MANIPUR UNIVERSITY

Draft Syllabus for
Bachelor of Science in Botany
2022

Preamble

Higher Education system in the country and all over the world have undergone paradigm shift in the both qualitative and quantitative aspects. Over the past decades the higher education system of our country has undergone substantial structural and functional changes. These changes have gained momentum with the introduction of Choice Based Credit System (CBCS) with learning outcome based curriculum to maximize the benefits. The National Education Policy 2020 stressed on developing overall personality of students by incorporating humanitarian and constitutional values, creativity and critical thinking, harnessing innovation, use of modern technology and interaction with various stakeholders. The new policy recognizes that the pedagogy should evolve to make education more experiential, holistic, integrated, learner-centric, flexible and developing skill sets to make the student face the challenges of the future. The new policy also envisages the refinement and improvement in the Learning Outcome Based Curriculum Framework

The current Undergraduate Curriculum Framework 2022 for the Botany underlines the perspective, philosophical basis and contemporary realities of higher education as enshrined in the National Education Policy 2020. This new framework will definitely help the teachers of the discipline to visualize the curriculum more specifically in terms of the learning outcomes expected from the students at the end of the instructional process.

The hallmark of the higher education is to develop an integrated personality of the individual and the educational system provides all knowledge and skills to the learner for this. Keeping in this line, sustained and continued endeavour efforts are exemplified in successive revision of undergraduate curricular framework over the decades, keeping pace with the emerging trends in higher education. The new curriculum is attended to keep pace with the emerging trends in higher education in the new millennium and its critical importance in empowering the youth for the future and equipping the youths with the prevailing priorities of optimum skill sets through innovative and practical oriented teaching-learning processes.

Introduction

Botany is the broad discipline encompassing various subjects involved with the study of plants. With the changing outlook in scientific world and development of molecular biology and computational biology, emphasis has been shifted to modern science at the cost of traditional botany. However, there is need to balance the traditional botany and upcoming modern computational and applied approach.

Considering these various facets of learning, adequate balance of topics in botany is arranged displaying latest APG IV based phylogenetic systematics of plants covering higher plants, lower plants, aquatic plants, nature/ field study, functional aspects of various cellular processes of plants, molecular genetics and modern tools i.e. tissue culture, genetic engineering and computational studies that are required to be introduced at undergraduate level.

This syllabus has been drafted to enable the students to equip for national level competitive exams that they may attempt in future. To ensure implementation of a holistic pedagogical model, several allied disciplines are covered/introduced in this syllabus, including Chemistry, Mathematics and a number of generic, and ability enhancement electives. In addition, employability of B.Sc. Botany graduate is given due importance such that their core competency in the subject matter, both theoretical and practical, is ensured. To expand the employability of graduates, a number of skill development courses are also introduced in this syllabus.

Aims of Bachelor's Degree Programs in B.Sc. Botany

1. To gain knowledge of diversity, life forms, life cycles, morphology and importance of viruses, bacteria, fungi and to introduce students about the concepts and principles of plant pathology, causal organisms of plant diseases and their control.
2. To gain knowledge of diversity, life forms, life cycles, morphology and importance of algae, bryophytes, pteridophytes and gymnosperms along with proficiency in the experimental techniques of analysis of these plant groups.
3. To enable students to understand and appreciate the relevance of Microbes and Plants to environment and sustainable development.
4. To develop an understanding of Evolution of Plant forms and the consequent Biodiversity developed. These are instrumental in creating awareness on the threats to biodiversity and sensitize students towards the Conservation of Biodiversity for sustainable development.
5. To help the students to gain knowledge on the activities in which the giant molecules and miniscule structures that inhabit the cellular world of life are engaged. This will provide inside into the organization of cell, its features and regulation at different

levels. Through the study of biomolecules and cell organelles, they will be able to understand the various metabolic processes such as respiration, photosynthesis etc. which are important for life.

6. To introduce students to application of microbes and plants in Industrial application and Environmental remediation strategies.
7. To explore the natural genetic variation in plants and to understand how diverse factors (at the cellular level) contribute to the expression of genotypes and hence to phenotypic variation.
8. To provide insight of physiological and biochemical processes in the plant systems with emphasis on different pathways, regulation and integration of metabolic processes with their role in crop productivity, and understanding of metabolic engineering.
9. To make the students familiar with economic importance of diverse plants that offer resources to human life and to emphasize the use of plants as food, medicine and for other utilities with huge economic value etc.
10. To give students knowledge on classical and modern plant biotechnology processes, role of biotechnology on global food security and commercial gains in biotechnology and agriculture, and also to familiarize with biotechnological tools
11. To understand biotechnological processes and its applicative value in pharmaceuticals, food industry, agriculture, ecology to modify plant responses and properties for global food security, human welfare and conservation of biodiversity.
12. Understanding of plant classification systematics, evolution, ecology, developmental biology, physiology, biochemistry, plant interactions with microbes and insects, morphology, anatomy, reproduction, genetics and molecular biology of various plants groups.
13. Understanding of various analytical techniques of plant sciences, use of plants as industrial resources or as human livelihood support system and the use of transgenic technologies for basic and applied research in plants.
14. Understanding of various life forms of plants, morphology, anatomy, reproduction, genetics, microbiology, molecular biology, recombinant DNA technology, transgenic technology and use of bioinformatics tools and databases and in the application of statistics to biological data
15. To provide new information, enhance core competency and discovery/inquiry based learning of learners. A botany graduate would be competent in the field to undertake further discipline-specific studies, as well as to begin domain-related employment.
16. To make students aware of most basic domain-independent knowledge, including critical thinking and communication.
17. To enable the graduate to prepare for national and International competitive examinations for employment.

Attributes of a Botany Graduate

- **Core competency**: The botany graduates are expected to know the fundamental concepts of botany and plant science that reflect the latest understanding of the field. The core competency are dynamic in nature and require frequent and time-bound revisions.

- **Communication skills:** Botany graduates are expected to possess minimum standards of communication skills expected of a science graduate. They are expected to read and understand documents with in-depth analyses and logical arguments. Graduates are expected to be well-versed in speaking and communicating their idea/finding/concepts to wider audience
- **Critical thinking**: Botany graduates are expected to know basics of cognitive biases, mental models, logical fallacies, scientific methodology and constructing cogent scientific arguments.
- **Psychological skills**: Graduates are expected to possess basic psychological skills required to face the world at large, as well as the skills to deal with individuals and students of various sociocultural, economic and educational levels. Psychological skills may include feedback loops, self-compassion, self-reflection, goal-setting, interpersonal relationships, and emotional management.
- **Problem-solving**: Graduates are expected to be equipped with problem solving philosophical approaches that are pertinent across the disciplines;
- **Analytical reasoning**: Graduates are expected to formulate cogent arguments and spot logical flaws, inconsistencies, circular reasoning etc in fallacious arguments.
- **Research-skills**: Graduates are expected to be keenly observant about what is going on in the natural surroundings to awake their curiosity. Graduates are expected to design a scientific experiment through statistical hypothesis testing and other a priori reasoning including logical deduction.
- **Teamwork**: Graduates are expected to be team players, with productive cooperations involving members from diverse socio-cultural backgrounds.
- **Digital Literacy**: Graduates are expected to be digitally literate for them to enroll and increase their core competency via e-learning resources such as MOOC and other digital tools for lifelong learning. Graduates should be able to spot data fabrication and fake news by applying rational skepticism and analytical reasoning.
- **Moral and ethical awareness**: Graduates are expected to be responsible citizen of India and be aware of moral and ethical baseline of the country and the world. They are expected to define their core ethical virtues good enough to distinguish what construes as illegal and crime in Indian constitution. Emphasis be given on academic and research ethics, including fair Benefit Sharing, Plagiarism, Scientific Misconduct and so on.
- **Leadership readiness**: Graduates are expected to be familiar with decision making process and basic managerial skills to become a better leader. Skills may include defining objective vision and mission, how to become charismatic inspiring leader and so on.

Qualification Descriptors

For a graduate student in Botany (Honours) the qualification descriptors may include following:

- To show a systematic, extensive, coherent knowledge and understanding of academic subjects and their applications, including critical understanding of the established

theories, principles and concepts of a number of advanced and emerging issues in the field of Botany;

- To gain knowledge to produce professionals in the field of plant sciences in research and development, academics (teaching in Schools, Colleges and University), government and public services e.g. conservationist, plant explorer, ecologist, horticulturist, plant biochemist, genetics, nursery manager, molecular biologist, plant pathologist, taxonomist, farming consultant and environmental consultant. Further application of knowledge can enhance productivity of several economically important products. Knowledge of plant sciences is also necessary for the development and management of forests, parks, wastelands and sea wealth
- Display skills and ability to use knowledge efficiently in areas related to specializations and current updates in the subject.
- Provide knowledge about plants, current research, scholarly and professional literature of advanced learning areas of plant sciences
- Use knowledge understanding and skills for critical assessment of wide range of ideas and problems in the field of Botany
- Communicate the outcomes of studies in the academic field of Botany through print and digital media.
- Apply one's knowledge and understanding of Botany to new/unfamiliar contexts and to identify problems and solutions in daily life
- Design and apply the knowledge of plant sciences in identifying the problems which can be solved through the use of plants
- To think of adopting expertise in plant structure, functions and solve the problems of environment, ecology, sustainable development and enhancing productivity.
- Concept and significance of sustainable development and use of the plant resources

Programme Learning Outcome

The student graduating with the Degree B.Sc (Honours) Botany should be able to acquire

- **Core competency**: Students will acquire core competency in the subject Botany, and in allied subject areas.
    - The student will be able to identify major groups of plants and compare the characteristics of lower (e.g. algae and fungi) and higher (angiosperms and gymnosperms) plants.
    - Students will be able to use the evidence based comparative botany approach to explain the evolution of organism and understand the genetic diversity on the earth.
    - The students will be able to explain various plant processes and functions, metabolism, concepts of gene, genome and how organism's function is influenced at the cell, tissue and organ level.
    - Students will be able to understand adaptation, development and behaviour of different forms of life.
    - The understanding of networked life on earth and tracing the energy pyramids through nutrient flow is expected from the students.

    - Students will be able to demonstrate the experimental techniques and methods of their area of specialization in Botany.
- **Analytical ability**: The students will be able to demonstrate the knowledge in understanding research and addressing practical problems.
    - Application of various scientific methods to address different questions by formulating the hypothesis, data collection and critically analyze the data to decipher the degree to which their scientific work supports their hypothesis.
- **Critical Thinking and problem solving ability**: An increased understanding of fundamental concepts and their applications of scientific principles is expected at the end of this course. Students will become critical thinker and acquire problem solving capabilities.
- **Digitally equipped**: Students will acquire digital skills and integrate the fundamental concepts with modern tools.
- **Ethical and Psychological strengthening**: Students will also strengthen their ethical and moral values and shall be able to deal with psychological weaknesses.
- **Team Player**: Students will learn team workmanship in order to serve efficiently institutions, industry and society.
- **Independent Learner**: Apart from the subject specific skills, generic skills, especially in botany, the program outcome would lead to gain knowledge and skills for further higher studies, competitive examinations and employment. Learning outcomes based curriculum would ensure equal academic standards across the country and broader picture of their competencies. The Bachelor program in Botany and Botany honours may be mono-disciplinary or multidisciplinary

Eligibility Criteria

The general feeder category for entry into Semester I – B.Sc. Botany (Honours) is the Secondary School Leaving Certificate obtained after successfully completing Grade 12. A programme of study leading to entry into the first year of the Bachelor's degree is open to those students who have met the entrance requirements, including specified levels of attainment at the secondary level of education mentioned in the programme admission regulations.

Admission to the Bachelor degree programme of study will depend on the evaluation of documentary evidence (including the academic record) of the applicant's ability to undertake and complete a Bachelor's degree programme which is specified in the UGC Guidelines for Multiple Entry and Exit Scheme in Academic Programmes Offered in Higher Education.

General Information

1. A student who pursues three years undergraduate degree programme in B.Sc. (Honours) Botany will earn at least 140 credits in that discipline (from 18 CCs and at least 2 DSEs of that discipline) and shall be awarded Honours degree in Botany, if he/she exits after completion of VI semester.
2. If a student wishes to pursue four years Honours Degree with research, he/she shall compulsorily opt for a Research Methodology course in either VI Semester or VII Semester as GE.
3. Dissertation or Academic Project in the 4th year shall commence from VII semester and conclude in VIII semester.
4. Exit options will be provided to students to avail the comfort of the flexibility of semester-wise academic load and to learn at his/her own pace. However, the mandatory number of credits have to be secured for the purpose of award of Certificate/Diploma/ Appropriate Bachelor's Degree in the field of Botany, to a student who chooses to exit at the end of even semesters.
5. For award of single discipline specific Honours degree in B.Sc. (Honours) Botany, Core Courses shall be from the Botany only.
6. There shall be a pool of DSEs from which a student may choose a course of study. Each of the DSE courses shall contain two components: Theory and Practical/Tutorial. To pursue B.Sc. (Honours) Botany, DSEs chosen should be from a pool of DSEs of Botany.
7. An elective course chosen generally from an unrelated discipline/subject, with an intention to seek a wide exposure is called a Generic Elective. Generic Electives shall be a pool of courses which is meant to provide multidisciplinary or interdisciplinary education to students. GEs shall consist of a pool of courses offered by various disciplines of study (excluding the GEs offered by the parent discipline), in groups of odd and even semesters, from which a student can choose.

8. A student who a pursues four-year undergraduate degree programme shall be awarded after completion of the VIII semester an appropriate degree.

Course Structure

Semester I

Core Courses		
Course code	Title of the paper	Credit
BOTC-101	Viruses, Bacteria, Fungi and Plant Pathology	4
BOTC-102(P)	Viruses, Bacteria, Fungi and Plant Pathology (Practical)	2
BOTC-103	Algae, Bryophytes, Pteridophytes and Gymnosperms	4
BOTC-104(P)	Algae, Bryophytes, Pteridophytes and Gymnosperms (Practical)	2
Ability Enhancement Compulsory Courses (AECC)		
	English/MIL	4
Skill Enhancement Courses (SEC) to be opted one course		
BOTS-105	Biofertilizers	2
BOTS-106(P)	Biofertilizers (Practical)	2
BOTS-107	Mushroom Cultivation	2
BOTS-108(P)	Mushroom Cultivation(Practical)	2
BOTS-109	Fermentation Technology	2
BOTS-110(P)	Fermentation Technology (Practical)	2
Value Addition Courses (VAC)		
	To be opted from central pool	2
	To be opted from central pool	2
Total Credit		**24**

Semester II

Core Courses		
Course code	Title of the paper	Credit
BOTC-201	Plant Systematics	4
BOTC-202(P)	Plant Systematics (Practical)	2
BOTC-203	Biomolecules and Cell Biology	4
BOTC-204(P)	Biomolecules and Cell Biology (Practical)	2
Ability Enhancement Compulsory Courses (AECC)		
	Environmental Science	4
Skill Enhancement Courses (SEC) to be opted one course		
BOTS-205	Botanical Garden and Landscaping	2
BOTS-206(P)	Botanical Garden and Landscaping (Practical)	2
BOTS-207	Nursery and Gardening	2
BOTS-208(P)	Nursery and Gardening (Practical)	2

BOTS-209	Floriculture	2
BOTS-210(P)	Floriculture (Practical)	2
Value Addition Courses (VAC)		
	To be opted from central pool	2
	To be opted from central pool	2
Total Credit		**24**

Exit option after first year: Bachelor's Certificate in Botany (Level 5) on completion of 46 credits

Semester III

Core Courses		
Course code	Title of the paper	Credit
BOTC-301	Plant Metabolism	4
BOTC-302(P)	Plant Metabolism (Practical)	2
BOTC-303	Ecology and Phytogeography	4
BOTC-304(P)	Ecology and Phytogeography (Practical)	2
BOTC-305	Genetics and Cytogenetics	4
BOTC-306(P)	Genetics and Cytogenetics (Practical)	2
Generic Elective Course (GEC)		
	Theory (To be opted from other discipline)	6/4
	Practical	2/0
Value Addition Courses (VAC)		
	To be opted from central pool	2
Total Credit		**26**

Semester IV

Core Courses		
Course code	Title of the paper	Credit
BOTC-401	Economic Botany and Plant Resource Utilization	4
BOTC-402(P)	Economic Botany and Plant Resource Utilization (Practical)	2
BOTC-403	Molecular Biology	4
BOTC-404(P)	Molecular Biology (Practical)	2
BOTC-405	Plant Morphology and Anatomy	4
BOTC-406(P)	Plant Morphology and Anatomy (Practical)	2
Generic Elective Course (GEC)		
	Theory (To be opted from other discipline)	6/4

	Practical	2/0
Value Addition Courses (VAC)		
	To be opted from central pool	2
Total Credit		**26**

Exit option after second year: Bachelor's Diploma in Botany (Level 6) on completion of 96 credits

Semester V

Core Courses		
Course code	Title of the paper	Credit
BOTC-501	Reproductive Biology of Angiosperms	4
BOTC-502(P)	Reproductive Biology of Angiosperms (Practical)	2
BOTC-503	Plant Physiology	4
BOTC-504(P)	Plant Physiology (Practical)	2
Discipline Specific Elective Course (DSE) to be opted one course		
BOTD-505	Stress Physiology	4
BOTD-506(P)	Stress Physiology (Practical)	2
BOTD-507	Plant Breeding	4
BOTD-508(P)	Plant Breeding(Practical)	2
BOTD-509	Plant Pathology	4
BOTD-510(P)	Plant Pathology (Practical)	2
Generic Elective Course (GEC)		
	Theory (To be opted from other discipline)	6/4
	Practical	2/0
Value Addition Courses (VAC)		
	To be opted from central pool	2
Total Credit		**26**

Semester VI

Core Courses		
Course code	Title of the paper	Credit
BOTC-601	Biostatistics and Bioinformatics	4
BOTC-602(P)	Biostatistics and Bioinformatics (Practical)	2
BOTC-603	Plant Biotechnology	4

BOTC-604(P)	Plant Biotechnology (Practical)	2
Discipline Specific Elective Course (DSE) to be opted one course		
BOTD-605	Microbiology	4
BOTD-606(P)	Microbiology (Practical)	2
BOTD-607	Biodiversity Conservation	4
BOTD-608(P)	Biodiversity Conservation (Practical)	2
BOTD-609	Post-Harvest Technology	4
BOTD-610(P)	Post-Harvest Technology (Practical)	2
Generic Elective Course (GEC)		
	Theory (To be opted from other discipline)	6/4
	Practical	2/0
Value Addition Courses (VAC)		
	To be opted from central pool	2
Total Credit		**26**

Exit option after third year: Bachelor's Degree in Botany (Level 7) on completion of 140 credits

Semester VII

Core Courses		
Course code	Title of the paper	Credit
BOTC-701	Molecular Taxonomy of Plants and Microbes	4
BOTC-702(P)	Molecular Taxonomy of Plants and Microbes (Practical)	2
BOTC-703	Recent Trends in Plant Sciences	4
BOTC-704(P)	Recent Trends in Plant Sciences (Practical)	2
Discipline Specific Elective Course (DSE) to be opted one course		
BOTD-705	Bioinstrumentation	4
BOTD-706(P)	Bioinstrumentation (Practical)	2
Generic Elective Course (GEC) to be opted two courses from other discipline		
	Theory	6/4
	Practical	2/0
Total Credit		**24**

Semester VIII

Core Courses		
Course code	Title of the paper	Credit

BOTC-801 BOTC-802(P)	Environmental Challenges and Sustainable Development Environmental Challenges and Sustainable Development (Practical)	4 2
BOTC-803 BOTC-804(P)	Research Methodology Research Methodology (Practical)	4 2
Discipline Specific Elective Course (DSE) to be opted one course		
BOTD-805	Project Work/Dissertation	6
Generic Elective Course (GEC) to be opted one course from other discipline		
	Theory	6/4
	Practical	2/0
Total Credit		**24**

Exit option after fourth year: Bachelor's Degree in Botany Honours (Level 8) on completion of 182 credits

I. Core Courses(Compulsory Courses)

1. Viruses, Bacteria, Fungi and Plant Pathology
2. Algae, Bryophyta, Pteridophyta and Gymnosperm
3. Plant Systematics
4. Biomolecules and Cell Biology
5. Plant Metabolism
6. Ecology and Phytogeography
7. Genetics and Cytogenetics
8. Economic Botany and Plant Resource Utilization
9. Molecular Biology
10. Plant Morphology and Anatomy
11. Reproductive Biology of Angiosperms
12. Plant Physiology
13. Biostatistics and Bioinformatics
14. Plant Biotechnology
15. Molecular Taxonomy of Plants and Microbes
16. Recent Trends in Plant Sciences
17. Environmental Challenges and Sustainable Development
18. Research Methodology

II. Ability Enhancement Compulsory Courses (AECC)

A. Semester I

1. English/MIL

B. Semester II

1. Environmental Science

III. Discipline Specific Elective Course (DSEC) (to be opted one course each in Semester V, VI, VII and VIII)

A. Semester V

1. Stress Physiology

2. Plant Breeding
3. Plant Pathology

B. Semester VI

1. Microbiology
2. Biodiversity Conservation
3. Post-Harvest Technology

C. Semester VII

1. Bioinstrumentation

D. Semester VIII

1. Project Work/Dissertation

IV. Generic Elective Courses (GEC)(to be offered to candidates of other discipline)

Semester III (To be opted one course)		
Course Code	Title of the Paper	Credit
BOTG-301 BOTG-302(P)	Algal Biotechnology Algal Biotechnology (Practical)	4 2
BOTG-303 BOTG-304(P)	Intellectual Property Rights Intellectual Property Rights (Practical)	4 2
BOTG-305 BOTG-306(P)	Medicinal and Aromatic Plants Medicinal and Aromatic Plants (Practical)	4 2
Semester IV(To be opted one course)		
Course Code	Title of the Paper	Credit
BOTG-401 BOTG-402(P)	Seed Technology Seed Technology (Practical)	4 2
BOTG-403 BOTG-404(P)	Food Science Food Science (Practical)	4 2
BOTG-405 BOTG-406(P)	Industrial Microbiology Industrial Microbiology (Practical)	4 2
Semester V (To be opted one course)		
Course Code	Title of the Paper	Credit
BOTG-501 BOTG-502(P)	Environmental Monitoring and Management	4

	Environmental Monitoring and Management (Practical)	2
BOTG-503	Global Climate Change	4
BOTG-504(P)	Global Climate Change (Practical)	2
BOTG-505	Environmental Toxicity	4
BOTG-506(P)	Environmental Toxicity (Practical)	2
Semester VI (To be opted one course)		
Course Code	Title of the Paper	Credit
BOTG-601	Biodiversity	4
BOTG-602(P)	Biodiversity (Practical)	2
BOTG-603	Plant Taxonomy and Ecology	4
BOTG-604(P)	Plant Taxonomy and Ecology (Practical)	2
BOTG-605(P)	Phytochemistry	4
BOTG-606(P)	Phytochemistry (Practical)	2
	Semester VII	
Course Code	Title of the Paper	Credit
BOTG-701	Plant Diversity and Human Welfare	4
BOTG-701(P)	Plant Diversity and Human Welfare (Practical)	2
	Semester VIII	
Course Code	Title of the Paper	Credit
BOTG-701	Plant Biochemistry	4
BOTG-701(P)	Plant Biochemistry (Practical)	2

V. Skill Enhancement Courses (SEC) (to be opted one course each in Semester I and Semester II)

A. Semester I

1. Biofertilizers
2. Mushroom Cultivation
3. Fermentation Technology

B. Semester II

1. Botanical Garden and Landscaping
2. Nursery and Gardening
3. Floriculture

VI. Value Added Course (VAC) (To be opted two courses each in Semester I and Semester II and one course each in Semester III, IV, V and VI)

List of Value Added Courses will be provided as central pool.

COURSE TEACHING-LEARNING PROCESS

The learning experiences gained for cognitive development in every student. The practical exercises help to develop an important aspect of the teaching-learning process. The important relevant teaching and learning processes involved in this course are;

1. Class lectures
2. Seminars
3. Tutorials
4. Group discussions and Workshops
5. Question framing
6. Short answer type questions
7. Long answer type questions
8. Objective type questions
9. Multiple choice questions
10. Statement, reasoning and explanation
11. Project-based learning
12. Field-based learning
13. Practical component and experiments
14. Quizzes
15. Presentations through Posters and power point
16. Internship in industry and research institutional

THEORY (LECTURE):

1. Lesson plan of each week will be prepared before the commencement of the session and followed during the session.
2. The theory topics are covered in lectures with the help of both conventional (chalk board and Charts) and modern (ICT) methods, including animations.
3. Emphasis is given on interactive class room environment so as to encourage students ask questions/ doubts/ queries for clarification/explanation and discussion.
4. Students are encouraged to refer to reference books in library to inculcate reading habit for better grasp and understanding on the subject.
5. Emphasis is given to illustrations- neat, well-labelled outline and cellular diagrams/ flowcharts for improving creative skills and to substantiate the text content.
6. On completion of theory syllabus, previous years' question papers are discussed so as to apprise students about the general format of semester exam question papers.
7. Total marks for each course shall be based on internal assessment (25%) and semester end examination (75%). Test/Assignment/Seminar/Field Work/Project Work/Case Study (20%) and Attendance (5%) are components of Internal Assessment Scheme for compilation of Internal Assessment Score of each student.

Practical:

1. Practical plan of each week will be prepared before the commencement of the session and followed during the session.
2. Every practical session begins with instructions, followed by students doing table work for detailed microscopic plant study.

3. Plant study is done using fixed plant materials, museum and herbarium specimens, photographs and permanent slides.
4. The students are instructed about maintaining practical records, which includes comments and diagrams.
5. Students are asked to submit practical records regularly, on a continuous basis, for checking.
6. On completion of practical syllabus, Practical Exam Guidelines are discussed to apprise students about the formant of Practical exam.
7. As part of Continuous Evaluation guidelines, total score for each student is calculated out of 25 marks, taking into consideration
8. Practical Records (10), Practical Test/ Assessment (10) and Practical Attendance (5)

Assessment Methods

A number of appropriate assessment methods of botany will be used to determine the extent to which students demonstrate desired learning outcomes. Involving students in highlighting the salient features/summary a topic through digital media such as Power Point presentations and animations enhance their communication skill. Making drawings should be compulsory part of practical record books. A continuous assessment method throughout the programme shall inculcate regular reading habit in the students and provide continuous observation learning abilities and challenges of the students'

Following assessment methodology will be adopted:

- Oral and written examinations
- Closed-book and open-book tests,
- Problem-solving exercises,
- Practical assignments and laboratory reports,
- Observation of practical skills,
- Individual and group project reports,
- Seminar and presentations,
- Interactive sessions.
- Evaluation of answer scripts and discussion on the mistakes committed

KEYWORDS

Plant Sciences, Biology, biodiversity, biotechnology, botany, bryophytes, fungi, algae, mocrobes, bacteria, plant pathology, plant reproduction, anatomy, developmental biology, molecular biology, genetics, systematics, taxonomy, plant physiology, biostatistics, bioinformatics, ecology, biochemistry

LINKAGE

The course learning outcomes in the Semester I will link with the core courses and other courses as stated below.

Semester I					
Programme Outcome	**CC1** **BOTC-101; BOTC-102(P)**	**CC2** **BOTC-103; BOTC-104(P)**	**SEC1** **BOTS-105; BOTS-106(P)**	**SEC2** **BOTS-107; BOTS-108(P)**	**SEC3** **BOTS-109; BOTS-110(P)**
Core competency	✓	✓			
Critical Thinking	✓	✓			
Analytical Reasoning	✓	✓	✓	✓	✓
Research Skills	✓	✓	✓	✓	✓
Teamwork	✓	✓	✓	✓	✓
Additional Knowledge Enhancement			✓	✓	✓
Exposure beyond discipline			✓	✓	✓
Digital Literacy			✓	✓	✓
Moral and Ethical awareness	✓	✓	✓	✓	✓

Course Content

Semester – I

Core Course – Viruses, Bacteria, Fungi and Plant Pathology

	L	T	P	Total
Credit	**4**	**0**	**2**	**6**
Paper Codes	**BOTC-101**		**BOTC-102(P)**	

Course Objective

To gain knowledge of diversity, life forms, life cycles, morphology and importance of viruses, bacteria, fungi and to introduce students about the concepts and principles of plant pathology, causal organisms of plant diseases and their control.

Learning outcomes

On completion of this course, the students will gain knowledge and will be able to:

1. Characteristics, diversity, nutrition and importance of microbes
2. Classify viruses, bacteria, fungi and lichens based on their characteristics and structures
3. Replication of viruses
4. Bacterial reproduction and genetic recombination
5. Reproduction and life cycle of representative species of different groups of fungi
6. Develop critical understanding of plant diseases and their remediation

Paper Code: BOTC-101
Paper Title: Viruses, Bacteria, Fungi and Plant Pathology (Theory)
Credit: 4

Course Content

Unit I: Viruses **12 Lectures**
History, nature, biochemical composition and structural organization (helical and icosahedral symmetry) of viruses; Classification (Baltimore); Nomenclature of plant viruses; Genome organization and replication of tobacco mosaic virus (TMV) and bacteriophage (T-phage); Lytic and lysogenic cycle, Symptoms and transmission of plant viral diseases; Structure, properties and importance of viroids and prions.

Unit II: Bacteria **15 Lectures**
Overview of cell structure and function in the prokaryotes (Bacteria and Archaea); Classification of prokaryotes based on cell structure (Archaea, Gram-positive and Gram-negative bacteria, Mollicutes); Metabolic diversity of bacteria (phototrophy, chemolithotrophy, autotrophy, heterotrophy, fermentation); Bacterial cell division and

microbial growth; Bacterial genome and plasmids; Reproduction and genetic recombination; Microbial growth control; Bacterial culture and staining; Economic importance of bacteria.

Unit III: Fungi **18 Lectures**

General characteristics; Thallus organisation; Cell wall composition; Nutrition; Classification; Reproduction in fungi; Economic importance of fungi; Characteristics and life cycles of the following fungal species: Chytridiomycota – *Synchytrium, Allomyces*; Oomycota - *Phytopthora, Albugo*; Zygomycota – *Rhizopus, Mucor*; Ascomycota - *Saccharomyces, Neruspora,*; Basidiomycota -*Puccinia, Agaricus*; Deuteromycota (mitosporic fungi) - *Fusarium.Aspergillus*.

Myxomycota - General characterises; Status of slime molds; Occurrence; Classification.

Lichens: Classification; Thallus organization; Reproduction; Physiology and economic importance.

Mycorrhiza – Ectomycorrhiza and endomycorrhiza and their significance.

Unit IV: Plant Pathology **15 Lectures**

History of plant pathology; Terms and concepts; Plant disease symptoms; Host- Pathogen relationships; Disease cycle and environmental relation; Methods of control of plant diseases; Plant quarantine; Fungal diseases – late blight of potato, brown leaf spot of rice, black rust of wheat; Bacterial diseases– citrus canker, angular leaf spot disease of cotton and bacterial blight of rice; Viral diseases – tobacco mosaic virus, vein clearing and tomato yellow leaf curl viruses.

Paper Code: BOTC-102(P)
Paper Title: Viruses, Bacteria, Fungi and Plant Pathology (Practical)
Credit: 2

1. Electron micrographs/Models of viruses – T4 and TMV, Line drawings/ Photographs of lytic and lysogenic cycle.
2. Collection and study of herbarium samples of virus plant diseases.
3. Types of bacteria from temporary/permanent slides/photographs. Electron micrographs or charts of bacterial binary fission, endospore, conjugation.
4. Gram-staining of root nodule bacterium (*Rhizobium*) and curd (*Lactobacillus*).
5. *Rhizopus* and*Mucor*: study of asexual stage from temporary mounts and sexual structures through permanent slides.
6. *Saccharomyces* and *Aspergillus*: study of asexual stage from temporary mounts and sexual structures through permanent slides.
7. *Alternaria*and*Fusarium*: Preparation of temporary mount.
8. *Puccinia*: preparation of temporary mount of different spores on wheat.
9. *Agaricus*: sectioning of gills.
10. Study of morphology and anatomy of lichens (crustose, foliose and fruticose) through temporary mounts/permanent slides.
11. Collection of herbarium specimens and study of pathological characteristics through temporary mounts/permanent slides of bacterial diseases (citrus canker, angular leaf spot of cotton); Viral diseases (TMV, vein clearing); Fungal diseases (larly blight of potato/ white rust of crucifers, black stem rust of wheat and brown leaf spot of rice).

Suggested readings

1. Agrios, G.N. 1997. Plant Pathology, 4th edition, Academic Press, U.K.
2. Alexopoulos, C.J., Mims, C.W., Blackwell, M. 1996. Introductory Mycology. 4th edition.John Wiley & Sons (Asia) Singapore.
3. Pandey. B.P. 2014 Modern Practical Botany, (Vol-I) S. Chand and Company Pvt. Ltd., New Delhi.
4. Pelczar, M.J. 2001. Microbiology, 5th edition, Tata McGraw-Hill Co, New Delhi.
5. Sarbhoy, A.K. 2006. Text Book of Mycology, ICAR Publications, New Delhi.
6. Sethi, I.K. and Walia, S.K. 2011. Text book of Fungi and Their Allies, Macmillan Publishers India Ltd.
7. Sharma, P.D. 2011. Plant Pathology, Rastogi Publication, Meerut, India.
8. Sharma T.A., Dubey, R.C. and Maheshwari, D.K. 1999. A Text Book of Microbiology. S Chand and Co, New Delhi
9. Singh, R. P. 2007. Microbial Taxonomy and Culture Techniques, Kalyani Publication, New Delhi.
10. Webster, J. and Weber, R. 2007. Introduction to Fungi. 3rd edition. Cambridge University Press, Cambridge.
11. Wiley, J.M, Sherwood, L.M. and Woolverton, C.J. 2013. Prescott's Microbiology. 9th Edition. McGraw Hill International.

Teaching Learning Process

1. Class lectures
2. Seminars
3. Group discussions and Workshops
4. Peer teaching and learning
5. Question preparation
6. Subjective type
   - Long answer
   - Short answer
7. Objective type
   - Multiple choice questions
   - One answer/two answer type questions
   - Assertion and reasoning
8. Practical
9. Field-based learning
10. Substantial laboratory-based practical component and experiments
11. Games
12. Technology-enabled learning
13. Internship in industry, and research establishments

Teaching Learning Plan:

- Week 1 : Lecture
- Week 2: Lecture

- Week 3: Lecture
- Week 4: Lecture
- Week 5: Lecture/Practical
- Week 6: Lecture/Practical
- Week 7: Lecture/Practical
- Week 8: Lecture/Practical
- Week 9: Lecture/Practical
- Week 10: Mid semester Exam
- Week 11: Lecture/Practical
- Week 12: Lecture/Practical/Field-based learning
- Week 13: Lecture/Practical
- Week 14: Lecture/Practical
- Week 15: Lecture/Practical

Assessment Methods

1. Drawings form the temporary preparations as practical record books
2. Highlighting the salient features of the genera/ groups through digital media such as power point presentations and animations

Unit No.	Particulars	Teaching and Learning Activity	Assessment Task
I	Virus	Class room lectures, demonstrations and Practical	Hands on exercises, PPT, assignments, tests
II	Bacteria	Class room lectures, demonstrations and Practical	Hands on exercises, PPT, assignments, tests
III	Fungi	Class room lectures, demonstrations and Practical	Hands on exercises, PPT, assignments, tests
IV	Plant Pathology	Class room lectures, demonstrations and Practical	Hands on exercises, PPT, assignments, tests

Core Course - Algae, Bryophytes, Pteridophytes and Gymnosperms

	L	T	P	Total
Credit	**4**	**0**	**2**	**6**
Paper Codes	**BOTC-103**		**BOTC-104(P)**	

Course Objectives

To gain knowledge of diversity, life forms, life cycles, morphology and importance of algae, bryophytes, pteridophytes and gymnosperms along with proficiency in the experimental techniques of analysis of these plant groups.

Learning outcomes

On completion of this course, the students will gain knowledge and will be able to:

1. Understand the classification, characteristic features, reproduction, life cycle patterns, biodiversity and economic importance of various groups of marine and fresh water algae.
2. Demonstrate an understanding of Bryophytes, Pteridophytes and Gymnosperms
3. Develop critical understanding on morphology, anatomy and reproduction of Bryophytes, Pteridophytes and Gymnosperms
4. Understanding of plant evolution and their transition to land habitat.
5. Demonstrate proficiency in the experimental techniques and methods of appropriate analysis of Algae, Bryophytes, Pteridophytes, Gymnosperms

Paper Code: BOTC-103
Paper Title: Algae, Bryophytes, Pteridophytes and Gymnosperms (Theory)
Credit: 4

Unit I: Algae **15 Lectures**

Characteristic features, range of thallus organization, cell structure and components, pigment system, reserve food materials, reproduction and classification proposed by Fritsch and Lee. Thallus structures, reproduction and life cycle of Cyanophyta (*Nostoc*, *Oscillatoria*, *Spirulina*); Chlorophyta (*Chlamydomonas*, *Volvox*, *Oedogonium*, *Coleochaete*); Charophyta (*Chara*); Xanthophyta (*Vaucheria*); Phaeophyta (*Ectocarpus*); Rhodophyta (*Polysiphonia*) and the economic importance of Algae.

Unit II: Bryophyta **15 Lectures**

Comparative and evolutionary trends in liverworts, hornworts and mosses. Progressive sterilization of the sporophytes, general characters, classification, structure of gametophytes and sporophytes, method of reproduction and life cycle of *Riccia, Marchantia, Pellia, Porella, Anthoceros, Sphagnum, Funaria.*

Unit III: Pteridophytes **12 Lectures**

General characteristics and classification, early land plant (*Cooksonia and Rhynia*), reproduction and life cycle of *Psilotum, Lycopodium, Selaginella, Equisetum, Pteris,*

*Marsilea.*Apogamy and Apospory, Heterospory and Seed habit, Telome theory, Stellar evolution, Ecological and economic importance.

Unit IV: Gymnosperms **18 Lectures**

Characteristic features and classification of Gymnosperms, morphology, reproduction and life cycle and economic importance of *Cycas, Pinus, Gnetum, Ephedra* and *Ginkgo.* Polyembryony and pollination drop with special reference to *Pinus.* Economic importance of Gymnosperms.

Palaeobotany: Geological time scale and dominant fossil flora of different ages, Fossil formation and types of fossilizations.

Paper Code: BOTC-104(P)
Paper Title: Algae, Bryophytes, Pteridophytes and Gymnosperm (Practical)
Credit: 2

1. Study of vegetative and reproductive structures of *Nostoc, Chalamydomonas, Volvox, Oedogonium, Chara, Vaucheria, Ectocarpus, Fucus*and *Polysiphonia*through temporary preparation and permanent slides.

2. Microscopic study of morphology and reproductive structure of *Riccia, Marchantia, Pellia, Porella, Anthoceros, Sphagnum, Funaria*through temporary and permanent slides.

3. Microscopic study of morphology and reproductive structure of *Psilotum, Lycopodium, Selaginella, Equisetum, Pteris*through temporary and permanent slides.

4. Study of morphology and microscopic reproductive structure of *Cycas, Pinus, Gnetum, Ephedra, Taxus*through temporary and permanent slides. Examination of available specimens/slides of fossil plants.

Suggested readings

1. Bhatnagar S.P., Moitra, A. 1996. Gymnosperms. New Age International Publishers, New Delhi, India
2. Kaur I., Uniyal P.L. 2020. Text Book of Bryophytes. New Delhi, Delhi: Daya Publishing House.
3. Kaur I., Uniyal P.L. 2019. Text Book of Gymnosperms. Daya Publishing House, New Delhi.
4. Kumar, H.D. 1999. Introductory Phycology, 2nd edition. New Delhi: Affiliated East-West Press.
5. Lee, R.E. 2008. Phycology, 4th edition. Cambridge University Press.
6. Pandey S.N., Misra, S.P., Trivedi, P.S. 1983. A Textbook of Botany Vol. 2. Bryophyta,Pteridophyta, Gymnosperms and Palaeobotany. Vikas Publishing House Pvt. Ltd., New Delhi.
7. Parihar, N.S. 1972. An Introduction to Embryophyta. Vol.II: Pteridophyta. Allahabad, UP: Central Book Deport.
8. Parihar, N.S. 1991. An Introduction to Embryophyta. Vol. I: Bryophyta. Allahabad, UP: Central Book Deport.
9. Vashistha P.C., Sinha A.K., Kumar A. 2010. Pteridophyta. S. Chand. Delhi, India.

Teaching Learning Process

14. Class lectures
15. Seminars
16. Group discussions and Workshops
17. Peer teaching and learning
18. Question preparation
19. Subjective type
    - Long answer
    - Short answer
20. Objective type
    - Multiple choice questions
    - One answer/two answer type questions
    - Assertion and reasoning
21. Practical
22. Field-based learning
23. Substantial laboratory-based practical component and experiments
24. Games
25. Technology-enabled learning
26. Internship in industry, and research establishments

Teaching Learning Plan:

- Week 1 : Lecture
- Week 2: Lecture
- Week 3: Lecture
- Week 4: Lecture
- Week 5: Lecture/Practical
- Week 6: Lecture/Practical
- Week 7: Lecture/Practical
- Week 8: Lecture/Practical
- Week 9: Lecture/Practical
- Week 10: Mid semester Exam
- Week 11: Lecture/Practical
- Week 12: Lecture/Practical/Field-based learning
- Week 13: Lecture/Practical
- Week 14: Lecture/Practical
- Week 15: Lecture/Practical

Assessment Methods

1. Drawings form the temporary preparations as practical record books
2. Herbarium preparation and specimen collection
3. Highlighting the salient features of the genera/ groups through digital media such as power point presentations and animations

Unit	Particulars	Teaching and	Assessment Task

No.		**Learning Activity**	
I	Algae	Class room lectures, demonstrations and Practical	Hands on exercises, PPT, assignments, tests
II	Bryophyte	Class room lectures, demonstrations and Practical	Hands on exercises, PPT, assignments, tests
III	Pteridophyte	Class room lectures, demonstrations and Practical	Hands on exercises, PPT, assignments, tests
IV	Gynosperm	Class room lectures, demonstrations and Practical	Hands on exercises, PPT, assignments, tests

Skill Enhancement Course – Biofertilizers (Practical based course)

	L	T	P	Total
Credit	**2**	**0**	**2**	**4**
Paper Codes	**BOTS-105**		**BOTS-106(P)**	

Course Objective

To gain knowledge on eco-friendly fertilizers like Rhizobium, AzospiriliumAzotobactor, cyanobacteria and mycorrhizae, their identification, growth multiplication and practical application of Organic farming and recycling of the organic waste.

Learning outcomes

On completion of this course, the students will gain knowledge and will be able to:

1. Identification, growth, multiplication of eco-friendly fertilizers like *Rhizobium, Azospirilium, Azotobactor*, cyanobacteria, mycorrhizae, etc. their role in mineral cycling and nutrition to plants.
2. Organic farming and recycling of the organic waste
3. The student would have a deep understanding of ecofriendly fertilizers.
4. Methods of decomposition of biodegradable waste and convert into the compost

Paper Code: BOTS-105
Paper Title: Biofertilizers (Theory)
Credit: 2

Unit I **8 Lectures**
Introduction, types and importance of bio-fertilizers in agriculture, organic farming system and biocontrol of plant diseases; History of bio-fertilizers production; Micro-organisms used in bio-fertilizer production- *Rhizobium, Azobacter*, *Azospirillum*, Cyanobacteria, Mycorrhiza, Actinomycorrhiza.

Unit II **8 Lectures**
Classification of biological nitrogen fixation; factors influencing nitrogen fixation; Rhizobia, process of nodule formation, role of Nif and Nod gene in biological nitrogen fixation; *Azolla* and *Anabaena* association, cyanobacteria in rice cultivation. Actnmycorrhizal symbiosis

Unit III **7**
LecturesMycorrhizal association: type, colonization of mycorrhiza and contribution in nutrient uptake. taxonomy, occurrence and distribution, phosphorus nutrition, growth and yield–its influence on growth and yield of crop plants.

Unit IV **7 Lectures**
Strategies of Mass multiplication and packaging; Quality standard for bio-fertilizers; Different methods of application of bio-fertilizers, Methods of quality control assessment in respect of bio-fertilizers; Registration of bio-fertilizers.

Paper Code: BOTS-106(P)
Paper Title: Biofertilizers (Practical)
Credit: 2

1. Study of bacteria and cyanobacteria (used in biofertilizers) from temporary mounts /permanent slides.
2. Study of *Rhizobium* from root nodules of leguminous plants by Gram staining method
3. Morphological study and isolation of *Anabaena* from *Azolla*leaf
4. Observation of different mycorrhizae from temporary mounts/permanent slides of mycorrhizal roots
5. Familiarity of different commercial biofertilizer formulations
6. Methods for field application of biofertilizers
7. Quality control of bio-fertilizers: ISI standards specified and estimating the viable bacterial count in carrier based bio-fertilizers,
8. Preparation of proposal of bio-fertilizers production unit

Suggested readings

1. Anonymous 2016. Proceedings of Workshop on Biofertilizers.New Delhi. Delhi: Zakir Husain Delhi College
2. Kumaresan, V. 2005. Biotechnology.New Delhi, Delhi: Saras Publication.
3. Sathe, T.V. 2004. Vermiculture and Organic Farming.New Delhi, Delhi: Daya publishers.
4. SubhaRao, N.S. 2000. Soil Microbiology.New Delhi, Delhi: Oxford & IBH Publishers.
5. SubbaRao, N.S. 1993. Biofertilizers in Agriculture and Forestry. Oxford and IBH. Publ. Co., New Delhi.
6. Vayas,S.C, Vayas, S., Modi, H.A. 1998. Bio-fertilizers and organic Farming. Nadiad, Gujarat: AktaPrakashan

Teaching Learning Process

Classroom lecture should be integrated with practical based learning and experience of the teachers. Practicals are designed on hand on experience basis. Visit to Institutes and farm houses are recommended to make better understanding and field based experience. Students will be motivated to start their start up in this field. Teaching and learning will be through group discussions, test, assignments and power point presentations.

Teaching Learning Plan

- Week 1: Lecture/practical
- Week 2: Lecture/practical
- Week 3: Lecture/practical
- Week 4: Lecture/practical
- Week 5: Lecture/practical
- Week 6: Lecture/practical/Field-based studies
- Week 7: Lecture/practical

- Week 8: Lecture/practical
- Week 9: Lecture/practical
- Week 10: Mid semester Exam
- Week 11: Lecture/practical
- Week 12: Lecture/practical
- Week 13 : Lecture/practical
- Week 14 : Lecture/practical
- Week 15 : Lecture/practical

Assessment Methods

- Field based projects should be mandatory to have understanding of various types of biofertilizers in various environmental conditions.
- Field report should be prepared to highlight the visit.
- Power point presentations are recommended.
- Continuous evaluation of the student should be done.

Unit No.	Particulars	Teaching and Learning Activity	Assessment Task
I		Class room lectures, demonstrations and Practical	Hands on exercises, PPT, assignments, tests, viva-voce
II		Class room lectures, demonstrations and Practical	Hands on exercises, PPT, assignments, tests, viva-voce
III		Class room lectures, demonstrations and Practical	Hands on exercises, PPT, assignments, tests, viva-voce
IV		Class room lectures, demonstrations and Practical	Hands on exercises, PPT, assignments, tests, viva-voce

Skill Enhancement Course – Mushroom Cultivation (Practical based course)

	L	T	P	Total
Credit	**2**	**0**	**2**	**4**
Paper Codes	**BOTS-107**		**BOTS-108(P)**	

Course Objective

To make student aware about the mushroom growing techniques, appreciation of medicinal and nutritional values, economic importance of mushrooms and economical and marketing aspects of mushroom cultivation.

Learning outcomes

On completion of this course, the students will gain knowledge of or be able to:

1. Identify various types and categories of mushrooms.
2. Demonstrate various types of mushroom cultivating technologies.
3. Value the economic factors associated with mushroom cultivation
4. Device new methods and strategies to contribute to mushroom production.

Paper Code: BOTS-107
Paper Title: Mushroom Cultivation (Theory)
Credit: 2

Unit I: 7 lectures

Introduction, History. Nutritional and medicinal value of edible mushrooms; Poisonous mushrooms; Types of edible mushrooms available in India (with local emphasis)- *Volvariellavolvacea, Pleurotus*spp.,*Agaricusbisporus, Schizophyllum commune, Auricularia*spp., *Lentinulaedodes*, *Ganoderma* spp.

Unit II: 9 lectures

Cultivation Technology : Infrastructure: substrates (locally available), polythene bag, vessels, Inoculation hook, inoculation loop, low cost stove, sieves, culture rack, mushroom unit (Thatched house) water sprayer, tray, small polythene bag. Pure culture: Media preparation, preparations of spawn, multiplication. Mushroom bed preparation - paddy straw, sugarcane trash, maize straw, banana leaves. Factors affecting the mushroom bed preparation- Low cost technology; Composting technology in mushroom production.

Unit III: **7 lectures**

Cultivation methods for *Pleurotus*, *Volvareilla*, *Lentinula* and *Agaricus;*Methods of harvesting, processing, grading and packing; Short-term storage (Refrigeration – up to 24 hours); Long term storage (canning, pickels, papads), drying, storage in salt solutions; Use of spent mushroom in vermin-composting and in organic farming.

Unit IV: **7 lectures**

Disease control and pest management: types of diseases and pests of mushrooms and their control methods; Mushroom Research Centres- National level and Regional level. Marketing and cost economics of mushroom culture- Cost benefit ratio; Marketing in India and abroad; Export Value.

Paper Code: BOTS-108(P)
Paper Title: Mushroom Cultivation (Practical)
Credit: 2

1. Principle and functioning of instruments used in the various techniques.
2. Preparation of various types of media.
3. Preparation of spawn.
4. Study of edible and poisonous mushrooms
5. Study of diseases of mushroom.
6. Nutritional and market value of mushroom
7. Centres of mushroom.
8. Techniques for the cultivation of *Agaricus, Pleurotus* and *Ganoderma.*
9. Visit to Institutes and cultivation centres.

Suggested Readings

1. Bahl, N. 2015. Hand book of Mushrooms, IV Edition, Oxford & IBH Publishing Co Ltd., New Delhi
2. Kannaiyan, S. and Ramasamy, K. 1980. A Hand Book of Edible Mushroom. Today & Tomorrows printers & publishers, New Delhi
3. Marimuthu, T., Krishnamoorthy, A.S., Sivaprakasam, K. and Jayarajan. R. 1991. Oyster Mushrooms, Department of Plant Pathology, Tamil Nadu Agricultural University, Coimbatore.
4. Swaminathan, M. 1990. Food and Nutrition. Bappco, The Bangalore Printing and Publishing Co. Ltd., No. 88, Mysore Road, Bangalore - 560018.
5. Tewari, P. and Kapoor, S.C.,1988. Mushroom cultivation, Mittal Publications, Delhi.

Teaching Learning Process

Classroom lecture should be integrated with practical based learning and experience of the teachers. Practicals are designed on hand on experience basis. Visit to Institutes and farm houses are recommended to make better understanding and field based experience. Students will be motivated to start their start up in this field. Teaching and learning will be through group discussions, test, assignments and power point presentations.

Teaching Learning Plan

- Week 1: Lecture/practical
- Week 2: Lecture/practical
- Week 3: Lecture/practical
- Week 4: Lecture/practical

- Week 5: Lecture/practical
- Week 6: Lecture/practical/Field-based studies
- Week 7: Lecture/practical
- Week 8: Lecture/practical
- Week 9: Lecture/practical
- Week 10: Mid semester Exam
- Week 11: Lecture/practical
- Week 12: Lecture/practical
- Week 13 : Lecture/practical
- Week 14 : Lecture/practical
- Week 15 : Lecture/practical

Assessment Methods

- Field based projects should be mandatory to have understanding of various types of mushrooms related to environmental conditions.
- Field report should be prepared to highlight the visit.
- Power point presentations are recommended.
- Continuous evaluation of the student should be done.

Unit No.	Particulars	Teaching and Learning Activity	Assessment Task
I		Class room lectures, demonstrations and Practical	Hands on exercises, PPT, assignments, tests, viva-voce
II		Class room lectures, demonstrations and Practical	Hands on exercises, PPT, assignments, tests, viva-voce
III		Class room lectures, demonstrations and Practical	Hands on exercises, PPT, assignments, tests, viva-voce
IV		Class room lectures, demonstrations and Practical	Hands on exercises, PPT, assignments, tests, viva-voce

Skill Enhancement Course - Fermentation Technology

	L	T	P	Total
Credit	**2**	**0**	**2**	**4**
Paper Codes	**BOTS-109**		**BOTS-110(P)**	

Course Objective

To provide knowledge about the various aspects of the fermentation technology and application for fermentative production.

Learning outcomes

On completion of this course, the students will gain knowledge and able to:

1. Understand the design of various reactors used in Industries.
2. Comprehend the criteria for selection of media for microbial growth
3. Develop knowledge about methods for strain improvement and preservation of cultures.
4. Gain better perspective about upstream as well as downstream processing involved in fermentation industries

Paper Code: BOTS-109
Paper Title: Fermentation Technology (Theory)
Credit: 2

Unit I **8 Lectures**
History, Scope and Development of Fermentation technology; Isolation and screening of industrially important microorganisms − primary and secondary screening; Maintenance of Strains; Strain improvement: Mutant selection and Recombinant DNA technology

Unit II **6 Lectures**
Natural and Synthetic media; Basic components of a media (Carbon sources; Nitrogen sources; Vitamins; Minerals; Anti-foaming agents); Role of buffers in media; Process of aeration, and agitation.

Unit III **8 Lectures**
Basic designs of Fermentor; Type of fermentors: Waldhof, Tower, Deepjet, Cyclone column, Packed tower and airlift fermenter; Scale up study and Product development; Down-stream processing and Product recovery; Regulation and safety

Unit IV **6 Lectures**
Production of alcohol; Organic acid − Citric acid; Antibiotic − Penicillin, Amino acid − Glutamic acid; Vitamin − B1; Single Cell Protein (SCP).

Paper Code: BOTS-110(P)
Paper Title: Fermentation Technology (Practical)
Credit: 2

1. Isolation of antibiotic producing microorganisms from soil
2. Isolation of enzyme producing microorganisms from soil
3. Isolation of organic acid producing microorganisms from soil
4. Production of Alcohol
5. Production of Citric acid

Suggested readings

1. Bryce, E.M., Demain, T.C., Allman. A.R. 2006. Fermentation Microbiology and Biotechnology. Second Edition. CRC Press, USA.
2. Chen, H. 2013. Modern Solid State Fermentation: Theory and Practice. Springer Press, Germany
3. Lancini, G., Lorenzetti, R. 2014. Biotechnology of Antibiotics and other Bioactive Microbial Metabolites. Springer publications, Germany.
4. Peppler, H.J., Perlman, D. 2014. Microbial Technology: Fermentation Technology. Academic Press.
5. Smith, J.E. 2009. Biotechnology. Cambridge University Press.UK.
6. Stanbury, P.F., Whitaker, A., Hall, S.J., 2016. Principles of Fermentation Technology. Butterworth-Heinemann Press. UK.
7. Todaro, C.M., Henry C. Vogel, H.C., 2014. Fermentation and Biochemical Engineering Handbook. William Andrew Press. Norwich, NY.

Teaching Learning Process

Classroom lecture should be integrated with practical based learning and experience of the teachers. Practicals are designed on hand on experience basis. Visit to Institutes and industrial units are recommended to make better understanding and field based experience. Students will be motivated to start their start up in this field. Teaching and learning will be through group discussions, test, assignments and power point presentations.

Teaching Learning Plan

- Week 1: Lecture/practical
- Week 2: Lecture/practical
- Week 3: Lecture/practical
- Week 4: Lecture/practical
- Week 5: Lecture/practical
- Week 6: Lecture/practical/Field-based studies
- Week 7: Lecture/practical
- Week 8: Lecture/practical
- Week 9: Lecture/practical
- Week 10: Mid semester Exam
- Week 11: Lecture/practical
- Week 12: Lecture/practical

- Week 13 : Lecture/practical
- Week 14 : Lecture/practical
- Week 15 : Lecture/practical

Assessment Methods

- Field based projects should be mandatory to have understanding of technology and applications of the discipline concerned
- Field report should be prepared to highlight the visit.
- Power point presentations are recommended.
- Continuous evaluation of the student should be done.

Unit No.	Particulars	Teaching and Learning Activity	Assessment Task
I		Class room lectures, demonstrations and Practical	Hands on exercises, PPT, assignments, tests, viva-voce
II		Class room lectures, demonstrations and Practical	Hands on exercises, PPT, assignments, tests, viva-voce
III		Class room lectures, demonstrations and Practical	Hands on exercises, PPT, assignments, tests, viva-voce
IV		Class room lectures, demonstrations and Practical	Hands on exercises, PPT, assignments, tests, viva-voce

Semester II

Core Course – Plant Systematics

	L	T	P	Total
Credit	**4**	**0**	**2**	**6**
Paper Codes	**BOTC-201**		**BOTC-202(P)**	

Course Objective

To gain the knowledge on the taxonomy and phylogeny of plants

Learning Outcomes

Students understand plant classifications, phylogeny and identification with nomenclatural rules

1. Classify Plant systematics and recognize the importance of herbarium and Virtual herbarium
2. Evaluate the Important herbaria and botanical gardens
3. Interpret the rules of ICN in botanical nomenclature
4. Assess terms and concepts related to Phylogenetic Systematics
5. Generalize the characters of the families according to Bentham & Hooker's system of classification

Paper code: BOTC-201
Paper Title: Plant Systematics (Theory)
Credit: 4

Unit I: Plant systematics **15 lectures**

Introduction to systematics; Plant identification, Classification, Nomenclature.
Evidence from palynology, cytology, phytochemistry [Alkaloids, Phenolics, Glucosides, terpenes and Semantides (in brief)] and molecular data (cp.DNA, mt-DNA, nuclear DNA, PCR amplification, sequence data analysis). Field inventory; Importance of Herbarium; Important herbaria and botanical gardens of the world and India; Virtual herbarium; E-flora; Documentation: Flora, Monographs, Journals; Keys: intended (yolked) and bracketed keys. Phenetics vs. Cladistics.

Unit II: Botanical Nomenclature and System of Classification **15 lectures**

Principles and rules (ICN); Ranks and names; Typification, author citation, valid publication, rejection of names, principle of priority and its limitations; Names of hybrids.

System of classification: Natural system of classification (Bentham and hooker), Takhtajan classification of Angiosperms, Principles of Angiosperm Phylogeny Group (APG IV) classification.

Unit III: Biometrics, Numerical Taxonomy and Cladistics **15 lectures**

Characters; Variations; OTUs, character weighting and coding; Cluster analysis; Phenograms, cladograms (definitions and differences).

Unit IV: Taxonomic hierarchy and Phylogenetic Systematics 15 lectures

Taxonomic Hierarchy: Concept of taxa (family, genus, species); Categories and taxonomic hierarchy; Species concepts (biological, morphological, evolutionary).

Phylogenetic Systematics: Terms and concepts (primitive and advanced, homology and analogy, parallelism and convergence, monophyly, paraphyly, polyphyly, clades. synapomorphy, symplesiomorphy, apomorphy. Origin and evolution of angiosperms; Co-evolution of angiosperms and animals; Methods of illustrating evolutionary relationship (phylogenetic tree, cladogram).

Paper code: BOTC-202(P)
Paper Title: Plant Systematics (Practical)
Credit: 2

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

   Ranunculaceae- *Ranunculus, Delphinium*

   Brassicaceae- *Brassica, Alyssum/ Iberis*

   Fabaceace- *Calliandra/Prosopis/ Acacia, Cajanus/Sesbania, Cassia*

   Myrtaceae- *Eucalyptus, Callistemon*Umbelliferae-*Coriandrum/ Anethum*/ FoeniculumAsteraceae- *Sonchus/ Launaea, Veronia/ Ageratum, Elipta/ Tridax*

   Solanaceae- *Solanumnigrum,Withaniasomnifera*Lamiaceae-*Salvia/Ocimum*Euphorbiaceae-*Euphorbia hirta/ E.milli,Jatropha*Liliaceae-*Asphodelus/Lilium/ Allium*Poaceae- *Triticum/ Hordeum/ Avena/ Poa*

   Malvaceae-*Abutilon/ Hibiscus/ Sida*Caryophyllaceae-*Stellaria*/ *Dianthus/Spergulla*Rubiaceae- *Hamelia patens / Ixora / Oldenlandia*sp.

   Apocyanaceae- *Catharanthusroseus/Cascabalathevitea/Tabernemontana* sp. Asclepediaceae- *Calotropisprocera*

   Moraceae- *Morusalba*

   Chenopodiaceae- *Chenopodiumalba*

   Cannaceae- *Canna indica*

   Ten families should be selected out of the given list of nineteen families with available seasonal species of genus indicated in parenthesis.
2. Field visit (local)- Subject to grant funds from the University

3. Mounting of a properly dried and pressed specimen of any wild plant on herbarium sheet (to be submitted with the record book).

Suggested readings

1. Gupta R.2011 (Ed.) Plant Taxonomy: past, present, and future. New Delhi: The Energy and resources Institute (TERI).
2. Hall, B.G. 2011. Phylogenetic Trees Made Easy: A How-To Manual. Sinauer Associates, Inc. USA
3. Raven, F.H., Evert, R. F., Eichhorn, S.E. 1992. Biology of Plants. W.H. Freeman and Company. New York, NY.
4. Simpson, M.G. 2010. Plant Systematics. Elsevier Academic Press, San Diego, CA, U.S.A.
5. Singh, G. 2012. Plant Systematics: Theory and Practice, 3rd edition. Oxford and IBH Pvt. Ltd. New Delhi.
6. Stace, C.A 1989 Plant Taxonomy and Biosystematics 2nd edition. Cambridge University Press, NY USA.
7. Stuessy, Tod F. 2009 Plant Taxonomy: The systematic evaluation of comparative data - 2nd edition. Columbia University Press
8. Walter S. Judd, et.al. 2015 Plant Systematics : A Phylogenetic Approach 4th Edition Sinauer Associates , Oxford University Press. USA.
9. http://www.mobot.org/MOBOT/research/APweb/
10. Any local/state/regional flora published by BSI or any other agency

Teaching Learning Process

1. Class lectures
2. Seminars
3. Group discussions and Workshops
4. Peer teaching and learning
5. Question preparation
6. Subjective type
   - Long answer
   - Short answer
7. Objective type
8. Multiple choice questions
   - One answer/two answer type questions
   - Assertion and reasoning
9. Practical
10. Field-based learning
11. Substantial laboratory-based practical component and experiments
12. Games
13. Technology-enabled learning
14. Internship in industry, and research establishments

Teaching Learning Plan:

Week 1 : Lecture

- Week 2: Lecture
- Week 3: Lecture
- Week 4: Lecture
- Week 5: Lecture/Practical
- Week 6: Lecture/Practical
- Week 7: Lecture/Practical
- Week 8: Lecture/Practical
- Week 9: Lecture/Practical
- Week 10: Mid semester Exam
- Week 11: Lecture/Practical
- Week 12: Lecture/Practical/Field-based learning
- Week 13: Lecture/Practical
- Week 14: Lecture/Practical
- Week 15: Lecture/Practical

Assessment Methods

1. Drawings form the temporary preparations as practical record books
2. Herbarium preparation and specimen collection
3. Highlighting the salient features of the genera/ groups through digital media such as power point presentations and animations

Unit No.	**Particulars**	**Teaching and Learning Activity**	**Assessment Task**
I	Plant systematics	Class room lectures, demonstrations and Practical	Hands on exercises, PPT, assignments, tests
II	Botanical Nomenclature and System of Classification	Class room lectures, demonstrations and Practical	Hands on exercises, PPT, assignments, tests
III	Biometrics, Numerical Taxonomy and Cladistics	Class room lectures, demonstrations and Practical	Hands on exercises, PPT, assignments, tests
IV	Taxonomic hierarchy and Phylogenetic Systematics	Class room lectures, demonstrations and Practical	Hands on exercises, PPT, assignments, tests

Core Course – Biomolecules and Cell Biology

	L	T	P	Total
Credit	**4**	**0**	**2**	**6**
Paper Codes	**BOTC-203**		**BOTC-204(P)**	

Course Objective

To help the students to gain knowledge on the activities in which the giant molecules and miniscule structures that inhabit the cellular world of life are engaged. This will provide inside into the organization of cell, its features and regulation at different levels. Through the study of biomolecules and cell organelles, they will be able to understand the various metabolic processes such as respiration, photosynthesis etc. which are important for life.

Learning outcomes:

On completion of this course, the students will be able to:

1. Develop understanding on chemical bonding among molecules
2. Identify the concept that explains chemical composition and structure of cell wall and membrane
3. Classify the enzymes and explain mechanism of action and structure
4. Compare the structure and function of cells & explain the development of cells
5. Describe the relationship between the structure and function of biomolecules

Key Words: Nucleic Acids, Amino Acids, Proteins, Lipids, Fatty Acids, Signal Transduction

Paper Code: BOTC – 203
Paper Title: Biomolecules and Cell Biology (Theory)
Credit – 4

Unit I: Bioenergetics and Enzymes **15 lectures**

Laws of thermodynamics, concept of free energy, endergonic and exergonic reactions, coupled reactions, redox reactions. ATP: structure, its role as an energy currency molecule. Structure of enzyme: holoenzyme, apoenzyme, cofactors, coenzymes and prosthetic group; Classification of enzymes; Features of active site, substrate specificity, mechanism of action (activation energy, lock and key hypothesis, induced - fit theroy), Michaelis – Menten equation, Lineweaver–Burk equation, and factors affecting enzyme activity (in brief).

Unit II: Biomolecules **15 lectures**

Types and significance of chemical bonds; Structure and properties of water; pH and buffers.Carbohydrates: Nomenclature and classification; Role of monosaccharides (glucose, fructose, sugar alcohols – mannitol and sorbitol); Disaccharides (sucrose, maltose, lactose), Oligosaccharides and polysaccharides (structural-cellulose, hemicelluloses, pectin, chitin, mucilage; storage – starch, inulin). Lipids: Definition and major classes of storage and structural lipids; Fatty acids structure and functions; Structural lipid: Triacylglycerols structure, functions and properties Phosphoglycerides.Proteins: Structure of amino acids;

Levels of protein structure-primary, secondary, tertiary and quaternary; Protein denaturation and biological roles of proteins. Nucleic acids: Structure of nitrogenous bases; Structure and function of nucleotides; Types of nucleic acids; Structure of A, B, Z types of DNA; Types of RNA; Structure of tRNA.

Unit III: Cell Biology - I **15 lectures**

Cell as a unit of structure and function; Characteristics of prokaryotic and eukaryotic cells; Plant and animal cells; Origin of eukaryotic cell (Endosymbiotic theory). Chemistry, structure and function of Plant cell wall. Overview of membrane function; fluid mosaic model; Chemical composition of membranes; Membrane transport – Passive, active and facilitated transport, endocytosis and exocytosis. Nucleus: Structure-nuclear envelope, nuclear pore complex, nuclear lamina, molecular organization of chromatin; nucleolus. Phases of eukaryotic cell cycle, mitosis and meiosis; Regulation of cell cycle - checkpoints and regulation; role of protein kinases.

Unit IV: Cell Biology – II **15 lecturers**

Cytoskeleton: Role and structure of microtubules, microfilaments and intermediary filament; Intracellular trafficking. Chloroplast, mitochondria and peroxisomes: Structural organization; Function; Semiautonomous nature of mitochondria and chloroplast. Lysosomes and Vacuoles. Endomembrane system: Endoplasmic Reticulum – Types and Structure. Golgi Apparatus – organization, protein glycosylation, protein sorting and export from Golgi ApparatusSignal Transduction: Receptors and primary and secondary signal transduction

Paper Code: BOTC – 204(P)
Paper Title: Biomolecules and Cell Biology (Practical)
Credit – 2

1. Qualitative tests for carbohydrates, reducing sugars, non-reducing sugars, lipids and proteins.
2. Study of plant cell structure with the help of epidermal peel mount of Onion/ Rheo/ Crinum
3. Demonstration of the phenomenon of protoplasmic streaming in Hydrilla leaf.
4. Separate chloroplast pigments by paper chromatography.
5. Study of cell and its organelles with the help of electron micrographs.
6. Study the phenomenon of plasmolysis and deplasmolysis.
7. Demonstrate the activity of any two enzymes (Urease, Amylase, and Catalase).
8. Study the effect of organic solvent and temperature on membrane permeability.
9. Study different stages of mitosis and meiosis.
10. Separation of protein by Electrophoresis. (Only demonstration to class by the instructor).

Suggested readings

1. Alberts, B., Johnson, A.D., Lewis, J., Morgan, D., Raff, M., Roberts, K., Walter, P. 2014. Molecular Biology of Cell. 6th Edition. WW. Norton & Co.
2. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2009. The World of the Cell. 7th edition. Pearson Benjamin Cummings Publishing, San Francisco.
3. Berg, J.M., Tymoczko, J.L. and Stryer, L. 2011. Biochemistry, W.H.Freeman and Company
4. Campbell, M.K. 2012. Biochemistry, 7th ed., Published by Cengage Learning.
5. Campbell, P.N. and Smith, A.D. 2011. Biochemistry Illustrated, 4th ed., Published by Churchill Livingstone
6. Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
7. Cooper., G.M. 2015. The cell: A Molecular Approach. 7th Edition. Sinauer Associates.
8. Hardin, J., Becker, G., Skliensmith, L.J. 2012. Becker's World of the Cell. 8th edition.Pearson Education Inc. U.S.A
9. Iwasa,J, Marshall , W. 2016. Karps's Cell and Molecular Biology; Concepts and experiments.
10. Karp, G. 2010. Cell Biology, John Wiley & Sons, U.S.A. 6th edition.
11. Nelson, D.L. and Cox, M.M. 2008. Lehninger Principles of Biochemistry, 5th Edition. W.H. Freeman and Company.
12. Reven, F.H., Evert, R.F., Eichhorn, S.E. 1992. Biology of Plants. New York, NY: W.H.Freeman and Company.
13. Tymoczko, J.L., Berg, J.M. and Stryer, L. 2012. Biochemistry: A short course, 2nd ed., W.H.Freeman.

Teaching Learning Process

1. Class lectures
2. Seminars
3. Group discussions and Workshops
4. Peer teaching and learning
5. Question preparation
6. Subjective type
   - Long answer
   - Short answer
7. Objective type
   - Multiple choice questions
   - One answer/two answer type questions
   - Assertion and reasoning
8. Practical
9. Field-based learning
10. Substantial laboratory-based practical component and experiments
11. Games
12. Technology-enabled learning

13. Internship in industry, and research establishments

Teaching Learning Plan:

- Week 1 : Lecture
- Week 2: Lecture
- Week 3: Lecture
- Week 4: Lecture
- Week 5: Lecture/Practical
- Week 6: Lecture/Practical
- Week 7: Lecture/Practical
- Week 8: Lecture/Practical
- Week 9: Lecture/Practical
- Week 10: Mid semester Exam
- Week 11: Lecture/Practical
- Week 12: Lecture/Practical/Field-based learning
- Week 13: Lecture/Practical
- Week 14: Lecture/Practical
- Week 15: Lecture/Practical

Assessment Methods

1. Drawings and illustrations may be made a compulsory part of practical record books
2. Testing the salient features of the biomolecules and cellular components through digital media such as ppt and animations.

Unit No.	Particulars	Teaching and Learning Activity	Assessment Task
I	Bioenergetics and Enzymes	Class room lectures, demonstrations and Practical	Hands on exercises, PPT, assignments, tests
II	Biomolecules	Class room lectures, demonstrations and Practical	Hands on exercises, PPT, assignments, tests
III	Cell Biology - I	Class room lectures, demonstrations and Practical	Hands on exercises, PPT, assignments, tests
IV	Cell Biology - II	Class room lectures, demonstrations and Practical	Hands on exercises, PPT, assignments, tests

Skill Enhancement Course – Botanical Garden and Landscaping

	L	T	P	Total
Credit	**2**	**0**	**2**	**4**
Paper Codes	**BOTS-205**		**BOTS-206(P)**	

Course Objective

To gain knowledge of botanical garden, aesthetic planning and outdoor and indoor landscaping

Learning Outcomes

After the completion of this course the learner will be able to:

1. Apply the basic principles and components of gardening
2. Conceptualize flower arrangement and bio-aesthetic planning
3. Design various types of gardens according to the culture and art of bonsai
4. Distinguish between formal, informal and free style gardens
5. Establish and maintain special types of gardens for outdoor and indoor landscaping

Paper code: BOTS-205
Paper Title: Botanical Garden and Landscaping (Theory)
Credit: 2

Course Content

Unit I **8 lectures**

Principles of gardening, garden components, adornments, lawn making, methods of designing rockery, water garden, etc. Special types of gardens, their walk-paths, bridges, constructed features. Greenhouse. Special types of gardens, trees, their design, values in landscaping, propagation, planting shrubs and herbaceous perennials. Importance, design values, propagation, plating, climbers and creepers, palms, ferns, grasses and cacti succulents.

Unit II **7 lectures**

Flower arrangement: importance, production details and cultural operations, constraints, postharvest practices. Bioaesthetic planning, definition, need, round country planning, urban planning and planting avenues, schools, villages, beautifying railway stations, dam sites, hydroelectric stations, colonies, river banks, planting material for play grounds.

Unit III **8 lectures**

Vertical gardens, roof gardens.Culture of bonsai, art of making bonsai. Parks and public gardens. Landscape designs, Styles of garden, formal, informal and free style gardens, types of gardens, Urban landscaping, Landscaping for specific situations, institutions, industries, residents, hospitals, roadsides, traffic islands, damsites, IT parks, corporate.

Unit IV **7 lectures**

Establishment and maintenance, special types of gardens, Bio-aesthetic planning, ecotourism, theme parks, indoor gardening, therapeutic gardening, non-plant components, water scaping, xeriscaping, hardscaping; Computer Aided Designing (CAD) for outdoor and

indoorscaping Exposure to CAD (Computer Aided Designing)

Paper code: BOTS-206(P)
Paper Title: Botanical Garden and Landscaping (Practical)
Credit: 2

1. Field trips: Field visit to regional/national Botanical Garden.
2. Identification of trees, shrubs and other herbaceous vegetation,
3. Prepare beds for growing nursery for herbs, shrubs and trees.
4. Count the number of types of animals, birds, and insects in the garden
5. Identification of pathogenic and non-pathogenic diseases of garden plants and grasses
6. More Practical may be added depending on the local habitats and available facilities
7. Try to grow herbs hydroponically

References

1. Berry, F. and Kress, J. (1991). Heliconia: An Identification Guide . Smithsonian Books.
2. Butts, E. and Stensson, K. (2012).Sheridan Nurseries: One hundred years of People,Plans, and Plants. Dundurn Group Ltd
3. Russell, T. (2012). Nature Guide: Trees: The world in your hands (Nature Guides).

Teaching Learning Process

1. Class lectures
2. Seminars
3. Group discussions and Workshops
4. Peer teaching and learning
5. Question preparation
6. Subjective type
   - Long answer
   - Short answer
7. Objective type
   - Multiple choice questions
   - One answer/two answer type questions
   - Assertion and reasoning
8. Practical
9. Substantial laboratory-based practical component and experiments
10. Games
11. Technology-enabled learning
12. Internship in industry, and research establishments

Teaching Learning Plan:

- Week 1 : Lecture
- Week 2: Lecture
- Week 3: Lecture
- Week 4: Lecture

- Week 5: Lecture/Practical
- Week 6: Lecture/Practical
- Week 7: Lecture/Practical
- Week 8: Lecture/Practical
- Week 9: Lecture/Practical
- Week 10: Mid semester Exam
- Week 11: Lecture/Practical
- Week 12: Lecture/Practical/Field-based learning
- Week 13: Lecture/Practical
- Week 14: Lecture/Practical
- Week 15: Lecture/Practical

Assessment Methods

1. Drawings form the temporary preparations as practical record books
2. Highlighting the properties of the organisms in digital media such as power point presentations and animations

Unit No.	Particulars	Teaching and Learning Activity	Assessment Task
I		Class room lectures, demonstrations and Practical	Hands on exercises, PPT, assignments, tests
II		Class room lectures, demonstrations and Practical	Hands on exercises, PPT, assignments, tests
III		Class room lectures, demonstrations and Practical	Hands on exercises, PPT, assignments, tests
IV		Class room lectures, demonstrations and Practical	Hands on exercises, PPT, assignments, tests

Skill Enhancement Course - Nursery and Gardening

	L	T	P	Total
Credit	**2**	**0**	**2**	**4**
Paper Codes	**BOTS-207**		**BOTS-208(P)**	

Course Objective

To gain knowledge of gardening, cultivation, multiplication, raising of seedlings of ornamental plants

Learning outcomes:

On completion of this course the students will be able to;

1. Understand the process of sowing seeds in nursery
2. List the various resources required for the development of nursery
3. Distinguish among the different forms of sowing and growing plants
4. Analyse the process of Vegetative propagation
5. Appreciate the diversity of plants and selection of gardening
6. Examine the cultivation of different vegetables and growth of plants in nursery and Gardening

Paper code: BOTS-207
Paper Title: Nursery and Gardening (Theory)
Credit: 2

Course Content

Unit I **7 lectures**

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

Unit II **7 lectures**

Seed: 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.

Unit III **7 lectures**

Vegetative propagation: 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 glasshouse.

Unit IV **7 lectures**

Gardening: 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. Transplanting of seedlings - Study of cultivation of different vegetables: cabbage, brinjal, lady's finger, onion, garlic, tomatoes, and carrots - Storage and marketing procedures.

Paper code: BOTS-208(P)
Paper Title: Nursery and Gardening (Practical)
Credit: 2

1. To study the process of sowing seeds in nursery
2. To list the various resources required for the development of nursery
3. To study the different forms of sowing and growing plants
4. To study the process of Vegetative propagation
5. Listing of garden plants
6. To study computer applications in landscaping
7. To examine the cultivation of different vegetables and growth of plants in nursery
8. To study cold storage models for vegetables
9. To visit nearby local Nursery and record the plant list

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., Bengaluru.
3. Kumar, N. (1997) Introduction to Horticulture, Rajalakshmi Publications, Nagercoil. Edmond Musser & Andres, Fundamentals of Horticulture, McGraw Hill Book Co., New Delhi.
4. Agrawal, P.K. (1993). Hand Book of Seed Technology, Dept. of Agriculture and Cooperation, National Seed Corporation Ltd., New Delhi.
5. Janick Jules (1979). Horticultural Science. (3rd Ed.), W.H. Freeman and Co., SanFrancisco, USA.

Teaching Learning Process

1. Class lectures
2. Seminars
3. Group discussions and Workshops
4. Peer teaching and learning
5. Question preparation
6. Subjective type
   - Long answer
   - Short answer
7. Objective type
   1. Multiple choice questions
   2. One answer/two answer type questions

3. Assertion and reasoning

8. Practical
9. Substantial laboratory-based practical component and experiments
10. Games
11. Technology-enabled learning
12. Internship in industry, and research establishments

Teaching Learning Plan:

- Week 1 : Lecture
- Week 2: Lecture
- Week 3: Lecture
- Week 4: Lecture
- Week 5: Lecture/Practical
- Week 6: Lecture/Practical
- Week 7: Lecture/Practical
- Week 8: Lecture/Practical
- Week 9: Lecture/Practical
- Week 10: Mid semester Exam
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- Week 12: Lecture/Practical/Field-based learning
- Week 13: Lecture/Practical
- Week 14: Lecture/Practical
- Week 15: Lecture/Practical

Assessment Methods

1. Drawings form the temporary preparations as practical record books
2. Highlighting the properties of the organisms in digital media such as power point presentations and animations

Unit No.	Particulars	Teaching and Learning Activity	Assessment Task
I		Class room lectures, demonstrations and Practical	Hands on exercises, PPT, assignments, tests
II		Class room lectures, demonstrations and Practical	Hands on exercises, PPT, assignments, tests
III		Class room lectures, demonstrations and Practical	Hands on exercises, PPT, assignments, tests
IV		Class room lectures, demonstrations and Practical	Hands on exercises, PPT, assignments, tests

Skill Enhancement Course – Floriculture

	L	T	P	Total
Credit	**2**	**0**	**2**	**4**
Paper Codes	**BOTS-209**		**BOTS-210(P)**	

Course Objective

To have knowledge of gardening and cultivation of ornamental plants and knowledge of landscaping, soil condition.

Learning outcomes:

After completing this course the learner will be able to;

1. Develop conceptual understanding of gardening from historical perspective
2. Analyze various nursery management practices with routine garden operations.
3. Distinguish among the various Ornamental Plants and their cultivation
4. Evaluate garden designs of different countries
5. Appraise the landscaping of public and commercial places for floriculture.
6. Diagnoses the various diseases and uses of pests for ornamental plants.

Paper code: BOTS-209
Paper Title: Floriculture (Theory)
Credit: 2

Course Content

Unit-I **8 lectures**

Introduction: History of gardening; Importance and scope of floriculture and landscape gardening.

Nursery Management and Routine Garden Operations: Sexual and vegetative methods of propagation; Soil sterilization; Seed sowing; Pricking; Planting and transplanting; Shading; Stopping or pinching; Defoliation; Wintering; Mulching; Topiary; Role of plant growth regulators.

Unit-II **6 lectures**

Ornamental Plants: Flowering annuals; Herbaceous perennials; Divine vines; Shade and ornamental trees; Ornamental bulbous and foliage plants; Cacti and succulents; Palms and Cycads; Ferns and Selaginellas; Cultivation of plants in pots; Indoor gardening; Bonsai.

Unit-III **8 lectures**

Principles of Garden Designs: English, Italian, French, Persian, Mughal and Japanese gardens; Features of a garden (Garden wall, Fencing, Steps, Hedge, Edging, Lawn, Flower beds, Shrubbery, Borders, Water garden). Some Famous gardens of India.

Landscaping Places of Public Importance: Landscaping highways and Educational institutions.

Unit-VI **8 lectures**

Commercial Floriculture: Factors affecting flower production; Production and packaging of cut flowers; Flower arrangements; Methods to prolong vase life; Cultivation of Important cut flowers (*Carnation, Aster, Chrysanthemum, Dahlia, Gerbera, Gladiolous*, Marigold, Rose, *Lilium*, Orchids). Diseases and pests of ornamental plants.

Paper code: BOTS-210(P)
Paper Title: Floriculture (Practical)
Credit: 2

1. Identification of commercially important floricultural crops.
2. Preparation of flower bed.
3. Seed sowing and transplantation methods.
4. Propagation by cutting, layering, budding and grafting.
5. Patterns of flower arrangement in vase.
6. Use of chemicals and other compounds for prolonging the vase life of cut flowers.
7. Drying and preservation of flowers.
8. Study of disease and pastes of ornamental plants.
9. Garden designing and hedge preparation methods.
10. Field visit to flower gardens.

Suggested readings

1. Randhawa, G.S., Mukhopadhyay, A. (1986). Floriculture in India. New York, NY: Allied Publishers.
2. Adams, C., M. Early and J. Brrok (2011).Principles of Horticulture.Routledge, U.K.
3. A.K.Singh.2006. Flower crops, cultivation andmanagement. New India publishing agency, Pitampura, New Delhi.
4. T.K. Bose, L.P. Yadav, P. Patil, P. Das and V.A. ParthaSarthy. 2003. Commercial Flowers. ParthaSankarBasu, Nayaudyog, 206, BidhanSarani, Kolkata.
5. S.K. Bhattacharjee and L.C. De. 2003. Advanced Commercial Floriculture. AavishkarPublishers,Distributors, Jaipur.
6. DewasishChoudhary and Amal Mehta. 2010. Flower crops cultivation and management. Oxford book company Jaipur, India. Randhawa,
7. G.S. AmitabhaMukhopadhyay, 2004. Floriculture in India.Allied Publishers Pvt. Ltd.
8. Arora, J.S. 2006. Introductory Ornamental Horticulture.Kalyani Publishers, Ludhiana.
9. Bhattacharjee, S.K. Advanced Commercial Floriculture. Aavishkar Publishers Distributors, Jaipur.
10. Sheela, V.L. 2008. Flower for trade. New India Publishing Agency, Pitampura, New Delhi-110088.
11. Abhinov Kumar. 2000. Production Technology of Ornamental Crops, Medicinal Plants and Landscaping. Kalyani Publishers, New Delhi.

Teaching Learning Process

1. Class lectures
2. Seminars
3. Group discussions and Workshops
4. Peer teaching and learning
5. Question preparation
6. Subjective type

- Long answer
- Short answer

7. Objective type
    - Multiple choice questions
    - One answer/two answer type questions
    - Assertion and reasoning
8. Practical
9. Substantial laboratory-based practical component and experiments
10. Games
11. Technology-enabled learning
12. Internship in industry, and research establishments

Teaching Learning Plan:

- Week 1 : Lecture
- Week 2: Lecture
- Week 3: Lecture
- Week 4: Lecture
- Week 5: Lecture/Practical
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- Week 10: Mid semester Exam
- Week 11: Lecture/Practical
- Week 12: Lecture/Practical/Field-based learning
- Week 13: Lecture/Practical
- Week 14: Lecture/Practical
- Week 15: Lecture/Practical

Assessment Methods

1. Drawings form the temporary preparations as practical record books
2. Highlighting the properties of the organisms in digital media such as power point presentations and animations

Unit No.	Particulars	Teaching and Learning Activity	Assessment Task
I		Class room lectures, demonstrations and Practical	Hands on exercises, PPT, assignments, tests
II		Class room lectures, demonstrations and Practical	Hands on exercises, PPT, assignments, tests
III		Class room lectures, demonstrations and Practical	Hands on exercises, PPT, assignments, tests
IV		Class room lectures,	Hands on

		demonstrations and Practical	exercises, PPT, assignments, tests