT-I: PHARMACOGNOSY I
Definition, scope and development of Pharmacognosy, classification of drugs.
(a) Sources of Drugs – Plants and Animals.
(b) Organized drugs, unorganized drugs (dried latex, dried juices, dried extracts, gums and mucilage, oleoresins and oleo- gum -resins).

Comparative study of IP, European Pharmacopoeia, BP / Ayurvedic Pharmacopoeia of India

UNIT-II: PHARMACOGNOSY II
Medicinal plants of Marathwada and Maharashtra: morphology, distribution, characteristics of powder constituents, chemical tests and uses of following drugs.
Root drugs: Asperagus, Withania.
Rhizome drugs: Zingiber, Curcuma
Stem/ Bark drugs: Tinospora, Acacia, Arjuna
Leaf drugs: Adhatoda, Vitex.
Fruit and Seed drugs: Mucuna, Terminalia bellerica
Fruit Drug: Coriandrum sativum Linn

UNIT III: EVALUATION OF DRUGS
Concept, considerations, parameters (Identity, quality and purity) and methods of quality control for medicinal plant materials as per various pharmacopoeia and other guidelines: Organoleptic (Morphological) evaluation, Microscopic or anatomical evaluation, physical evaluation, chemical evaluation, analytical evaluation (Chromatographic techniques and spectrophotometric methods), biological evaluation (Introduction and Indication, significance, Methods of studies).
Presentation of data Monographs and Revisions, Synopsis. Use of GPS and computational in field work.

UNIT-IV: CULTIVATION OF DRUGS, PROCESSING AND QUALITY CONTROL

Cultivation and Collection of drugs of natural origin. Factors influencing cultivation of medicinal plants. Role of Pharmacognosy in allopathy and traditional systems of medicine namely, Ayurveda, Unani, Siddha and Homeopathy (AYUSH).

Formulation & Manufacturing, Quality Control & Analysis, Drug adulteration, type of adulterants, Regulatory Affairs.

References:


BOL-E201 Lab Course in Pharmacognosy:
1. Pharmacognostic evaluation of roots of Asparagus
2. Separation of alkaloids from roots of Withania somnifera by HPTLC
3. Pharmacognostic evaluation of Zingiber officinale rhizome (Ginger) and stem of Tinospora cordifolia.
4. Quantitative estimation of curcumin from rhizome of Curcuma longa.
5. Detection of curcumin from rhizome of Curcuma longa using TLC.
6. Pharmacognostic evaluation of bark of Acacia Arabica and fruits and seeds of Mucuna prurenes
7. Pharmacognostic evaluation of leaves of Adhathoda vasaka/ Vitex nugendo
8. Study of adulteration of leaf of Sanna (Cassia aungustifolia) /Adulteration of Oil- Test for Neem, Karanj, Castor.
9. Chemical test for primary metabolites- Fats, Protein, Carbohydrates, (Morphology of starch grain)
10. Estimation of Phenolics from plant sample
11. Determination of antifungal activity by picrate paper method
12. Determination of antibacterial activity by well plate method
13. Extraction of alpha amylase from germinating seeds
14. Determination of Km and Kmax of alpha amylase
15. Location of Plant species using Global Positioning system
16. Field Trips: Departmental arranged one long (7 days/6 night) and four short field visits for plant collection and study of local flora.
Max Mark: 100 Periods: 60

Learning Objectives:
1. To understand the origin and diversity of plants
2. To understand the various threats of biodiversity and the strategies for conservation
3. To analyze the biogeography, status and loss of biodiversity

Learning Outcomes:
This paper creates awareness about significance and conservation of biodiversity and their relevance with the socio-economic aspects. This paper also helps to aware students about various rules, regulations and their amendments about the conservation of plant resources.

UNIT I: INTRODUCTION TO PLANT DIVERSITY AND RESOURCES
Concept, scope, and significance of plant diversity in sustainable development, Concept and scope of genetic diversity, Major types of floristic found in India, Forest resources for sustainable development.

UNIT II: BIODIVERSITY AND CONSERVATION OF PLANT RESOURCES
Causes and Strategies for Conservation of Plant Resources, ex situ and in situ conservation, Significance of National parks, Sanctuaries, reserved forest, protected areas in plant Resource conservation, Peoples participation in plant resource management; Social forestry and other programmes, movements of afforestation.

