

NOWGONG COLLEGE  
(Autonomous)



SYLLABUS

Department of Botany

Learning Outcome-based Curriculum Framework (LOCF) of  
Four Year Undergraduate Programme  
Choice-based Credit System with flexibility

Effective from Academic Year 2023-24

## **Introduction**

Greek philosopher Theophrastus defined 'Botany' as the branch of biology about 300 B.C. to understand the properties and biological processes of plants. The human development continues to be contingent on using plants for food, shelter and medicine. The necessity of understanding plants is increasing and it forms the basis of different disciplines. The advancement of tools and techniques led to new way of thinking about plant, thereby magnify possibility to expand and improve the various aspects of Botany in theoretical and experimental levels. Hence, the Botany as a discipline of study is extremely diverse and vast and branches into various specialized fields. The discipline is also interrelated to other disciplines such as zoology, geography, chemistry, physics, mathematics, statistics, biochemistry, molecular biology, bioinformatics, environmental studies etc. Being a vast field with variety of applications, Botany offers a diverse range of career options to a learner or student. Keeping in view, the benefits of knowledge of the discipline, the curriculum is framed for undergraduate and postgraduate teaching. The Board of Studies (BoS), department of Botany, Nowgong College (Autonomous) effortlessly framed a purposeful, deliberate and systematic organization of the curricula in core, generic, elective, open and discipline specific courses with sole aim to improve student learning and teacher's planning. On completion of the undergraduate and postgraduate programmes, a student will be able to accomplish the outcomes such as critical thinking, effective communication, social interacting, environmental consciousness and life long learning.

The contents of the syllabus of B.Sc. course in Botany of Nowgong College (Autonomous) under the New Education Policy (NEP), 2020 that make the transition from simple to complex concepts relevant to the interdisciplinary nature with multiple entry and multiple exit criteria as proposed by NEP, 2020. During structuring the syllabus, the course contents are considered on modern aspects as well as the traditional components. The Major courses of the first two semesters are introductory courses in Virus, Bacteria, Algae, Fungi, Archegoniate, Microbiology and Phytopathology. In third and fourth semesters, a student will have the basic knowledge of Archegoniates, Biomolecules and Cell Biology, Plant physiology and metabolism, Economic Botany, Anatomy of Angiosperms and Reproductive Biology of Angiosperms. In fifth and sixth semesters, a student will be exposed to the world of Horticulture practices & Post-harvest technology, Genetics, Molecular Biology, Plant Ecology & Phytogeography, Plant Systematics, Plant Biotechnology and Bioinformatics, Biostatistics and Analytical techniques in Plant Sciences followed by a project work. In seventh and eight semesters, a student will have the knowledge of Industrial and environmental microbiology, Instrument & Laboratory techniques, Intellectual Property Rights, Floriculture and followed by a dissertation work with an option to opt dissertation to three major papers viz., Biofertilizers, Herbal Technology and Stress Biology. Along with these, they will have to know the tools and techniques of plant science and to do Hands-on Training/Practical in Laboratory techniques, Data analysis etc.

Simultaneously, the Minor courses made up of inclusion of introductory Plant Biodiversity, Ecology, Systematics, Economic Botany, Physiology & Metabolism, Anatomy, Reproductive Biology, Genetics and Biostatistics as Minor course papers. Simultaneously, hands-on-training/ practical have been induced throughout the semesters so that students can build the enormous idea about the discipline along with project/dissertation work. Moreover, the department offers some applied courses as skill enhancement courses (SEC) in Nursery & Gardening, Natural Resource Management and Plant Diversity & Human Welfare, Medicinal botany followed by Add on course in Mushroom Cultivation considering the enhancement of knowledge on employment and entrepreneurship of students.

### **1. Introduction to the Programme**

B.Sc. Botany is a four-year undergraduate program with specialization in the subject Botany compiled in new framework of NEP, 2020. The programme fosters interdisciplinary approach to all the prospects of the plant world. Although it sounds like encompassing only the study of plants, however it also extends its periphery to the microbial world, microphytes, several branches of bio-sciences and many more. It aims to promote holistic education useful in handling social, economics, engineering, physical and bio-sciences problems. The curriculum is dispensed using a combination of classroom teaching, project-based learning, practical's, group discussions, presentations, home assignments, industry interactions and exposure, internships and fieldwork. B.Sc. Botany programme is designed in such a way that students will be exposed to the real- world of diversity of flora, inculcate the ideas of their role and utility, identify their metabolism of biochemical pathways in expression of each and every condition of their existence. The course is designed in such a way that students can absorb strong foundation of botany.

### Course & Credit Structure

The B.Sc. Botany is a four-year programme divided into eight semesters with a maximum of 176 credits.

Semester	Major (Maj)	Minor (Min)	Inter-Disciplinary	AEC	SEC	VAC (Any two in each semester)	Research project/ Dissertation/ Internship	Total
I	BOTA-MAJ-1014 (Microbiology and Phycology)	BOTA- MIN-1014 Biodiversity (Microbes, Algae, Fungi and Archegoniate)	BOTA-IDC-1014 Indian Knowledge System (IKS)	ASSA/HIND/B-ENG/ -AEC-1012 Jugajogmulok Axomiya/ Vyakaran Evam Vyavaharik Hindi/Byowoharic Bangla – I  Business English: Networking (Online)	BOTA-SEC-1014 (Nursery and Gardening)	UNIN-VAC-1012 (Understanding India)  ENSC-VAC-1012 (Environmental Science)  NASS-VAC-1012 (National Service Scheme)  Online Courses: 1. OUFU-VAC-1012 Our Energy Future 2. PHSR-VAC-1012 Philosophy, Science and Religion 3. MOTH-VAC-1012 Model Thinking <b>(Any Two)</b>	Students exiting the program after securing 44 credits will be awarded UG certificate in the relevant discipline/ subject provided they secure additional 4 credits in work based Vocation Courses offering during summer term for internship/ apprenticeship in addition to 6 credits from Skill based Courses earned during 1 <sup>st</sup> & 2 <sup>nd</sup> Semester	22

II	BOTA-MAJ-2014 (Mycology and Phytopathology)	BOTA- MIN-2014 (Plant Ecology and Systematics)	BOTA-IDC-2014 (Plant Ecology and Systematics)	<b>Offline Courses:</b> ENGL-AEC-2012 (English and Mass Communication)	BOTA-SEC-2014 (Natural Resource Management)	<b>Offline Courses:</b> DITS-VAC-2012 (Digital Technological Solutions)  YOMH-VAC-2012 (Yoga and Mental Health)  NACC-VAC-2012 (National Cadet Corps)			22
<b>Certificate after 1 year (Total Credit = 44)</b>									
III	BOTA-MAJ-3014 (Archegoniate) BOTA-MAJ-3024 (Biomolecules and Cell Biology)	BOTA- MIN-3014 (Economic Botany)	BOTA-IDC-3014 (Economic Botany)	ASSA/HIND/BENG -AEC-3012 Byowoharic Axomiya/ Karyalayi Hindi /Byowoharic Bangla – II	BOTA-SEC-3014 (Plant Diversity and Human Welfare)	-----		Students exiting the program after securing 88 credits will be awarded UG Diploma in the relevant discipline/ subject provided they secure additional 4 credits in Skill based Vocation Courses	22

IV	BOTA-MAJ-4014(Plant Physiology and Metabolism) BOTA-MAJ-4024 (Economic Botany) BOTA-MAJ-4034(Anatomy of Angiosperms)B OTA-MAJ-4044 (Reproductive Biology of Angiosperms)	BOTA- MIN-4014 (Plant Physiology and Metabolism)	-----	ENGL-AEC-4012 (Academic Writing)	-----			offered 2 <sup>nd</sup> year summer term.	22
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**Diploma after 2 years (Total Credit = 88)**

V	BOTA-MAJ-5014 (Horticulture Practices and Post-Harvest Technology) BOTA-MAJ-5024 (Genetics ) BOTA-MAJ-5034 (Molecular Biology) BOTA-MAJ-5044 (Plant Ecology and Phytogeography)	BOTA- MIN-5014 (Anatomy of Angiosperms)	-----	-----	-----	-----		BOTA-INTE-5012 (Internship)	22
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VI	BOTA-MAJ-6014 (Plant Systematics) BOTA-MAJ-6024 (Plant Biotechnology and Bioinformatics ) BOTA-MAJ-6034 (Biostatistics ) BOTA-MAJ-6044 (Analytical Techniques in Plant Sciences) BOTA-MAJ-6052 (Dissertation/ Project)	BOTA- MIN- 6014 (Reproductive Biology of Angiosperms)	-----	----	----			-----	22
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**Degree after 3 years (with Major/Minor) (Total Credit = 132)**

VII	BOTA-MAJ-7014 (Industrial and Environmental Microbiology) BOTA-MAJ-7024 (Instrument and Laboratory Techniques) BOTA-MAJ-7034 (Intellectual Property Rights)	BOTA- MIN-7014 (Genetics)	-----	-----	-----	REET- VAC-7012 (Research Ethics)		REME-MAJ-7044 (Research Methodology)	22
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VIII	BOTA-MAJ-8014 (Floriculture )	BOTA- MIN-8014 (Biostatistics)				INPR- VAC-8012 (Intellectual Property Right)		BOTA-DISS-80112 (Dissertation) (Those who are undertaking Research Project or Dissertation)  OR  BOTA-MAJ-8024 (Biofertilizers ) BOTA-MAJ-8034 (Herbal Technology) BOTA-MAJ-8044 (Stress Biology) (Those who are not undertaking Research Project or Dissertation)	22
<b>Degree after 4 years (with Honours/ by Research) (Total Credit = 176)</b>									176

- N.B.: 1. 4 credit papers = 100 marks (60T+20IA+20P)  
2. 2 credit papers (except AEC) = 50 marks (30T+10IA+10P)  
3. 2 credit papers (Only AEC) = 50 marks (40T+10IA)

Question Pattern:

- For 100 marks papers [ 1 marks x 7 (no option) , 2 marks x 4(no option) , 5 marks x 3 (5 options), 10 marks x 3 ( 5 options) ]
- For 50 marks papers [ 1marks x 4 (no option), 2 marks x 3 (no option), 5 marks x 2 (4 options), 10 marks x 1 ( 2 options ) ]
- For AEC 50 marks papers [ 1 marks x 4 ( no options) , 2 marks x 3 ( no options), 5 marks x 2 ( 4 options), 10 marks x 2 (4 options) ]



### 3. Details of Semester-Wise Courses

#### Major (MAJ) Papers

BOTA-MAJ-1014 Microbiology and Phycology (Theory+ Practical)

BOTA-MAJ-2014 Mycology and Phytopathology (Theory+ Practical)

BOTA-MAJ-3014 Archegoniate (Theory+ Practical)

BOTA -MAJ-3024 Biomolecules and Cell Biology (Theory+ Practical)

BOTA -MAJ-4014 Plant Physiology and Metabolism (Theory+ Practical)

BOTA -MAJ-4024 Economic Botany (Theory+ Practical)

BOTA -MAJ-4034 Anatomy of Angiosperms (Theory+ Practical)

BOTA -MAJ-4044 Reproductive Biology of Angiosperms (Theory+ Practical)

BOTA -MAJ-5014 Horticulture Practices and Post-Harvest Technology (Theory+ Practical)

BOTA -MAJ-5024 Genetics (Theory+ Practical)

BOTA -MAJ-5034 Molecular Biology (Theory+ Practical)

BOTA -MAJ-5044 Plant Ecology and Phytogeography (Theory+ Practical)

BOTA -MAJ-6014 Plant Systematics (Theory+ Practical)

BOTA -MAJ-6024 Plant Biotechnology and Bioinformatics (Theory+ Practical)

BOTA -MAJ-6034 Biostatistics (Theory+ Practical)

BOTA-MAJ-6044 Analytical Techniques in Plant Sciences (Theory+ Practical)

BOTA-MAJ-6052 Project

BOTA-MAJ-7014 Industrial and Environmental Microbiology (Theory+ Practical)

BOTA-MAJ-7024 Instrument and Laboratory Techniques (Theory+ Practical)

BOTA-MAJ-7034 Intellectual Property Rights (Theory+ Practical)

BOTA-MAJ-8014 Floriculture (Theory+ Practical)

BOTA-DISS-80112 Dissertation

OR

BOTA-MAJ-8024 Biofertilizers (Theory+ Practical) (Those who not undertaking Research Project or Dissertation)

BOTA-MAJ-8034 Herbal Technology (Theory+ Practical) (Those who not undertaking Research Project or Dissertation)

BOTA-MAJ-8044 Stress Biology (Theory+ Practical) (Those who not undertaking Research Project or Dissertation)

#### Minor (MIN) Papers (to be offered to other Departments/Disciplines)

BOTA-MIN-1014 Biodiversity (Microbes, Algae, Fungi and Archegoniate) (Theory+ Practical)

BOTA-MIN-2014 Plant Ecology and Systematics (Theory+ Practical)

BOTA-MIN-3014 Economic Botany (Theory+ Practical)

BOTA -MIN-4014 Plant Physiology and Metabolism (Theory+ Practical)

BOTA -MIN-5014 Anatomy of Angiosperms (Theory+ Practical)

BOTA -MIN-6014 Reproductive Biology of Angiosperms (Theory+ Practical)

BOTA -MIN-7014 Genetics (Theory+ Practical)

BOTA -MIN-8014 Biostatistics (Theory+ Practical)

#### Skill Enhancement Course (SEC) Papers

BOTA-SEC-1014 Nursery and Gardening (Theory+ Practical/Presentation)

BOTA-SEC-2014 Natural Resource Management (Theory+ Practical/Presentation)

BOTA-SEC-3014 Plant Diversity and Human Welfare (Theory+ Practical/Presentation)

#### **4. Graduate Attributes**

On completion of the programme students are expected to inculcate the knowledge of flora, effective communication, critical thinking, research methods and scientific outreach. The attributes expected from the graduates of B.Sc. Botany are:

- i. A holistic knowledge and understanding of basic concepts in botany and its application with allied subjects.
- ii. Enable students to explore the living world particularly plants, microbes, etc.
- iii. To understand the different biochemical as well as physiological pathways within the plants and their intervention.
- iv. To enable the students to understand basic concepts and aspects related to research, various techniques to collect the biological data to analyse the data and interpret the results thereafter.

#### **5. Programme Objectives**

- i. To imbibe strong foundation of botany among students.
- ii. To make acquainted students with basic to high-level botanical concepts.
- iii. To teach/strengthen students' knowledge of both theoretical and practical outreach over the subject.
- iv. To promote application-oriented pedagogy by exposing students to the real living world.
- v. Promote research aptitude through research project, student's project, publication of research, participation in conferences and seminars, research collaboration and linkage.

#### **6. Programme Learning Outcomes**

This program exposes students to the beautiful world of botany and how it affects all aspects of our daily lives. This course aims to provide students with all major botanical concepts and the tools necessary to explore them. The introduction of computer software helps them analyse data optimising the use of time and resources. Exposure to a large amount of real-life data helps improve your analytical skills. Each job is practical, which will stimulate your exploration and hone your acting skills. To a large extent, this teaching method provides them with the motivation and confidence to start working as a botanist in the near future. The course structure also motivates/assists students to pursue careers in related disciplines, especially biotechnology, pharmacognosy, ethnobotany, etc.

#### **7. Teaching Learning Process**

The Department of Botany at Nowgong College (Autonomous) is primarily responsible for organising the Bachelor of Science course in Botany. Tutorial and practice related instructions are provided by the respective registering units under the general guidance of Department of Botany of

Nowgong College (Autonomous). There shall be 90 instructional days excluding examination in a semester.

### **8. Teaching Pedagogy**

Teaching Pedagogy involves classroom interaction, discussion, lectures, course-based practical work, viva- voce, mock test, demonstration, presentation, classroom tests, assignments and dissertation work. The achievement of course is described in each course papers as learning outcomes in detail.

### **9. Assessment Methods/Evaluation System**

The students registered for academic programmes will study semester I to VIII in the Nowgong College (Autonomous) and during these semesters Major, Minor, SEC courses and Add on courses as offered by the department.

# SEMESTER-I

Course Code: BOTA-MAJ-1014

Course Name: Microbiology and Phycology

PAPER CREDIT:04 (3T+1P)

Total No. of Lectures: 45L + 15P

Total marks=100 (60T + 20IA+ 20P)

## Objectives:

Learners shall learn the various aspects of microbial world specially metabolic processes and taxonomy, structure, physiology, genetics and economic importance of virus, bacteria and algae.

## Learning Outcome:

1. Detailed knowledge on microbes, viruses & bacteria; their importance in agriculture and medicine
2. Knowledge on algal classification; economic and ecological importance of Algae
3. Practical knowledge on structure of T-Phage and TMV, lytic and lysogenic life cycle
4. Practical knowledge on microscopy of bacteria and algae

## CONTENT

### 1.1 THEORY

#### UNIT 1: Microbial world (5 lectures)

Introduction to microbiology- Scope and interrelationship with other disciplines; general concept of microbes in industry and environment.

#### UNIT 2: Viruses and Bacteria (15 lectures)

Discovery, characteristics, general structure- DNA virus (T-phage) and RNA virus (TMV), reproduction- lytic and lysogenic cycle; Viral plant diseases; viroids and prions.

Discovery, characteristics, ultra-structure, reproduction-vegetative, asexual and recombination. Role of bacteria in agriculture and industry (Alcohol and Antibiotic production).

#### UNIT 3: Algae (10 lectures)

General characteristics, range of distribution, thallus structure, reproduction, basis of classification- pigments and storage products. Types of life cycle.

#### UNIT 4: Type Genus (15 lectures)

General characteristics, phylogeny and economic importance of Cyanophyceae, Chlorophyceae and Xanthophyceae. Life history of *Anabaena/Nostoc*, *Chlorella*, *Volvox*, *Chara* and *Vaucheria*.

General characteristics, phylogeny and economic importance of Phaeophyceae and Rhodophyceae. Life history of *Ectocarpus*, *Fucus* and *Sheathia*. Thallus structure, reproduction and economic importance of Bacillariophyceae.

### 1.2 Practical/ Presentation: (15 lectures)

#### (A). Microbiology

1. Electron micrographs/Models of viruses: T-Phage and TMV/ Line drawings/ Photographs of Lytic and Lysogenic Cycle.
2. Types of Bacteria to be observed from temporary/permanent slides/photographs. Microphotographs of bacteria, binary fission, endospore,

conjugation, root nodule.

3. Gram staining: Preparation of slides.

**Demonstration:**

1. Isolation of soil microflora.
2. Endospore staining with malachite green using the endospores of bacteria.

**(B). Phycology**

3. Study of vegetative and reproductive structures of *Anabaena/Nostoc*, *Volvox*, *Chara*, *Vaucheria*, *Ectocarpus*, *Fucus* and *Sheathia* through electron micrographs/permanent slides.

**Suggested Readings:**

1. Studies in Botany: Debabrata Mitra, Jibesh Ghua & Salil Chowdhury, Vol. I & II, Moulik Library.
2. Botany for Degree Students: A.C. Dutta (Revised by T.C. Dutta), 6<sup>th</sup> Edition, Oxford Publisher.
3. Life Sciences: Fundamentals and Practice, Pranab Kumar and Usha Mina, Vol. I & II, Pathfinder Publication.
4. Botany for Degree Students: Algae, B.R Vashishta, Dr. A. K Sinha and Dr. Adarsh Kumar, S Chand & Company; 2nd edition (1 December 2010).
5. Textbook of Algae, O.P. Sharma (Tata McGraw-Hill Education, 2011).
6. Mycology and Microbiology (A Textbook for UG and PG Courses) (K.V.B.R. Tilak, K.V. Mallaiah, C. Manoharachary, I.K. Kunwar; Scientific Publishers (India); Edition: 1, 2016.
7. Microbiology and Phycology; Amit\_Jain; Mahaveer Publications.
8. A Textbook of Microbiology; D K Maheshwari and R C Dubey; S Chand Publishing.

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# SEMESTER-I

Course Code: BOTA-MIN-1014

Course Paper: Biodiversity (Microbes, Algae, Fungi and Archegoniate)

PAPER CREDIT:04 (3T+1P)

Total No. of Lectures: 45L + 15P

Total marks=100 (60T + 20IA+ 20P)

## Objectives:

Learners shall learn - the various aspects of microbial world especially historical development, taxonomy, structure, physiological & genetics and economic importance of virus, bacteria and cryptogamic plants.

## Learning Outcome:

1. Knowledge on structure and reproduction of viruses and bacteria, and their economic importance
2. Describe general characteristics, morphological diversity, thallus organization, life cycles, ecological and economic importance of algae
3. Describe general characteristics, morphological diversity, thallus organization, life cycles, ecological and economic importance of fungi
4. General characteristics, classification, morphological diversity and evolutionary significance of bryophytes
5. General characteristics and classification of pteridophytes; evolution of stele, heterospory and seed habit in pteridophytes
6. Classify gymnosperms, and describe their general characteristics and economic importance
7. Practical knowledge on staining and slide preparation to study bacteria, algae and fungi under the microscope
8. Practical knowledge on vegetative and reproductive structures of some representative bryophytes, pteridophytes and gymnosperms

## CONTENT

### 1.1 THEORY

#### UNIT 1: Microbes and lower cryptogams (7 lectures)

**Viruses** – Discovery, general structure, replication (general account), DNA virus (T-phage); Lytic and lysogenic cycle, RNA virus (TMV); Economic importance;

**Bacteria** – Discovery, General characteristics and cell structure; Reproduction – vegetative, asexual and recombination (conjugation, transformation and transduction); Economic importance.

#### UNIT 2: Algae, Fungi and Symbiotic association (18 lectures)

**(A). Algae:** General characteristics; Ecology and distribution; Range of thallus organization and reproduction; Classification of algae; Morphology and life-cycles of the following: *Nostoc*, *Chlamydomonas*, *Oedogonium*, *Vaucheria*, *Fucus*, *Polysiphonia*. Economic importance of algae.

**(B). Fungi:** Introduction- General characteristics, significance, range of thallus organization, cell wall composition, nutrition, reproduction and classification; True Fungi- General characteristics, ecology and significance, life cycle of *Rhizopus* (Zygomycota) *Penicillium* (Ascomycota), *Puccinia*, *Agaricus* (Basidiomycota);

**(C). Symbiotic Associations-** Lichens: General account, reproduction and significance; Mycorrhiza: ectomycorrhiza and endomycorrhiza and their significance.

### **UNIT 3: Introduction to Archegoniate**

**(8 lectures)**

Unifying features of archegoniate, Transition to land habit, Alternation of generations.

General characteristics, adaptations to land habit, Classification, Range of thallus organization. Classification (up to family), morphology, anatomy and reproduction of *Marchantia* and *Funaria*. (Developmental details not to be included). Ecology and economic importance of bryophytes with special mention of *Sphagnum*.

### **UNIT 4: Pteridophytes and Gymnosperms**

**(12 lectures)**

General characteristics, classification, Early land plants (*Cooksonia* and *Rhynia*). Classification (up to family), morphology, anatomy and reproduction of *Selaginella*, *Equisetum* and *Pteris* (Developmental details not to be included). Heterospory and seed habit, stelar types. Ecological and economical importance of Pteridophytes.

General characteristics, classification. Classification (up to family), morphology, anatomy and reproduction of *Cycas* and *Pinus*. (Developmental details not to be included). Ecological and economical importance.

### **1.2 Practical/ Presentation**

**(15 lectures)**

1. EMs/Models of viruses – T-Phage and TMV, Line drawing/Photograph of Lytic and Lysogenic Cycle.
2. Types of Bacteria from temporary/permanent slides/photographs; Binary Fission; Conjugation; Structure of root nodule.
3. Gram staining.
4. Study of vegetative and reproductive structures of Nostoc, Chlamydomonas (electron micrographs), Oedogonium, Vaucheria, Fucus\* and Polysiphonia through temporary. preparations and permanent slides.
5. *Rhizopus* and *Penicillium*: Asexual stage from temporary mounts and sexual structures through permanent slides.
6. *Puccinia*: Herbarium specimens of Black Stem Rust of Wheat and infected Barberry leaves; section/tease mounts of spores on Wheat and permanent slides of both the hosts.
7. *Agaricus*: Specimens of button stage and full grown mushroom; Sectioning of gills of Agaricus.
8. Lichens: Study of growth forms of lichens (crustose, foliose and fruticose)
9. Mycorrhiza: ecto mycorrhiza and endo mycorrhiza (Photographs)
10. *Marchantia*- morphology of thallus, w.m. rhizoids and scales, v.s. thallus through gemma cup, w.m. gemmae (all temporary slides), v.s. antheridiophore, archegoniophore, l.s. sporophyte (all permanent slides).
11. *Funaria*- morphology, w.m. leaf, rhizoids, operculum, peristome, annulus, spores (temporary slides); permanent slides showing antheridial and archegonial heads, l.s. capsule and protonema.
12. *Selaginella*- morphology, w.m. leaf with ligule, t.s. stem, w.m. strobilus, w.m. microsporophyll and megasporophyll (temporary slides), l.s. strobilus (permanent slide).

13. *Equisetum*- morphology, t.s. internode, l.s. strobilus, t.s. strobilus, w.m. sporangiophore, w.m. spores (wet and dry)(temporary slides); t.s rhizome (permanent slide).

14. *Pteris*- morphology, t.s. rachis, v.s. sporophyll, w.m. sporangium, w.m. spores (temporary slides), t.s. rhizome, w.m. prothallus with sex organs and young sporophyte (permanent slide).

15. *Cycas*- morphology (coralloid roots, bulbil, leaf), t.s. coralloid root, t.s. rachis, v.s. leaflet, v.s. microsporophyll, w.m. spores (temporary slides), l.s. ovule, t.s. root (permanent slide).

16. *Pinus*- morphology (long and dwarf shoots, w.m. dwarf shoot, male and female), w.m. dwarf shoot, t.s. needle, t.s. stem, , l.s./t.s. male cone, w.m. microsporophyll, w.m. microspores (temporary slides), l.s. female cone, t.l.s. & r.l.s. stem (permanent slide).

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**Course Code: BOTA-IDC-1014**

**Course Name: Indian Knowledge System (IKS)**

**PAPER CREDIT:04 (3T+1P)**

**Total No. of Lectures: 45L + 15P**

**Total marks=100 (60T + 20IA+ 20P)**

**Objectives:** The main objectives of this course are as follows:

- Creating awareness among the youth about the history and rich culture of our country
- Understanding the values of traditional knowledge systems of India
- Promoting the youth to do research in the various fields of Indian knowledge system
- Converting the Indian wisdom into the applied aspect of the modern scientific paradigm
- Encouraging the youth towards professional and entrepreneurship development

**Learning Outcome:**

On completion of the course, the learner will inculcate a strong conceptual idea of the vast traditional knowledge system that prevails in India, may it be from history of the ancient education system, contributions of the Indologists, origin and development of the classical Sanskrit literature, philosophies behind the origin and development of the Indian education systems as well as the concept of the traditional knowledge in life sciences as a part of application in day-to-day life.

## **CONTENT**

### **Theory**

#### **Unit-I: Origin and Development of Indian Knowledge System (Philosophy)**

The Vedas: Mantra (Samhita) and Brahmana

The Aranyakas and the Upanisads: (Jnanakanda and Karmakanda)

Yogasutra: Hatha Yoga and Raja Yoga

#### **Unit-II: Origin and Development of Classical Sanskrit Literature**

Ramayana– Time, Subject matter, social, cultural and historical importance

Mahabharata- Time, Development, Subject matter, social, cultural and historical importance

Puranas- Subject matter, characteristics, social, cultural and historical importance

#### **Unit-III: Education System and its Evolution in Ancient India**

Fundamentals of Ancient Indian Education; Evolution of Education system

Main centres of Education in Ancient India: Takshasila, Nalanda, Vallabhi etc.

Traditional Knowledge System in socio-cultural aspects

Appreciation of Indian Knowledge System: Contributions of the Indologists

#### **Unit IV- Traditional Knowledge System in Life Sciences**

[A] **Ethnobotany:** Definition, Scope, Discipline and sub-disciplines; Importance and application of traditional Knowledge in socio cultural aspects as a source of medicine and aromatic oils etc.; Bioprospection; Basics of Intellectual Property Rights in Traditional Knowledge.

[B] **Ethnozoology**: Definition, scope, discipline and sub-discipline, importance and application of the traditional ethnozoological knowledge in socio cultural aspects as source of medicine, ornaments, medico-religious practices etc.; Bioprospection, and commercial use of ethnozoological knowledge, integration of ethnozoology in biodiversity conservation.

**Practical/ Presentation:**

Topics to be selected based on course contents of the theory

**Suggested Readings:**

1. *Textbook on The Knowledge System of Bhārata* by Bhag Chand Chauhan
2. *History of Science in India Volume-1, Part-I, Part-II, Volume VIII*, by Sibaji Raha, et al. National Academy of Sciences, India and The Ramkrishan Mission Institute of Culture, Kolkata (2014).
3. *Pride of India- A Glimpse of India's Scientific Heritage* edited by Pradeep Kohle et al. Samskrit Bharati (2006).
4. *Vedic Physics* by Keshav Dev Verma, Motilal Banarsidass Publishers (2012).
5. *India's Glorious Scientific Tradition* by Suresh Soni, Ocean Books Pvt. Ltd. (2010).
6. *History of Sanskrit Literature* by A.B.Keith, MLBD, Delhi
7. *History of Classical Sanskrit Literature* by M.Krishnamachariar, MLBD, Delhi
8. *A Concise History of Sanskrit Literature* by Gaurinath Shastri, MLBD, Delhi
9. *Education in Ancient India* by A.S. Altekar, Nand Kishore and Bros, Varanasi, 1957
10. *Hindu Civilization* by R.K Mookherji, Longman, 1936
11. *The Penguin History of Early India from the Origins to AD 1300* by Romila Thapar, Penguin Books, 2002
12. *The History and Culture of the Indian People (ed.): The Vedic Age (Volume 1), The Classical Age (Volume 3), British Paramountcy and Indian Renaissance (Volume 9 and 10 Part-I and II)* by R.C. Majumdar.
13. *A Critical Survey of Indian Philosophy*, C.D. Sharma
14. *Introduction to Indian Philosophy*, Dutta & Chatterjee.
15. *History of Indian Philosophy*, Vol-01, S.N. Dasgupta.
16. *Indian Philosophy*, Vol-01, S. Radhakrishnan.
17. *Hand Book of Ethnobotany*, S K Jain and V. Mudgal, (1999). M/S Bisen Singh & Mahendra Pal Singh, Dehradun, India.
18. *Glimpses of Indian Ethnobotany*, S.K. Jain, (1981). Oxford & IBH, New Delhi.
19. *Ethnobiology: Therapeutics and Natural Resources*. Ghosh and Ashis Kumar, Dya Publishing House, New Delhi.
19. *Ethnozoology: Animals in Our Life*, (Eds.) Romulo Romeu Nobrega Alves and Ulysses Paulino Albuquerque. Academic Press, UK

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# **SEMESTER -I**

**Course Code: BOTA-SEC-1014**

**Course Paper: Nursery and Gardening**

**PAPER CREDIT:04 (3T+1P)**

**Total No. of Lectures: 45L + 15P**

**Total marks=100 (60T + 20IA+ 20P)**

## **Objectives:**

This paper aims to build up a clear knowledge on various aspects of nursery and gardening practices.

## **Learning Outcome:**

1. Brief idea about objectives, scope, infrastructure and maintenance of Nursery
2. Concept on structure, types and dormancy of seeds and brief idea about seed storage including types and process and knowledge on seed production technology
3. Knowledge on various modes of vegetative propagation and maintenance of plants in green house
4. Brief idea about development and maintenance of gardening including scope and types and understand the various gardening operations including management of pests and diseases
5. Detail knowledge on managements of seeds and seedlings and concept about cultivation, storage and marketing of important vegetables

## **CONTENT**

### **1.1 THEORY**

#### **UNIT 1: Nursery**

**(5 lectures)**

Definition, objectives and scope and building up of infrastructure for nursery, planning and seasonal activities - Planting - direct seeding and transplants.

#### **UNIT 2: Seed**

**(15 lectures)**

Structure and types - Seed dormancy; causes and methods of breaking dormancy. Seed storage: Seed banks, factors affecting seed viability, genetic erosion - Seed production technology - seed testing and certification. Sowing/raising of seeds and seedlings - Transplanting of seedlings - Study of cultivation of different vegetables: cabbage, brinjal, lady's finger, onion, garlic, tomatoes, and carrots – Storage and marketing procedures.

#### **UNIT 3: Vegetative propagation**

**(10 lectures)**

Air-layering, cutting, selection of cutting, collecting season, treatment of cutting, rooting medium and planting of cuttings - Hardening of plants - green house - mist chamber shed root, shade house and glass house.

#### **UNIT 4: Gardening**

**(15 lectures)**

Definition, objectives and scope - different types of gardening - landscape and home gardening - parks and its components - plant materials and design - computer applications in landscaping - Gardening operations, soil laying, manuring, watering, management of pests and diseases and harvesting.

## **1.2 Practical/ Presentation**

**(15 lectures)**

1. Report on different types of gardens.
2. Methods of seed storage in your locality.
3. Study on cutting and layering techniques.
4. Field study/ visit to Nursery/Garden.

### **Suggested Readings:**

1. Bose T.K. & Mukherjee, D., 1972, Gardening in India, Oxford & IBH Publishing Co., New Delhi.
2. Sandhu, M.K., 1989, Plant Propagation, Wile Eastern Ltd., Bangalore, Madras.
3. Kumar, N., 1997, Introduction to Horticulture, Rajalakshmi Publications, Nagercoil.
4. Agrawal, P.K. 1993, Hand Book of Seed Technology, Dept. of Agriculture and Cooperation , National \_Seed Corporation Ltd. , New Delhi.
5. Sujit Chakrabarty 2018. Organic Home Gardening Made Easy. Notion Press. ISBN 978-1643240855
6. Arun Kr. Singh and Abhinav Kumar 2020. Plant Propagation and Nursery Management. Bhavya Books (BET) New Delhi. ISBN 978-9383992539
7. Suzana Bashir and Shabana Gulzar 2020. Nursery and Gardening: Principle and Practices. Walnut Publication. ISBN 978-939026175-8

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## SEMESTER-II

Course Code: BOTA-MAJ-2014

Course Name: Mycology and Phytopathology

PAPER CREDIT:04 (3T+1P)

Total No. of Lectures: 45L + 15P

Total marks=100 (60T + 20IA+ 20P)

### Objectives:

This paper aims to build up a clear knowledge on various applied aspects of mycology and plant pathology.

### Learning Outcome:

1. Detailed knowledge on different classes of fungi, their structure, classification, life cycle and reproduction.
2. Knowledge on diseases in plants caused by viruses, bacteria and fungi along with biotechnological applications of fungi.
3. Structural analysis of different classes of fungi and their reproductive stages.
4. Knowledge on structures of symbiotic associations (Lichen and Mycorrhiza).

## CONTENT

### 2.1 THEORY

#### UNIT 1: Fungi

(15 lectures)

General characteristics, affinities with plants and animals, thallus organization, cell wall composition, nutrition, classification, ecological significance and economic importance [industry (fermentation and organic acid), agriculture (biofertilizer), pharmaceuticals (antibiotic production), biocontrol and mycotoxin].

General characteristics, ecology and life cycle of Phycomycetes, Ascomycetes, Basidiomycetes and Deuteromycetes; Heterothallism, heterokaryosis and parasexuality; Life cycles of *Saccharomyces*, *Penicillium*, *Peziza*, *Agaricus*, *Polyporus*; Degeneration of sex in fungi; Bioluminescence; Fairy Rings and Mushroom Cultivation.

#### UNIT 2: Symbiotic associations - Lichen and Mycorrhiza

(10 lectures)

Lichen-Occurrence; General characteristics; Growth forms and range of thallus organization; Nature of associations of algal and fungal partners; Reproduction; Economic and Ecological importance.

Mycorrhiza-types and their significance.

#### UNIT 3: Phytopathology

(10 lectures)

Terms and concepts; General symptoms; Etiology; Host-Pathogen relationships; Disease cycle and Environmental relation; Prevention and Control of plant diseases and Role of quarantine.

#### UNIT 4: Plant Diseases

(10 lectures)

Bacterial diseases – Citrus canker (*Xanthomonas citri*).

Viral diseases – TMV.

Fungal diseases – Late blight of potato (*Phytophthora infestans*), Black stem rust of wheat (*Puccinia graminis-tritici*).

## 2.2 Practical/ Presentation

(15 lectures)

1. Introduction to the world of fungi (Unicellular, coenocytic/septate mycelium, ascocarps and basidiocarps).
2. *Mucor*: study of asexual stage and sexual structures.
3. *Penicillium*: study of asexual stage and sexual stage.
4. *Peziza*: Study of reproductive structure; sectioning through ascocarp.
5. *Puccinia*: Herbarium specimens of Black Rust on wheat stem and infected leaves of *Justicia gendarussa*; Sections through infected part/ mounts of spores.
6. *Agaricus*: Specimens of button stage and fullgrown mushroom; sectioning of gills of *Agaricus*.
7. Lichens: Study of growth forms of lichens and mycorrhizae through live/preserved specimens.
8. Phytopathology: Herbarium specimens of bacterial diseases-Citrus Canker; Viral diseases-TMV; Fungal diseases-Black stem rust of wheat; and other plant diseases of seasonal occurrence in plants (relevant to the course content).

### Suggested Readings:

1. Plant Pathology; R.S. Mehrotra and Ashok Aggarwal (2017).
2. Introduction To Principles of Plant Pathology; R S Singh; Medtech (2017).
3. Plant Pathology at a Glance; R P Singh; Daya Publishing House.
4. Mycology and Microbiology (A Textbook for UG and PG Courses) (K.V.B.R. Tilak, K.V. Mallaiah, C. Manoharachary, I.K. Kunwar; Scientific Publishers (India); Edition: 1, 2016.
5. An Introduction to Fungi (4<sup>th</sup> Edition): H C Dubey. Scientific Publishers, India
6. Botany for Degree Students: Fungi-B R Vashishta, A K Singha and Anil Kumar.S Chand Publication
7. Illustrated Glossary of Mycology: Vaidya Jitendra. Career Publications
8. Physiology of Fungi: K. S. Bilgrami and R. N. Verma. Scientific Publishers Journals Dept Publication

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## SEMESTER- II

Course Code: BOTA-MIN-2014

Course paper: Plant Ecology & Systematics

PAPER CREDIT:04 (3T+1P)

Total No. of Lectures: 45L + 15P

Total marks=100 (60T + 20IA+ 20P)

### Objectives:

Learners shall know and understand the concept of plant ecology, methods for studying basic ecology of an area along with plant systematics.

### Learning Outcome:

1. Understanding the ecological factors and adaptive characters of hydrophytes and xerophytes.
2. Knowledge on ecosystem, trophic levels, energy flow in ecosystems along with population and community ecology.
3. Practical knowledge on soil temperature measurement, humidity measurement, rainfall estimation and light intensity measurement.
4. Basics of plant taxonomy and systematics- its components and applications.
5. Practical knowledge on plant identification upto the family level belonging to Brassicaceae, Solanaceae and Lamiaceae; Preparation of herbarium specimens.
6. General idea on phytogeography and endemism.
7. Importance of traditional knowledge in relation to plant uses.

## CONTENT

### 2.1 THEORY

#### UNIT 1: Plant Ecology

(10 lectures)

(A). **Introduction-** Basic concepts; Levels of organisation; Inter-relationships between the living world and the environment, biotic and abiotic components.

(B). **Population and community ecology-** Definitions, characteristics, trophic organization, ecological pyramid, biotic interrelations, habitat and niche.

(C). **Ecosystem-** Definition and structure, Food chains and Food webs; Energy flow; Production and productivity; Biogeochemical cycles; Succession-processes and types.

#### UNIT 2: Plant Systematics

(25 lectures)

(A). **Introduction-** Definition of taxonomy and systematics; history of plant systematics; concept and components (characterization, identification, nomenclature and classification); importance of botanical garden, herbarium and museum; Documentation-flora, manual, monograph, revision, journal, catalogue, e-flora, icones; taxonomic aids- botanical keys (basic concept).

(B). **Taxonomic approach to Nomenclature-** Concept of taxa (family, genus and species), taxonomic hierarchy, principles and rules (ICN), typification, author's citation, effective and valid publication, rejection of names, principles of priority, names of hybrids, taxonomic characters, OUT's.

(C). **Systems of Classification-** History of plant classification systems; Classification systems of Bentham and Hooker (up to series); Brief reference of Angiosperm Phylogeny Group (APG) classification.

#### UNIT 3: Phytogeography

(5 lectures)

Principles, Continental drift, Endemism; Brief description of major terrestrial biomes (one each from tropical, temperate & tundra); Phytogeographical division of India; Local Vegetation.

**UNIT 4: Ethnobotany** (5 lectures)

Definition, concept and scope; discipline and sub-disciplines of ethnobotany; importance of traditional knowledge in relation to plant uses and Intellectual Property Rights (IPR).

**2.2 Practical/ Presentation** (15 lectures)

**(A). Plant Ecology:**

1. Study of instruments used to measure microclimatic variables: Soil thermometer, maximum and minimum thermometer, anemometer, psychrometer/hygrometer, rain gauge and lux meter.
2. Determination of pH of various soil and water samples (pH meter, universal indicator/Lovibond comparator and pH paper).
3. Study of biotic interactions of the following: Stem parasite (*Cuscuta*), Root parasite (*Orobanchae*) Epiphytes, Predation (Insectivorous plants).
4. Determination of minimal quadrat size for the study of herbaceous vegetation in the college campus, by species area curve method (species to be listed).
5. Quantitative analysis of herbaceous vegetation in the college campus for frequency and comparison with Raunkiaer's frequency distribution law.
6. Quantitative analysis of herbaceous vegetation for density and abundance in the college campus.

**(B). Plant Systematics:**

1. Study of vegetative and floral characters of the following families (Description, V.S. flower, section of ovary, floral diagram/s, floral formula/e and systematic position according to Bentham & Hooker's system of classification):

Families	Representatives
Solanaceae	<i>Solanum nigrum/Solanum virginianum</i>
Euphorbiaceae	<i>Euphorbia hirta</i>
Rubiaceae	<i>Hedyotis diffusa</i>
Scrophulariaceae	<i>Scoparia dulcis</i>
Lamiaceae	<i>Leucas aspera</i>
Malvaceae	<i>Sida</i> sp.
Verbenaceae	<i>Lantena / Lippia /Duranta</i>
Musaceae	<i>Musa</i> sp.
Orchidaceae	<i>Dendrobium, Aerides, Rynchosylis retusa</i>

2. Preparation of herbarium and bottle specimen (*minimum 10 numbers*); cataloguing and arrangement of herbarium.
3. Field visit to familiarise students with plant diversity and ecology of different sites.

**Suggested Readings:**

1. Odum, E.P. (2005). Fundamentals of Ecology. Cengage Learning India Pvt. Ltd., New



- Delhi. 5<sup>th</sup> edition.
2. Singh, J.S., Singh, S.P., Gupta, S. (2006). Ecology Environment and Resource Conservation. Anamaya Publications, New Delhi, India.
  3. Sharma, P.D. (2010). Ecology and Environment. Rastogi Publications, Meerut, India. 8<sup>th</sup> edition.
  4. Wilkinson, D.M. (2007). Fundamental Processes in Ecology: An Earth Systems Approach. Oxford University Press. U.S.A.
  5. Kormondy, E.J. (1996). Concepts of ecology. PHI Learning Pvt. Ltd., Delhi, India. 4<sup>th</sup> edition.
  6. Singh, G. (2012). *Plant Systematics: Theory and Practice* Oxford & IBH Pvt. Ltd., New Delhi. 3<sup>rd</sup> edition.
  7. Jeffrey, C. (1982). An Introduction to *Plant Taxonomy*. Cambridge University Press, Cambridge.
  8. Judd, W.S., Campbell, C.S., Kellogg, E.A., Stevens, P.F. (2002). *Plant Systematics-A Phylogenetic Approach*. Sinauer Associates Inc., U.S.A. 2<sup>nd</sup> edition.
  9. Maheshwari, J.K. (1963). *Flora of Delhi*. CSIR, New Delhi.
  10. Radford, A.E. (1986). *Fundamentals of Plant Systematics*. Harper and Row, New York.

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## **SEMESTER -II**

**Course Code: BOTA-SEC-2014**

**Course Paper: Natural Resource Management**

**PAPER CREDIT:04 (3T+1P)**

**Total No. of Lectures: 45L + 15P**

**Total marks=100 (60T + 20IA+ 20P)**

### **Objectives:**

This paper aims to study the different aspects of natural resource management.

### **Learning Outcome:**

1. Comprehensive knowledge on different types of natural resources and their ecological, economical and socio-cultural values.
2. Basic understandings of land, water and forest resources.
3. Overall knowledge on resource degradation, their judicious use and management for sustainability.
4. Knowledge on biodiversity - its importance, management and Bioprospecting.
5. Knowledge on IPR, and global arena on resource management, conservation and benefit sharing.
6. Hands on experience on the domestic solid waste estimation and determining its impact on land degradation.
7. Hands on experience on forest study using tools like GPS/GIS and understanding of ecological importance of forest resources.

### **CONTENT**

#### **2.1 THEORY**

#### **UNIT 1: Natural resources**

**(5lectures)**

Definition and types; Sustainable utilization- concept and approaches.

#### **UNIT 2: Land Resources and water resources**

**(10 lectures)**

**Land resources**-Utilization of land (agricultural, pastoral, horticultural, silvicultural); Soil degradation and management.

**Water resources**-Sources of fresh water (rivers, lakes, groundwater, aquifers, watershed); Marine; Estuarine; Wetlands; Threats and management strategies.

#### **UNIT 3: Biological, Forest and Energy resources**

**(15 lectures)**

**Biological resources**- Biodiversity: definition and types; significance, threats and management strategies; Bio- prospecting; IPR; CBD; National Biodiversity Action Plan.

**Forest Resources**- Definition, Cover and its significance (with special reference to India); Major and minor forest products; Forest resource depletion and its management.

**Energy Resources**- Renewable and non-renewable sources of energy.

#### **UNIT 4: Contemporary practices in resource management**

**(15 lectures)**

EIA, GIS, Participatory Resource Appraisal, Ecological Footprint with emphasis on carbon footprint, Resource Accounting; Waste management; National and international efforts in resource management and conservation.

## **2.2 Practical/ Presentation**

**(15 lectures)**

1. Estimation of solid waste generated by a domestic system (biodegradable and non- biodegradable) and its impact on land degradation.
2. Collection of data on forest cover of specific area.
3. Measurement of dominance of woody species by DBH (diameter at breast height) method.
4. Calculation and analysis of ecological footprint.
5. Ecological modeling.

### **Suggested Readings:**

1. Vasudevan, N. (2006). Essentials of Environmental Science. Narosa Publishing House, New Delhi.
2. Singh, J. S., Singh, S.P. and Gupta, S. (2006). Ecology, Environment and Resource Conservation. Anamaya Publications, New Delhi.
3. Rogers, P.P., Jalal, K.F. and Boyd, J.A. (2008). An Introduction to Sustainable Development. Prentice Hall of India Private Limited, New Delhi.

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**Add-on Course**  
**Course Paper: Mushroom Cultivation**  
**PAPER CREDIT:02 (1T+1P)**

**Total No. of Lectures: 15L + 15P**

**Total marks=50 (T30 + 10IA+ 10P)**

**Objectives:**

This paper aims to study the cultivation of mushrooms.

**Learning Outcome:**

1. Learner will understand about the basic concept of mushroom cultivation.

**1**

**1.1 THEORY**

**Unit-I: History of Mushrooms**

**(10 lectures)**

General characteristics of mushrooms; History of mushroom cultivation in India with special reference to NE region.

**(A). Mushroom Ecology-** Occurrence; natural habitats; wild mushroom collection; spore print, drying and preservation techniques.

**(B). Mushroom Morphology-** Different parts of a typical mushroom and variations in mushroom morphology; Key to differentiate edible and poisonous mushrooms.

**(C). Biology of Mushrooms-** General characters of mushroom with reference to general morphology and distinguishing characteristics; Life cycles of *Agaricus bisporous* and *Pleurotus* sp.

**Unit 2: Mushroom Cultivation**

**(5 lectures)**

Introduction to cultivable mushrooms of India; Cultivation techniques of Oyster mushroom.

**1.2 Practical/ Presentation**

**(15 Lectures)**

1. To study the external characters of mushroom.
2. To study the internal structure of mushroom.
3. To study the different species of mushrooms.
4. To study the morphological characteristics of edible mushroom.
5. To study the morphological characteristics of poisonous mushroom.
6. To study the life cycle of typical mushroom (Photographs/Diagrammatic representation).
7. Photographic collection of different species of mushroom.
8. Preparation of record-book of different types and methods of preservation of mushrooms from surroundings.
9. Field study

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