UNIT III: BIOTECHNOLOGY & PLANT RESOURCE MANAGEMENT
India as a major biodiversity centre, Biotechnological innovations in plant resource management, Computational methods for plant resource management. Recent scientific trends in plant resource management.

Endemism, definition and types, endemism in India, RED list categories of IUCN, Hot spots and Hottest hotspots, Keystone and Flagship species

UNIT IV: LEGAL PROVISIONS IN THE MANAGEMENT OF PLANT RESOURCES

References:
1. Biodiversity Depletion by P. C. Sinha (Anmol publications)
2. Essentials of Ecology and Environmental Science by S.V S. Rana
3. Ecology by N. S. Subramanyam & A. V. S. S. Sambamurthy

**BOL E202 Lab Course in Biodiversity and Conservation**

1. To determine the Biodiversity Index for given ecological habitat (Dominance index, Shannon-Wiener Index, Simpson Index, Derger-Parker Index, Similarity Index, Diversity index. Evaluate and interpret each of the index values)
2. Study of tissues and diversity in shape and size of plant cells (palisade cells, guard cells, parenchyma, collenchyma, sclerenchyma, xylem and phloem through temporary/permanent slides
3. Using a hand held GPS instrument, locate coordinates of a demarcated field
4. Estimation of Primary productivity of water bodies.
5. Study of the traditional knowledge of biodiversity conservation of any local communities.
6. Determination of requisite size of the quadrant for vegetation analysis.
7. Analysis of frequency distribution of plants in a piece of vegetation by quadrat method.
8. To measure the above-ground plant biomass in a grassland/To determine the biomass of a particular area.
9. To study the biotic components of a pond.
10. To measure the vegetation cover of grassland through point-frame method.
11. To prepare a list of plants occurring in grassland and also to prepare chart along the line transect.
12. Visit to National Botanical Garden / Sanctuaries / Parks etc.
Learning Objectives:
1. To impart knowledge about basic principles of plant tissue culture.
2. To understand basics of secondary metabolite production.

Learning Outcomes: On completion of this course, the students shall:
1. Acquire knowledge in Plant Tissue Culture including secondary metabolite production
2. Shall develop scientific skills to work in Plant tissue culture, Pharmaceutical and research laboratories.

UNIT-I
History, Laboratory Requirements and General Techniques; Cellular Totipotency; Tissue Culture Media: Introduction, media constituents, media selection, media preparation; Callus Culture. Micropropagation: Introduction, techniques, applications, production of pathogen free plants; Somatic Embryogenesis; Haploid Production: Introduction, techniques, factor affecting androgenesis, ontogeny of androgenic haploids, plant regeneration from pollen embryos, homozygous diploids, applications, limitations.

UNIT-II
Somaclonal & gametoclonal variations; Protoplast Culture: Protoplast isolation, fusion and regeneration, Cybrids; Embryo Culture and embryo rescue: Introduction, techniques; Synthetic Seeds; Cell and Suspension Culture. Introduction, isolation of single cells, suspension cultures, culture of single cells, plant cell reactors, applications of cell culture; Production of secondary metabolites.

References:
3. An Introduction to Plant Biotechnology by H C Chawla Oxford and IBH 2002
Learning Objectives:
1. To impart knowledge about basic principles in plant identification
2. To acquaint the students with identification of plants.

Learning Outcomes: On completion of this course, the students shall develop scientific skills in identification of plants.

UNIT I: IDENTIFICATION OF MEDICINAL PLANTS
- Introduction, Nomenclature and Classification
- The Evolution of Plants: Learning Plants by Family (By using characters)
- Anatomy: Stems, Roots, Leaves, Reproductive Tissue
- Botanical Keys and Herbaria
- Herbs: Annuals, Perennials, Biennials
- Shrubs: Perennials, Biennials
- Trees: Perennials

UNIT II: IDENTIFICATION OF EDIBLE AND ORNAMENTAL PLANTS
- Woody Ornamentals
- Turf & Vines
- Indoor Plants
- Aquatic Plants
- Vegetables & Edible Plants
- Plant Identification & Horticulture: bringing it all together

References:

