



Savitribai Phule Pune University, Pune

(Formerly, University of Pune)

Under Graduate Degree Program in Botany (B.Sc. Botany)

(Faculty of Science & Technology)

Revised Syllabi as per National Education Policy (2020) for

T.Y.B.Sc. Botany (Semester V and VI)

(For Colleges Affiliated to Savitribai Phule Pune University, Pune)

To be implemented from

Academic Year 2026-2027

Framed by

BOARD OF STUDIES IN BOTANY

Savitribai Phule Pune University,

Ganeshkhind, Pune -07.


(Dr. Mahesh N. Khando)
Chairman - BoS Botany

AIMS AND OBJECTIVES

- To promote the possibility of self-employment in plant science and allied sectors.
- To bridge the gap between knowledge-based conventional education and market demands and to provide an alternative to those pursuing higher education.
- To enrich students' training and knowledge useful in botanical, agricultural, environmental, horticultural, and plant-based industries.
- To introduce the concepts of experimental design, scientific investigation, and research methodologies in Botany.
- To inculcate a sense of job responsibility while maintaining social and environmental awareness.
- To help students build a progressive and successful career in plant sciences, biotechnology, environmental management, and allied industries.

PROGRAM OUTCOMES (POS)

According to NEP-2020 criteria, the undergraduate degree in Botany program at Savitribai Phule Pune University affiliated colleges is structured to provide students with advanced field-related knowledge and essential fundamentals. Through a unique combination of required major core courses with in-depth exposure to multidisciplinary minor, elective, and vocational skill courses, students will acquire the fundamental and advanced knowledge essential for research, industries, environmental sustainability, and entrepreneurship.

With the knowledge gained in the field of Botany, this upgraded curriculum will develop educated, outcome-oriented students who are nurtured through discovery and learning, equipped with practical skills to solve real-life problems, and competent with recent pedagogical trends in education including E-learning, flipped classrooms, hybrid learning, and experiential learning. These candidates will become responsible citizens capable of contributing toward sustainable development and global scientific advancement.

After successful completion of the Under Graduate (UG) Degree program, the students would be able to:

- **P01:** Attain thoughtful proficiency in the field of plant sciences and Botany.
- **P02:** Acquire the ability to perform effectively in multidisciplinary domains.
- **P03:** Attain the ability to apply scientific knowledge for investigation, innovation, biodiversity conservation, and sustainable development.
- **P04:** Learn value-based ethical practices and principles committed to professional ethics.
- **P05:** Incorporate 21st century skill-oriented self-directed and life-long learning.

- **P06:** Obtain the ability to apply botanical knowledge in diverse contexts with a global perspective.
- **P07:** Attain maturity to respond responsibly toward environmental and societal challenges.

PROGRAM SPECIFIC OUTCOMES (PSOs)

- **PSO1:** Recall the diversity, classification, evolution, morphology, anatomy, physiology, genetics, ecology, and developmental changes among lower and higher plant groups.
- **PSO2:** Understand advanced concepts in Botany and their applications in agriculture, biotechnology, environmental science, and conservation biology.
- **PSO3:** Acquire and utilize skills in plant propagation, tissue culture, organic farming, medicinal plant utilization, floriculture, horticulture, biodiversity conservation, and plant processing technologies.
- **PSO4:** Understand the importance of plants and plant resources in agriculture, environment, healthcare, and sustainable development.
- **PSO5:** Adapt scientific research methods for plant improvement, biodiversity studies, environmental monitoring, and entrepreneurship development.
- **PSO6:** Enrich critical thinking, scientific attitude, problem-solving ability, practical competence, and communication skills.
- **PSO7:** Apply botanical knowledge and plant resources for sustainable development, environmental conservation, and societal welfare while recognizing ethical values.
- **PSO8:** Demonstrate scientific understanding to identify research problems, design experiments, use appropriate methodologies, analyze and interpret data, and provide practical solutions while exhibiting organizational and management skills.

1. Title of the Course: B.Sc. Botany (03 years) / B.Sc. with Honours in Botany (04 years)

Syllabus revised for T.Y.B.Sc. Botany as per National Education Policy (NEP) 2020 for the Colleges Affiliated to Savitribai Phule Pune University, Pune.

2. Faculty - Science and Technology

3. To be implemented - For T.Y.B.Sc. Botany (Semester V and Semester VI), from June 2026.

4. Preamble

Botany is a fundamental branch of biological science dealing with the scientific study of plants and their relationship with the environment and human welfare. The subject includes various disciplines such as taxonomy, plant physiology, genetics, ecology,

microbiology, biotechnology, plant pathology, economic botany, horticulture, and environmental biology.

India is one of the richest countries in plant diversity and agriculture-based economy. Plants play an essential role in food security, medicine, environmental protection, industry, and sustainable development. Therefore, botanical education is important for understanding plant resources, conservation, crop improvement, environmental management, and emerging biotechnological applications.

The Botany program aims to provide students with theoretical knowledge and practical skills in plant sciences and allied areas. The curriculum emphasizes laboratory work, field studies, industrial exposure, research orientation, and entrepreneurship development. Students will gain hands-on experience in plant identification, herbarium techniques, tissue culture, nursery management, biodiversity assessment, medicinal plants, organic farming, environmental conservation, and other applied areas of Botany.

The course prepares students for employment opportunities in:

- Botanical Survey and Research Institutions
- Agricultural and Horticultural Industries
- Seed and Nursery Industries
- Plant Tissue Culture Laboratories
- Environmental Consultancy Services
- Forest and Biodiversity Departments
- Pharmaceutical and Herbal Industries
- Biotechnology Industries
- Educational Institutions
- NGOs related to environment and conservation
- Government and Semi-government organizations

The course focuses on skill development, scientific attitude, and practical exposure through laboratory experiments, field projects (FP), industrial visits, on job trainings (OJT) and community engagement programs (CEP). Greater emphasis is laid on practical learning and vocational applications to enhance employability and entrepreneurship opportunities among students.

The teaching centers will help develop trained and skilled man-power for industries, research organizations, and environmental sectors. Students can also become entrepreneurs in plant-based enterprises such as nurseries, medicinal plant cultivation, floriculture, landscaping, mushroom cultivation, organic farming, apiculture, and sericulture.

Program Duration and Exit Options

The UG Program lasts for **Three** years, Six Semesters / **Four** years, Eight semesters.

Student may leave the program after the third year if, he/she would like to receive a three-year undergraduate degree.

If the student decides to withdraw after the first or second year, he/she will receive a UG Certificate or UG Diploma, depending on how many credits he/she is able to complete. Re-entering within three years to finish the degree program is allowed for students who leave with a UG certificate or UG diploma. A student must earn a minimum of 18 credits and a maximum of 26 credits each semester. It is recommended, nevertheless, that student should opt 22 credits per semester. This clause aims to give student the comfort of a flexible semester-based course load. However, Table 1 lists the minimum number of credits required to be earned in order to be awarded an Undergraduate Certificate / Undergraduate Diploma / Bachelor Degree / Bachelor's Degree with Honors in Botany.

Table1: Type of Awards and Stages of Exit

Sr. No.	Type of Award	Stage of Exit	Mandatory Credits
1.	Undergraduate Certificate in Botany	After successful completion of First year Semesters	44
2.	Undergraduate Diploma in Botany	After successful completion of Second year Semesters	88
3.	Bachelor of Science in Botany	After successful completion of Third year Semesters	132
4.	Bachelor of Science in Botany (Honours)	After successful completion of Fourth year Semesters	176

5. Eligibility Criteria -

The students who had opted Botany as one of the core subjects at F.Y.B.Sc. level as well as Botany as 'MAJOR SUBJECT' and have qualified with minimum number of credits and ATKT rules as laid down by SPPU, Pune are eligible for applying at T.Y.B.Sc. Botany MAJOR subject. Admissions will be given as per the selection procedure / policies adopted by the college keeping in accordance with the conditions laid down by the Savitribai Phule Pune University, Pune. Reservation and relaxation are as per the State Government rules.

6. Fee Structure – As per the norms of Savitribai Phule Pune University, Pune.

7. Duration of the Course

Certificate Course	- 01 year (Completion of 02 Semesters)
Diploma Course	- 02 years (Completion of 04 Semesters)
B.Sc. Degree	- 03 years (Completion of 06 Semesters)
B.Sc. Degree with Honors	- 04 years (Completion of 08 Semesters)

8. No. of semesters – Two semesters per year

9. Medium of instructions and teaching: English

10. Course Implementation Criteria for Theory and Practical:

a. Each semester comprises of 15 weeks (12 weeks Actual Teaching + 3 weeks for Continuous Internal Evaluation).

b. One Credit of the Theory = 15 clock hours (Teaching 1 clock hour per week for each credit), (15 clock hours should comprised of 12 hours of Actual Teaching + 3 hours of Continuous Internal Evaluation – Assignments, Tutorials, Practice, Problem solving sessions, Group discussion, Study/Field visits, report preparation, viva-voce, PowerPoint presentations, Participation in Individual/Group Activity. Seminars and Unit Tests).

c. One Credit of Practical = 30 clock hours (2 clock hours per credit per week)

One Credit = 30 clock hours (24 hours' Actual Table work + 6 hours for in-time Journal completion, visit attendance, visit report preparation and Continuous Internal Evaluation of each practical).

d. Practical for each course comprises of 02 Credits = 60 clock hours. Therefore,

- Minimum 12 laboratory sessions of 04 clock hours must be conducted in one semester.
- In case of short practical, two practical's should be conducted in one session.
- Each practical of 04 clock hours in the laboratory should consist of: Table performance for concerned practical, proactive participation in each practical, regular attendance, careful observations, calculation, writing results and conclusion, and submission of on time practical journal in hand-written format.
- Pre-laboratory reading and post laboratory assignments should be given on each practical as a part of continuous internal evaluation.

e. Practical Batch for the Practical based courses = The practical batch for the practical based courses should comprise of **maximum 12 students**.

f. Field Project (FP): 02 credits (60 hours including field study / survey, actual laboratory work, regular observation recordings, field project report writing, compilation, presentations, Assignments etc.)

- **Number of students per Batch for the Field Project – 05 students per batch**
- **Student:Mentor ratio = 5:1**

g. Community Engagement Program (CEP): 02 Credits (60 hours including Community Engagement activities, proactive participation at Individual / Group level in the activity, labwork, Report writing, compilation, presentations, assignments etc.)

- **Number of students per Batch for the CEP – 05 students per batch**

- **Student:Mentor ratio = 5:1**

h. On Job Training (OJT): 04 Credits (120 hours including duration from enrollment of the student to the concerned institution / center / industry under the supervision of the one mentor from the host institution and another subject mentor from the respective college of the student. Besides the regular attendance, continuous interaction with the mentors, proactive participation at Individual / Group level during the training program, completion of the Job / duties in time assigned during the tenure, punctuality, honesty, time management, Report writing, compilation, presentations, assignments etc.)

- **Student:Mentor ratio = 5:1**

11. Examination and Evaluation Pattern:

a. For each Semester having 15+35 Pattern (applicable only for the academic year 2026-27): The examinations will be conducted semester wise for both Theory as well as Practical courses and applicable only for the academic year 2026-27.

- **Theory Paper of 02 Credits -**

- Internal Exam (**15 M**) + University Theory Exam (**35 M**) = **Total 50 M**
- **Internal Exam evaluation criteria: 10 M written exam + 05 M Assignment submission.**

Written Paper exam	Assignment submission
Question Pattern: ½ mark questions of MCQ, True/False statements, Definitions, Answer in one line, etc.	Assignment to be given to the students on the topics taught in due course of time.
10 Marks	05 Marks
Duration: 40 Minutes	-----

- **Duration:** For Internal written exam of **10M = 40 Min.**
For University written Exam = **02 hours.**

- **Practical Paper of 2 Credits -**

- Internal Exam (**15 M**) + University Practical Exam (**35 M**) = **Total 50 M**
- **Internal Practical Exam evaluation criteria: For 15 M**

Attendance to the regular practical	Journal completion and certification in due time	Attendance to study visit and Report preparation	Viva-voce / Assignment submission in due time	Total Marks
03 M	04 M	04 M	04 M	15 M

- **Duration:** For Internal exam = Continuous and semester-end evaluation
For University Exam = 04 hours.

b. For each Semester having 20+30 Pattern (to be implemented from the academic year 2027-28 onwards): The examinations to be conducted semester wise for both Theory as well as Practical courses with 20+30 pattern will be implemented from the academic year 2027-28.

- **Theory Paper of 02 Credits -**

- Internal Exam (20 M) + University Theory Exam (30 M) = Total 50 M
- Internal Exam evaluation criteria: 10 M written exam + 10 M Assignment submission.

Written Paper exam	Assignment submission
Question Pattern: ½ mark questions of MCQ, True/False statements, Definitions, Answer in one line, etc.	Assignment to be given to the students on the topics taught in due course of time.
10 Marks	10 Marks
Duration: 40 Minutes	-----

- **Duration:** For Internal written exam of 10M = 40 Min.

For University Exam = 02 hours.

- **Practical Paper of 2 Credits -**

- Internal Exam (20 M) + University Practical Exam (30 M) = Total 50 M
- Internal Practical Exam evaluation criteria: For 20 M

Attendance to the regular practical	Journal completion and certification	Attendance to study visit and Report preparation	Viva-voce / Assignment submission	Total Marks
05 M	05 M	05 M	05 M	20 M

- **Duration:** For Internal exam = Continuous and semester-end evaluation

For University Exam = 04 hours.

- **Evaluation criteria for Field Project of 2 Credits -**

- The field project of each student should be evaluated for Total 50 Marks (15 Marks for Internal + 35 Marks for External evaluation, applicable only for the academic year 2026-27 and 20 Marks for Internal + 30 Marks for External evaluation, only applicable from the academic year 2027-28 onwards).
- During Internal Evaluation of FP, following points should be considered:
 1. Selection and appropriateness of the field project topic.
 2. Punctuality and participation of the student.
 3. Field work and scientific observations.

4. Interaction with the mentor / FP coordinator.
5. Regular attendance
6. Maintenance of field diary and records.
7. Viva voce, presentation.
- **The criteria for External Evaluation of FP should include:**
 1. Originality and significance of the project and its relevance to Botany.
 2. Soundness of methodology, research design, and field approach.
 3. Quality and accuracy of data collection, analysis, and interpretation.
 4. Validity and significance of findings and conclusions.
 5. Clarity, organization, and effectiveness of the project report and presentation.
- **Evaluation criteria for Community Engagement Program (CEP) of 2 Credits -**
 - **Evaluation Criteria:** The role of each student in CEP should be evaluated for Total 50 Marks (**15 Marks for Internal + 35 Marks for External evaluation, applicable only for the academic year 2026-27** and **20 Marks for Internal + 30 Marks for External evaluation, applicable only from the academic year 2027-28 onwards**).
 - **During Internal Evaluation of CEP following points shall be considered:**
 1. Effectiveness of program design and planning.
 2. Student participation and engagement in community activities.
 3. Effectiveness of student communication with community members.
 4. Demonstration of botanical knowledge and environmental awareness skills.
 5. Maintenance of program records and documentation.
 - **The criteria for External Evaluation of CEP shall include:**
 1. Clarity, organization, and effectiveness of the report and presentation.
 2. Assessment of the program's impact on the local community and environment.
 3. Evaluation of student learning outcomes and skill development.
 4. Assessment of the program's effectiveness in achieving environmental and social objectives.
- **Evaluation criteria for On Job Training (OJT) of 4 Credits -**
 - **Evaluation Criteria:** The role of each student in OJT should be evaluated for Total 100 Marks (**30 Marks for Internal + 70 Marks for External evaluation, applicable only for the academic year 2026-27** and **40 Marks for Internal + 60 Marks for External evaluation, applicable only from the academic year 2027-28 onwards**).
 - **During Internal Evaluation following points shall be considered:**
 1. Regularity, punctuality, and discipline during On Job Training.

2. Active participation and involvement in assigned workplace activities.
 3. Technical skills and practical knowledge demonstrated during training.
 4. Problem-solving ability and application of subject knowledge in workplace situations.
 5. Communication skills and professional interaction with supervisors and coworkers.
 6. Ability to work independently as well as in a team.
 7. Maintenance of daily work records, logbook, and training documentation.
 8. Overall attitude, sincerity, and professional ethics during training.
- **The criteria for External Evaluation shall include:**
1. Clarity, organization, and effectiveness of the training report and presentation.
 2. Assessment of practical skills and technical competency gained during training.
 3. Evaluation of understanding of workplace operations and management practices.
 4. Assessment of professional ethics, teamwork, and workplace adaptability.
 5. Evaluation of problem-solving skills and decision-making ability.
 6. Assessment of the relevance and quality of the work completed during training.
 7. Evaluation of overall learning outcomes and skill development achieved through training.
 8. Assessment of the effectiveness of the training in achieving academic and professional objectives.

12. Award of Class/Grade and Degree: The class / grade and degree for the courses of each semester will be followed as per the norms and conditions laid down by SPPU, Pune.

13. Important Note:

- a. There shall be at least a short tour/field visit/industrial visit (1-2 days) per year for all UG students. Tours are the part of curriculum and obligatory to each student, failing which they will not be considered eligible to appear for the practical examination. Under unavoidable circumstances, if the student fails to attend the tour, he/she have to produce justifiable evidence for not attending the tour. However, in lieu of tour the candidate will have to complete the work assigned by the Department.
- b. The documents to be produced by each student at the time of practical examination (at the end of each Semester) are:
 - Submission of practical records (Journals).
 - Submission of a Tour / Visit report duly signed by the concerned practical In-charge and Head of the Department.
 - Any submissions / assignments, etc. based on the practical course.

Question paper pattern for Theory (2 Credit courses)**(Applicable only for the Academic year 2026-27)**

A student will have to solve the question paper of 35 marks for external exam. The paper setter should set the paper on entire syllabus, including optional questions. As the course is of 02 Credits (30 clock hour lectures), paper setter should allot 2.03 marks per lecture and accordingly, questions should be set for 30 lectures, 61 marks on entire syllabus.

Question Paper Pattern**Time: 2 Hours]****[Max. Marks: 35****Instructions to candidates:**

- 1) All questions are compulsory.**
- 2) Follow the instructions given for each question.**
- 3) Draw neat labeled diagram wherever necessary.**

Que. 1) Answer any five of the following in one sentence.**05 Marks**

- i.
- ii.
- iii.
- iv.
- v.
- vi.

Que. 2a) Write any one of the following.**06 Marks**

- i.
- ii.

Que. 2b) Write any one of the following.**04 Marks**

- i.
- ii.

Que. 3a) Solve any one of the following.**06 Marks**

- i.
- ii.

Que. 3b) Solve any one of the following.**04 Marks**

- i.
- ii.

Que. 4) Write notes on (Any four).**10 Marks**

- a.
- b.
- c.
- d.
- e.
- f.

Question paper pattern for Theory (02 Credit courses)**(To be applicable from the Academic year 2027-28 onwards)**

A student will have to solve the question paper of 30 marks. The paper setter should set the paper on entire syllabus for total 52 marks, including optional questions. As the course is of 02 Credits (30 clock hour lectures), paper setter should allot 1.73 marks per lecture and accordingly, questions should be set for 30 lectures, 52 marks on entire syllabus.

Question Paper Pattern***Time: 2 Hours]******[Max. Marks: 30******Instructions to candidates:***

- 1) All questions are compulsory.***
- 2) Follow the instructions given for each question.***
- 3) Draw neat labeled diagram wherever necessary.***

Q.1) Answer any Six of the following in one sentence. [6]

- a)
- b)
- c)
- d)
- e)
- f)
- g)
- h)

Q.2a) Answer any One of the following. (Long answer question). [5]

- 1.
- 2.

Q. 2b) Write any One of the following. (Short answer question). [3]

- 1.
- 2.

Q.3a) Answer any One of the following. (Long answer question). [5]

- 1.
- 2.

Q. 3b) Write any One of the following. (Short answer question). [3]

- 1.
- 2.

Q.4) Write note on (any Four). [8]

- a)
- b)
- c)
- d)
- e)
- f)

CREDIT FRAMEWORK FOR T.Y.B.Sc. BOTANY, SEMESTER – V (Level 5.5 / 300)

COURSE DETAILS	COURSE CODE	COURSE TITLE	CREDITS
Vertical – 1 (V1)			
Major Core Courses – (4 T + 2 P) x 2 C = 12 C	BOT-301-MJ-T	Taxonomy of Cryptogams	2 C
	BOT-302-MJ-T	Advanced Plant Physiology	2 C
	BOT-303-MJ-T	Plant Breeding and Seed Technology	2 C
	BOT-304-MJ-T	Cell and Molecular Biology	2 C
	BOT-305-MJ-P	Practical Based on BOT 301-MJ-T and BOT-302-MJ-T	2 C
	BOT-306-MJ-P	Practical Based on BOT 303-MJ-T and BOT-304-MJ-T	2 C
Major Elective Courses – (1 T + 1 P) x 2 C= 4 C (Any one from basket)	BOT-310-MJ-T	Advances in Agro-tourism	2 C
	BOT-311-MJ-T	Plants Utilization	
	BOT-312-MJ-T	Computational Botany	
	BO- 313-MJ-P	Practical Based on BOT-310-MJ-T	2 C
	BOT-314-MJ-P	Practical Based on BOT-311-MJ-T	
	BOT-315-MJ-P	Practical Based on BOT-312-MJ-T	
Vertical – 2 (V2)			
Minor Courses – (1 T = 2 C) (Any one from basket)	BOT-341-MN-T	Vegetable Seed Production	2 C
	BOT-342-MN-T	Nursery Management, Landscape Designing and Gardening	
	BOT-343-MN-T	Feed and Fodder Production Technology	
Vertical – 3 (V3)			
GE / OE - (0C)	-----	-----	0 C
Vertical – 4 (V4)			
Vocational Skill Courses (VSC) – (1 T/ P= 2 C) (Any one from basket)	BOT-321-VSC-T	Intellectual Property Rights (IPR)	2 C
	BOT-322-VSC-P	Stress Physiology of Agricultural Crops	
	BOT-323-VSC-P	Advanced Plant Biotechnology	
SEC – (0 C)	-----	-----	0 C
Vertical – 5 (V5)			
IKS - (0 C)	-----	-----	0 C
AEC – (0 C)	-----	-----	0 C
VEC – (0 C)	-----	-----	0 C
Vertical – 6 (V6)			
FP / CEP – (2 C)	BOT-331-FP / BOT-331-CEP	Field Project (FP) / Community Engagement Programme (CEP) in Botany	2 C
CC – (0 C)	-----	-----	0 C
Total Credits (V1+V2+V3+V4+V5+V6)			22 C

CREDIT FRAMEWORK FOR T.Y.B.Sc. BOTANY, SEMESTER – VI (Level 5.5 / 300)

COURSE DETAILS	COURSE CODE	COURSE TITLE	CREDITS
Vertical – 1 (V1)			
Major Core Courses – (4 T + 2 P) x 2 C = 12 C	BOT-351-MJ-T	Taxonomy of Phanerogams	2 C
	BOT-352-MJ-T	Genetics	2 C
	BOT-353-MJ-T	Plant Pathology and Protection	2 C
	BOT-354-MJ-T	Biochemistry	2 C
	BOT-355-MJ-P	Practical Based on BOT-351-MJ-T and BOT-352-MJ-T	2 C
	BOT-356-MJ-P	Practical Based on BOT-353-MJ-T and BOT-354-MJ-T	2 C
Major Elective Courses – (1 T + 1 P) x 2C = 4 C (Any one from basket)	BOT-360-MJ-T	Phyto-clinical Techniques	2 C
	BOT-361-MJ-T	Agricultural Business Management	
	BOT-362-MJ-T	Botany in relation to Apiculture and Sericulture	
	BOT-363-MJ-P	Practical Based on BOT-360-MJ-T	2 C
	BOT-364-MJ-P	Practical Based on BOT-361-MJ-T	
	BOT-365-MJ-P	Practical Based on BOT-362-MJ-T	
Vertical – 2 (V2)			
Minor Courses – (0 C)	-----		0 C
Vertical – 3 (V3)			
GE / OE - (0 C)	-----	-----	0 C
Vertical – 4 (V4)			
Vocational Skill Courses (VSC) – (1 T/ P = 2 C) (Any one from basket)	VSC-371-BOT-P	Advances in Fermentation Technology	2 C
	VSC-372-BOT-P	Commercial Mushroom and SCP Production Technology	
	VSC-373-BOT-P	Millets for Sustainable Human Welfare	
SEC – (0 C)	-----	-----	0 C
Vertical – 5 (V5)			
IKS - (0 C)	-----	-----	0 C
AEC – (0 C)	-----	-----	0 C
VEC – (0 C)	-----	-----	0 C
Vertical – 6 (V6)			
OJT – (4 C)	BOT-381-OJT	On Job Training (OJT) in Botany	4 C
CC – (0 C)	-----	-----	0 C
Total Credits (V1+V2+V3+V4+V5+V6)			22 C
Total Credits for TYBSC - Semester V (22 C) + Semester VI (22 C)			44 C

Exit Option: Award of Three-Year UG Degree (B.Sc. Botany) in Major with 132 Credits OR Continue with Major and Minor.

SEMESTER - V

SEMESTER - V

COURSE DETAILS	COURSE CODE	COURSE TITLE	CREDITS
Vertical - 1 (V1)			
Major Core Courses - (4 T + 2 P) x 2 C = 12 C	BOT-301-MJ-T	Taxonomy of Cryptogams	2 C
	BOT-302-MJ-T	Advanced Plant Physiology	2 C
	BOT-303-MJ-T	Plant Breeding and Seed Technology	2 C
	BOT-304-MJ-T	Cell and Molecular Biology	2 C
	BOT-305-MJ-P	Practical Based on BOT-301-MJ-T and BOT-302-MJ-T	2 C
	BOT-306-MJ-P	Practical Based on BOT 303-MJ-T and BOT-304-MJ-T	2 C

T.Y.B.Sc. Botany [Semester - V]
Course Category –Major Core Course (MJ)
Course Code – BOT-301-MJ-T

Course Title: Taxonomy of Cryptogams

[No. of Credits: 2 C]

[No. of Lectures: 30 L]

COURSE OBJECTIVES:

1. To understand the origin, diversity, and evolution of cryptogams.
2. To study the morphology, anatomy, reproduction, and life cycles of lower plants.
3. To learn the classification and taxonomy of algae, fungi, bryophytes, and pteridophytes.
4. To understand the ecological and evolutionary importance of cryptogams.
5. To develop skills in cryptogamic herbarium preparation and digital database usage.

COURSE OUTCOMES (COS):

- CO 1:** To able, understand diagnostic characters of representative of major groups.
- CO 2:** To acquire knowledge of traditional and applied aspects of cryptogams in India.
- CO 3:** To understand classification systems of cryptogams.
- CO 4:** To understand the taxonomic principles applied to cryptogams.
- CO 5:** To develop right understanding of preparation herbarium specimens and identification by using databases.

Sr. No.	Topic Details	No. of Lectures
	CREDIT I	15 L
1.	Introduction to Cryptogams 1.1 Introduction and definition 1.2 General characteristics of cryptogams 1.3 Geological time scale with reference to major events: Origin of cryptogams, Great oxygenation event, endosymbiotic theory, Silurian–Devonian colonization of land.	03
2.	Algae 2.1 Introduction and definition 2.2 General characteristics of algae 2.3 Outline Classification of algae according to H C Bold and M J Wynne 1985 up to classes with examples. 2.4 Life Cycle of <i>Anabaena</i> , <i>Spirogyra</i> , <i>Chara</i> , <i>Sargassum</i> with reference to taxonomic position, occurrence, thallus structure, and reproduction.	06
3.	Fungi 3.1 Introduction and definition 3.2 General characteristics of fungi 3.3 Classification of fungi according to Alexopoulos up to classes with examples 3.4 Life Cycle of <i>Mucor</i> , <i>Saccharomyces</i> , <i>Puccinia</i> , and <i>Cercospora</i> with reference to taxonomic position, occurrence, thallus structure, and	06

	reproduction.	
	CREDIT II	15 L
4.	Bryophytes 4.1 Introduction and definition 4.2 General characters of bryophytes 4.3 Classification of Bryophytes according to G.M. Smith (1955) up to classes with examples. 4.4 Comparative account of Life cycle of <i>Marchantia</i> , <i>Anthoceros</i> and <i>Funaria</i> with reference to taxonomic position, morphology, anatomy, and reproduction.	04
5.	Pteridophytes 5.1 Introduction and definition 5.2 General characteristics of pteridophytes, 5.3 Classification of pteridophytes according to K.R. Sporne (1975) up to classes with examples 5.4 Life cycle of <i>Psilotum</i> , <i>Selaginella</i> , <i>Equisetum</i> , and <i>Pteris</i> with reference to taxonomic position, morphology, anatomy, reproduction, sporophytes and gametophytes. 5.5 Origin of Pteridophytes, Algal and Bryophyte origin. 5.6 Evolution of Pteridophytes- Telome theory and Enation theory. 5.7 Carboniferous forests and pteridophytes dominance.	07
6.	Cryptogamic herbarium and Data bases 6.1 Concept and Preparation of Cryptogam Herbaria with reference to algae by floating-out on paper method; fungi, lichen and bryophytes by air drying methods (Pocket method); and pteridophytes by pressing method. 6.2 E- herbarium or virtual herbarium: Definition, Components, Technique, Standardization; advantages and disadvantages of virtual herbarium. 6.3 Data bases concept and need: Electronic repository, Relational structure, Metadata integration. 6.4 Digital databases: Global Biodiversity - The Global Biodiversity international facility (GBIF); Algae Base; Index Fungorum, The Bryophyte Portal, Pteridophyte Collections Consortium (PCC).	04

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17. Sporne K R 1991 The morphology of Pteridophytes B I Publishing Pvt Ltd Bombay
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T.Y.B.Sc. Botany [Semester - V]**Course Category – Major Core Course (MJ)****Course Code – BOT-302-MJ-T****Course Title: Advanced Plant Physiology****[No. of Credits: 2 C]****[No. of Lectures: 30 L]****COURSE OBJECTIVES:**

1. To understand the fundamental physiological processes occurring plants.
2. To explain the mechanisms of photosynthesis and respiration.
3. To understand plant growth and development.
4. To understand the mechanism of translocation of organic solutes in plants.
5. To study the factors regulating dormancy breaking and germination in plants.

COURSE OUTCOMES (COS):**CO 1:** Students will be able to understand and explain photosynthetic process in plant.**CO 2:** Students will be able to explain the mechanism of translocation.**CO 3:** Students will be able to explain the mechanism of respiration.**CO 4:** Students will be able to understand the process, regulation and significance of plant senescence.**CO 5:** Students will understand the plant growth and development.**CO 6:** Student will be able to explain the mechanism and regulation of seed dormancy and germination.

Sr. No.	Topic Details	No. of Lectures
	CREDIT I	15 L
1.	Photosynthesis 1.1. Introduction and definition 1.2. Structure and organization of chloroplast 1.3. Photosynthetic pigments and light absorption – 1.3.1. Solar spectrum - action and absorption spectra, 1.3.2. Red drop and Emerson enhancement effect. 1.4 Photosystem I and II 1.5. Light Reaction 1.5.1. Electron transport Chain (ETC) 1.5.2. Photophosphorylation: Cyclic and Non-cyclic 1.6. Dark Reaction (Photosynthetic Carbon Reduction): 1.6.1. C ₃ pathway 1.6.2. C ₄ pathway 1.6.3 CAM pathway 1.7. Photorespiration (C ₂ cycle) 1.8. Factors affecting photosynthesis	07
2.	Respiration 2.1. Introduction and definition 2.2. Types of respiration: 2.2.1. Aerobic respiration	05

	2.2.2. Anaerobic respiration 2.3. Mechanism of aerobic respiration: 2.3.1. Glycolysis, 2.3.2. TCA cycle, 2.3.3. Electron transport chain, 2.3.4. Terminal oxidation 2.3.5. Oxidative phosphorylation 2.4. Pentose Phosphate pathway 2.5. Mechanism of anaerobic respiration 2.5.1. Alcoholic and lactic acid fermentation 2.6. Factors affecting respiration.	
3.	Translocation 3.1. Introduction, definition and concept of translocation 3.2. Evidences for Phloem transport-ringing experiment 3.3. Pressure flow theory (Munch Hypothesis) 3.4. Loading and unloading of phloem 3.5. Source to sink relationship	03
	CREDIT II	15 L
4.	Nitrogen Metabolism 4.1. Introduction, definition and concept 4.2. Nitrogen cycle 4.2.1 Nitrogen fixation 4.2.2. Nitrification 4.2.3 Assimilation of nitrate and nitrite 4.2.4. Ammonification 4.2.5 Denitrification 4.3. Synthesis of Amino acids 4.3.1 Transamination 4.3.2 Reductive amination	04
5.	Growth and Development 5.1. Introduction, definition and concept of growth 5.2. Phases of growth 5.3. Growth curve and growth analysis 5.4. Embryogenesis and post embryonic development 5.5. Primary Growth and axis development 5.6. Vegetative Growth and Organogenesis 5.7. Secondary Growth and branching 5.8. Leaf and Root Development	03
6.	Plant Senescence 6.1. Introduction, definition and concept 6.2. Physiological and biochemical changes during senescence 6.3. Importance of senescence in plant life cycle 6.4. Difference between senescence and aging	03
7.	Seed dormancy and germination 7.1. Introduction and definition of seed dormancy 7.2. Types of seed dormancy	05

	7.2.1. Physical dormancy 7.2.2. Morphological dormancy 7.2.3. Physiological dormancy 7.3. Methods to break seed dormancy / Seed priming treatment 7.3.1. Definition and concept of seed priming 7.3.2. Physical methods– scarification, temperature treatment, light treatment 7.3.3. Chemical method - water soaking, GA ₃ , KNO ₃ , Acid treatment 7.4. Definition and concept of seed germination 7.5. Metabolic changes during seed germination 7.6. Vigor Index	
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2. Moore T. C. (1989), Biochemistry and Physiology of Plant Hormones, Springer – Verlag, New York, USA.
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5. Bidwell, R.G.S. 1974. Plant Physiology. Macmillan Pub. Co., N.Y
6. V. Verma (1996). Fundamentals of Plant Physiology, S. Chand and Company Ltd, Ram Nagar, New Delhi.
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T.Y.B.Sc. Botany [Semester - V]**Course Category – Major Core Course (MJ)****Course Code – BOT-303-MJ-T****Course Title: Plant Breeding and Seed Technology****[No. of Credits: 2 C]****[No. of Lectures: 30 L]****COURSE OBJECTIVES:**

1. To understand the principles, scope, and history of plant breeding.
2. To study conventional and modern methods of plant breeding.
3. To learn the concepts of hybridization, selection, and mutation breeding.
4. To understand the importance of seed technology in agriculture.
5. To study seed production, processing, certification, and testing methods.
6. To understand seed storage, seed pathology, and seed protection measures.

COURSE OUTCOMES (COS):**CO1:** Students will explain the basic principles and objectives of plant breeding.**CO2:** Students will describe different methods of plant breeding and their applications.**CO3:** Students will perform basic procedures involved in seed production and processing.**CO4:** Students will identify different classes of seeds and seed certification procedures.**CO5:** Students will analyse seed quality through purity, moisture, and germination tests.**CO6:** Students will understand seed storage practices and management of seed-borne diseases and pests.

Sr. No.	Topic Details	No. of Lectures
	CREDIT I – Plant Breeding	15 L
1.	Introduction to Plant Breeding 1.1 Introduction and definition 1.2 Scope and objectives 1.3 History of Plant Breeding	01
2.	Conventional methods of plant breeding - I: Plant Introduction 2.1 Definition and concept of plant introduction 2.2 Types - primary and secondary 2.3 Procedure 2.4 Merits and demerits with important achievements	02
3.	Conventional methods of plant breeding - II: Selection 3.1 Definition and concept of selection 3.2 Types - mass selection, pureline selection and clonal selection. 3.3 Advantage, disadvantages and achievements of selection	03
4.	Conventional methods of plant breeding - III: Hybridization 4.1 Definition, concept and objectives of hybridization 4.2 Precaution to be taken during hybridization 4.3 Types: inter-varietal and distant 4.4 General procedure of hybridization 4.5 Methods of hybridization: Pedigree and bulk	05

	4.6 Hybrid vigour and Heterosis 4.7 Important achievements	
5.	Modern Methods of Plant Breeding 5.1 Mutation breeding 5.1.1 Definition and concept of mutation breeding; Mutants, Mutagenesis and Mutagen 5.1.2 Types of mutation - Spontaneous and Induced 5.1.3 Mutagens - Physical and Chemical 5.1.4 Induced Mutagenesis - Methodology 5.1.5 Application and limitations of mutation breeding 5.2 Plant Biotechnology 5.2.1 Definition, concept and applications with prominent examples	04
	CREDIT II – Seed Technology	15 L
6.	Introduction to Seed Technology 1.1 Definition and Concept of Seed 1.2 Seed as a basic input in agriculture 1.3 Difference between seed and grain 1.4 Classes of seed: Nucleus, Breeder, Foundation and Certified 1.5 Role of seed technology 1.6 Seed legislation – introduction, Seed legislation in India (Seed Act)	03
7.	Seed Production and Seed Processing 7.1 Introduction 7.2 International Seed Testing Association (ISTA), National Seed Corporation 7.3 Role of National Seed Corporation (NSC) and State Seed Corporation (SSC) 7.4 General principles and methods for Seed Production 7.5 Seed Processing	03
8.	Seed Certification 8.1 Definition, Objectives and Concept of seed certification 8.2 General Process and phases of seed certification 8.3 Field inspection and duties of seed inspector	02
9.	Seed Testing 9.1 Physical Purity Analysis - Definition of purity components, Physical Purity Work Board, Procedure/Methodology 9.2 Moisture Testing - Concept, Hot Air oven method, Digital Moisture Meter 9.3 Germination testing - Definition and objectives, Methods for germination testing: Paper Sand and Soil; Seedling evaluation: Normal Seedlings, Abnormal Seedlings, Multigerm Seed Units and Non-germinated Seeds	03
10.	Seed Pathology and Entomology 10.1 Definition 10.2 Seed borne pathogens - Fungi, Bacteria and Viruses 10.3 Influence of seed borne pathogens on seed production 10.4 Common insect pest and its impact on seed production	02

11.	Seed Storage 11.1 Definition and concept 11.2 Seed treatment 11.3 Management of seed storage structures 11.4 Sanitization, Dehumidification, Fumigation	02
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2. Harpal Singh Tomar 2017 Seed Technology, 3rd edition, Rama Publishing house, Meerut (UP)
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T.Y.B.Sc. Botany [Semester - V]**Course Category – Major Core Course (MJ)****Course Code – BOT-304-MJ-T****Course Title: Cell and Molecular Biology****[No. of Credits: 2 C]****[No. of Lectures: 30 L]****COURSE OBJECTIVES:**

After completing this course, students will be able to:

1. Understand the basic structure and function of the cell.
2. Describe the organization and functions of cellular organelles.
3. Explain the molecular basis of DNA, RNA, and protein synthesis.
4. Understand cell division and regulation of gene expression.
5. Recognize basic applications of molecular biology in biotechnology.

COURSE OUTCOMES (COS):

Upon successful completion, students will be able to:

CO1: Explain cell structure and cellular functions.

CO2: Describe DNA replication, transcription, and translation.

CO3: Differentiate mitosis and meiosis.

CO4: Understand basic gene regulation mechanisms.

CO5: Identify applications of molecular biology techniques.

Sr. No.	Topic Details	No. of Lectures
	CREDIT I – Cell Biology	15 L
1.	Introduction to Cell Biology 1.1 Introduction and definition 1.2 History of Cell Biology, 1.3 Units of measurement for cell, 1.4 Prokaryotic and Eukaryotic cell 1.5 Interdisciplinary nature of Cell Biology	02
2.	Cell Structure 2.1 Cell wall 2.2 Plasma membrane 2.3 cytoplasmic matrix	02
3.	Cell organelles 3.1 Mitochondria 3.2 Chloroplast, 3.3 Endoplasmic Reticulum (ER), 3.4 Golgi apparatus, 3.5 Lysosomes, 3.6 Vacuoles, 3.7 Peroxisomes 3.8 Glyoxysomes	04
4.	Nucleus	03

	4.1 Morphology and ultrastructure of Nucleus, Nucleolus and Nucleolar organizer 4.2 Nuclear envelope - structure of nuclear pore complex 4.3 Transport of molecules across nuclear envelope	
5.	Chromosomes 5.1 Euchromatin and heterochromatin Histones 5.2 Packing of DNA into chromosomes in eukaryotes, 5.3 Karyotype and ideogram, 5.4 Giant chromosome - Polytene chromosomes and Lampbrush chromosomes.	04
	CREDIT II – Molecular Biology	15 L
6.	Genetic material 6.1 Historical perspective from 1953 to 2020 6.2 Griffith's and Avery's transformation experiments 6.3 Hershey-Chase bacteriophage experiment	02
7.	DNA replication - Prokaryotes and Eukaryotes 7.1 Molecular mechanism of DNA replication 7.2 Enzymes involved in both prokaryotic and eukaryotic DNA replication and their inhibitors (antibiotics)	03
8.	Transcription - Prokaryotes in details and passing remarks on Eukaryotes 8.1 Types of RNA: mRNA, tRNA, rRNA 8.2 Types of promoters 8.3 Types of RNA polymerase enzymes in eukaryotes 8.4 Molecular mechanism of transcription	04
9.	Translation (Prokaryotes and Eukaryotes) 9.1 Definition 9.2 Concept and properties of genetic code 9.3 Molecular mechanism of translation	03
10.	Regulation of gene expression 10.1 Concept of operon, <i>lac</i> operon and <i>trp</i> operon 10.2 Positive and negative control 10.3 One gene one enzyme hypothesis	03

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1. Cell and Molecular Biology, S. C. Rastogi
2. Cytology, T. S. Verma and V. K. Agarwal
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4. Fundamentals of Molecular Biology, Veer Bala Rastogi
5. Fundamentals of Molecular Biology, G. K. Pal and Ghaskadabi
6. Cell Biology, Molecular Biology, Genetic, Evolution and Ecology, Verma and Agarwal
7. Cell and Molecular Biology, Robertis and DeRobertis
8. Molecular Cell Biology, 4th Edition, Lodish S. Baltimore
9. Molecular Biology of Gene, Watson J. D.
10. Biochemistry and Molecular Biology of Plants, Buchanan B. B.
11. Molecular and Cell Biology, Wolfe S.L.

T.Y.B.Sc. Botany [Semester - V]**Course Category – Major Core Course (MJ)****Course Code – BOT-305-MJP****Course Title: Practical based on BOT 301 MJ-T and BOT 302 MJ-T****[No. of Credits: 2 C]****[No. of Lectures: 60 L]****COURSE OBJECTIVES:**

1. To study the morphology, anatomy, and reproduction of algae, fungi, bryophytes, and pteridophytes.
2. To understand the systematic and taxonomic position of important cryptogamic plants.
3. To develop practical skills in identification and microscopic observation of lower plants.
4. To learn physiological experiments related to photosynthesis and respiration in plants.
5. To study seed germination, seed dormancy, and seed vigor analysis techniques.
6. To develop scientific observation and field study skills through botanical excursions and report writing.

COURSE OUTCOMES (COS):**CO1:** Students will identify important genera of algae, fungi, bryophytes, and pteridophytes.**CO2:** Students will explain the morphology, anatomy, and reproduction of cryptogamic plants.**CO3:** Students will perform physiological experiments using standard laboratory techniques.**CO4:** Students will analyze photosynthetic pigments and respiratory activities in plants.**CO5:** Students will evaluate seed germination percentage and vigor index in plant materials.**CO6:** Students will prepare scientific tour reports based on botanical field observations.

Sr. No.	Titles of the Practical	No. of Practical
CREDIT I - Practical based on BOT-301-MJ-T		
1.	Study of Algae with reference to systematic position, thallus structure and reproduction of <i>Anabaena</i> , and <i>Spirogyra</i> .	1 P
2.	Study of Algae with reference to systematic position, thallus structure and reproduction of <i>Chara</i> and <i>Sargassum</i> .	1 P
3.	Study of Fungi with reference to systematic position and thallus morphology of <i>Mucor</i> and <i>Saccharomyces</i> .	1 P
4.	Study of Fungi with reference to systematic position, and thallus morphology of <i>Puccinia</i> and <i>Cercospora</i> .	1 P
5.	Study of Bryophyte with reference to systematic position, thallus morphology and gametophyte structure of <i>Marchantia</i> , <i>Anthoceros</i> and <i>Funaria</i>	1 P
6.	Study of Pteridophyte with reference to taxonomic position, morphology and anatomy of sporophyte and reproductive structure of <i>Psilotum</i> and <i>Selaginella</i>	1 P
7.	Study of <i>Equisetum</i> and <i>Pteris</i> with reference to taxonomic position, morphology and anatomy of sporophyte and reproductive structure	1 P
CREDIT II - Practical based on BOT-302-MJ-T		
8.	Estimation of chlorophyll a and b by Spectrophotometry	1 P

9.	Separation of photosynthetic pigment by Paper / Thin Layer chromatography.	1 P
10.	To determine diurnal fluctuation in TAN values of CAM plants.	1 P
11.	Comparison of the rate of respiration in any two parts of a plant.	1 P
12.	Demonstration of - A. Ringing Experiment B. Respiration in Roots C. Nitrogen rich biofertilizers D. Arc indicator E. Cytokinins delay of senescence F. Nyctinastic movement in plant (in <i>Mimosa</i>)	1 P
13.	Study of seed priming treatments to break seed dormancy and enhance the rate of seed germination.	1 P
14.	Calculate seed germination percentage and vigor index in any suitable plant material	1 P
15.	Botanical excursion, herbarium preparation technique for Algae, Fungi, Bryophytes and Pteridophytes. Submission of Herbarium and Tour Report, with photographs.	1 P

T.Y.B.Sc. Botany [Semester - V]**Course Category – Major Core Course (MJ)****Course Code – BOT-306-MJP****Course Title: Practical based on BOT 303 MJ-T and BOT 304 MJ-T****[No. of Credits: 2 C]****[No. of Lectures: 60 L]****COURSE OBJECTIVES:**

1. To develop practical skills in plant breeding and hybridization techniques.
2. To study pollen viability, floral morphology, and mutation effects in crops.
3. To learn methods of seed testing, purity analysis, and germination studies.
4. To understand the life cycle and management of common seed insect pests.
5. To study plant cell structure, mitosis, and meiosis using microscopic techniques.
6. To understand basic molecular biology techniques including DNA isolation and PCR concepts.

COURSE OUTCOMES (COS):

- CO1:** Students will perform emasculation, pollination, bagging, and tagging techniques in crops.
- CO2:** Students will analyse seed quality through moisture, purity, and germination tests.
- CO3:** Students will identify common seed insect pests and suggest control measures.
- CO4:** Students will prepare and observe mitotic and meiotic stages in plant cells.
- CO5:** Students will calibrate microscopes and measure cell dimensions accurately.
- CO6:** Students will isolate plant genomic DNA and explain basic molecular biology processes.

Sr. No.	Title of the Practical	No. of Practical
CREDIT I – Practical based on BOT-303-MJ-T		
1.	Demonstration of Hybridization Techniques - Emasculation, Hand Pollination, Bagging and Tagging in any suitable crop - cotton / tomato / pulses	1 P
2.	Breeding methods in self and cross-pollinated crops (Interactive).	1 P
3.	Study of pollen viability and floral morphology of crops.	1 P
4.	Effect of chemical mutagens on seed germination and seedling growth.	1 P
5.	To test seed moisture by hot air oven method and study germination methods - Paper, Sand and Soil	1 P
6.	Physical purity analysis of seed sample.	1 P
7.	To study any one common seed insect pest w.r.t to their life cycle, way of infestation/damage, symptoms and control measures.	1 P
8.	Visit to a Plant Breeding Research Centre/Seed Industry and report submission.	1 P
CREDIT II – Practical based on BOT-304-MJ-T		
9.	Study of plant cell structure in different plant tissues (e.g., Hydrilla leaf, Onion epidermal peel, and Rhoeo leaf) and Calibration of the ocular micrometer and measurement of cell dimensions (e.g., pollen grains or stomatal guard cells).	1 P

10.	Study of mitosis: Preparation of onion root tip squash using Acetocarmine /Aceto-orcein staining and identification of different stages: Prophase, Metaphase, Anaphase, and Telophase.	1 P
11.	Study of meiosis in onion or <i>Tradescantia</i> / <i>Rhoeo</i> flower buds.	1 P
12.	Preparation of fixatives; Acetocarmine and Aceto-orcein stains. Demonstration of ultrastructure of Nucleus, Chloroplast, Mitochondria, ER, and Golgi complex using Electron Micrographs (TEM/SEM).	1 P
13.	Isolation of plant genomic DNA by suitable method and its estimation by DPA method.	2 P
14.	Demonstrations of: A. The Semi-conservative mode of DNA replication through 3D models or charts B. The process of Transcription through 3D models or charts C. The role of Taq Polymerase, Primers, and Thermal Cyclers in PCR D. Polytene and Lampbrush chromosomes from permanent slides or micrographs	1 P

SEMESTER - V

COURSE DETAILS	COURSE CODE	COURSE TITLE	CREDITS
Vertical - 1 (V1)			
Major Elective Courses – (1 T + 1 P) x 2 C= 4 C (Any one from basket)	BOT-310-MJ-T	Advances in Agro-tourism	2 C
	BOT-311-MJ-T	Plants Utilization	
	BOT-312-MJ-T	Computational Botany	
	BOT-313-MJ-P	Practical Based on BOT-310-MJ-T	2 C
	BOT-314-MJ-P	Practical Based on BOT-311-MJ-T	
	BOT-315-MJ-P	Practical Based on BOT-312MJ-T	

T.Y.B.Sc. Botany [Semester - V]**Course Category – Major Elective Course****Course Code – BOT-310-MJ-T****Course Title: Advances in Agro-tourism****[No. of Credits: 2 C]****[No. of Lectures: 30 L]****COURSE OBJECTIVES:**

1. To develop advanced understanding of Agro-tourism as a sustainable rural enterprise.
2. To study modern innovations, digital tools, and smart technologies used in Agro-tourism.
3. To train students in Agro-tourism entrepreneurship, business planning, and financial sustainability.
4. To analyze environmental, socio-economic, and policy aspects of Agro-tourism development.
5. To develop skills in research, case study analysis, and project-based learning in Agro-tourism.
6. To promote rural livelihood enhancement through value addition and experiential tourism.

COURSE OUTCOMES (COS):

After completion of the course, students will be able to:

CO 1: Design and manage advanced Agro-tourism models professionally.

CO 2: Prepare business and feasibility plans for Agro-tourism enterprises.

CO 3: Apply digital marketing and smart tourism technologies.

CO 4: Evaluate sustainability and environmental impacts of Agro-tourism.

CO 6: Conduct field surveys and research studies related to rural tourism.

CO 7: Develop entrepreneurial and leadership skills in Agro-tourism management.

Sr. No.	Topic Details	No. of Lectures
	CREDIT I	15 L
1.	Advanced concepts in agro-tourism 1.1 Introduction to Agro-tourism - Definition, scope, and the intersection of agriculture and tourism. 1.2 Evolution of Agro-tourism: Global and Indian perspectives 1.3 Agro-tourism as a tool for rural economy diversification 1.4 Experiential tourism and farm experience design 1.5 Agro-tourism and Sustainable Development Goals (SDGs)	02
2.	Activities and management of agro-tourism centres 2.1 Introduction 2.2 Agricultural activities 2.3 Animal-based activities 2.4 Cultural and recreational activities 2.5 Adventure and nature-based activities 2.6 Management of agro-tourism centres	02
3.	Planning and development of agro-tourism 3.1 Introduction	03

	3.2 Site Selection for agro-tourism centres 3.3 Infrastructure requirements 3.4 Recreational and educational facilities 3.5 Benefits of agro-tourism centres 3.6 Challenges in agro-tourism development	
4.	Agro-tourism planning and infrastructure development 4.1 Business models in Agro-tourism 4.2 Feasibility analysis and site planning 4.3 Infrastructure planning and eco-friendly design 4.4 Risk management and safety standards 4.5 Legal requirements and licensing procedures	04
5.	Agro-tourism entrepreneurship and financial management 5.1 Agro-tourism entrepreneurship development 5.2 Business plan preparation 5.3 Cost-benefit analysis and revenue models 5.4 Funding sources: Government schemes, subsidies, PPP models 5.5 Accounting and financial sustainability	04
	CREDIT II	15 L
6.	Digital and smart agro-tourism 6.1 Digital tourism platforms and online booking systems 6.2 Social media branding and influencer marketing 6.3 GIS and smart farming integration in tourism 6.4 Virtual farm tours and immersive technologies (AR/VR concept) 6.5 Customer data management and analytics	03
7.	Sustainable practices and environmental management 7.1 Eco-tourism principles in Agro-tourism 7.2 Organic farming and biodiversity conservation 7.3 Waste management and renewable energy use 7.4 Water conservation and climate adaptation strategies 7.5 Responsible tourism and ethical practices	04
8.	Cultural Heritage and rural experience development 8.1 Preservation of rural traditions and indigenous knowledge 8.2 Local food systems and farm-to-table tourism 8.3 Folk art, festivals, and cultural interpretation 8.4 Community participation and stakeholder engagement 8.5 Women and youth empowerment through agro-tourism	04
9.	Agro-tourism policy, research and case studies 9.1 National and Maharashtra agro-tourism policies (advanced analysis) 9.2 Government schemes supporting agro-tourism enterprises 9.3 Successful Agro-tourism case studies (India and International) 9.4 Impact assessment methods 9.5 Research methodology in agro-tourism studies	04

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WEB RESOURCES

1. Agri Tourism Development Corporation – www.agritourism.in
2. Ministry of Tourism – www.tourism.gov.in
3. National Council of Agricultural Research – www.icar.org.in
4. FAO Official Website – www.fao.org

T.Y. B.Sc. Botany [Semester - V]
Course Category –Major Elective Course
Course Code – BOT-311-MJ-T
Course Title: Plants Utilization

[No. of Credits: 2 C]

[No. of Lectures: 30 L]

COURSE OBJECTIVES:

1. To understand the concept and scope of plant utilization.
2. To study economically important plants used as food and medicine.
3. To learn about industrial and commercial uses of plant resources.
4. To understand nutraceuticals and functional plants.
5. To promote sustainable utilization and conservation of plant resources.
6. To develop awareness about the role of plants in human welfare.

COURSE OUTCOMES (COS):

After completing this course, students will be able to:

- CO1:** Explain the scope and importance of plant utilization.
CO2: Identify major cereals, pulses, fruits, and vegetables.
CO3: Describe medicinal and industrial plant resources.
CO4: Understand nutraceutical and functional plants.
CO5: Analyse sustainable utilization practices.
CO6: Apply knowledge of plant resources in agriculture and industry.

Sr. No.	Topic Details	No. of Lectures
	CREDIT I - Fundamentals of Plant Utilization	15 L
1.	Introduction to plant utilization 1.1 Concept and scope of economic botany 1.2 Historical background of plant utilization 1.3 Centres of origin and domestication of crop plants	03
2.	Cereals and Millets 2.1 Origin, morphology, and economic importance 2.2 Major cereals: Rice, Wheat, Maize, Barley, and Sorghum 2.3 Nutritional significance of millets	04
3.	Pulses and Oil yielding plants 3.1 Importance of legumes in nutrition 3.2 Groundnut, Soybean, Mustard – uses and products 3.3 Edible oils and their significance	04
4.	Fruits, Vegetables, and Spices 4.1 Economic importance of selected fruits and vegetables 4.2 Spices and condiments: Cardamom, Black Pepper, Vanilla, Tamarind, Turmeric, Fennel, Fenugreek, Nutmeg 4.3 Post-harvest importance	04

	CREDIT II - Medicinal and Industrial Plant Resources	15 L
5.	Nutraceutical and functional plants 5.1 Introduction, Definition of nutraceuticals and functional foods 5.2 Difference between food and nutraceuticals, Concept of health-promoting plants 5.3 Nutraceutical Plants: Turmeric - anti-inflammatory activity; Amla - vitamin C source; Garlic - cardiovascular benefits; Ginger - digestive properties 5.4 Importance in Human Health - Prevention of chronic diseases, Boosting immunity, Role in metabolism, Improving nutritional status	03
6.	Medicinal Plants 6.1 Importance - Traditional and modern medicinal systems, Role in Ayurveda and herbal medicine 6.2 Active Principles / Bioactive Compounds: Alkaloids - therapeutic properties; Glycosides - cardiac and laxative action; Tannins - astringent properties; Essential oils - aromatic and medicinal uses. 6.3 Study of Selected Medicinal Plants: 6.3.1 <i>Azadirachta indica</i> (Neem) - Botanical description, Active compounds (Azadirachtin), Antibacterial and antifungal uses, 6.3.2 <i>Withania somnifera</i> (Ashwagandha) - Roots as medicinal part, Stress-relieving and tonic properties. 6.3.3 <i>Rauvolfia serpentina</i> (Sarpagandha) - Root alkaloids (Reserpine) - Use in hypertension 6.4 Cultivation and Processing - Nursery raising, Harvesting methods, Drying and storage, Quality control, Marketing of medicinal plants	05
7.	Fibre, Latex, and Timber yielding plants 7.1 Fibre Yielding Plants 7.1.1 Cotton - Source: Seed hairs; Uses: Textile industry, medical cotton 7.1.2 Jute - Source: Stem fibres, Uses 7.2 Latex Yielding Plants 7.2.1 Rubber (<i>Hevea brasiliensis</i>) - Latex secretion, Tapping methods, Coagulation and processing, Uses. 7.3 Timber Yielding Plants - Characteristics of good timber, Teak, Sal, and Deodar, Uses. 7.4 Forest Products - Gums and resins, Tannins and dyes, Non-timber forest products (NTFPs)	04
8.	Sustainable Utilization of Plant Resources 8.1 Overexploitation of Plant Resources - Deforestation, Habitat destruction, Loss of biodiversity, Unsustainable harvesting 8.2 Conservation of Plant Resources. 8.3 Role in Rural Economy - Employment generation, Cottage industries, Tribal livelihood, Herbal trade 8.4 Sustainable Harvesting Practices- Controlled collection, Crop rotation, Regeneration techniques, Eco-friendly methods 8.5 Environmental and Social Importance - Climate regulation, Soil conservation, Water cycle maintenance, Social awareness	03

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T.Y.B.Sc. Botany [Semester - V]
Course Category – Major Elective Course
Course Code – BOT-312-MJ-T
Course Title: Computational Botany

[No. of Credits: 2 C]

[No. of Lectures: 30 L]

COURSE OBJECTIVES:

1. Develop a clear understanding of the role of biostatistics in biological and life science research.
2. Identify different types of biological data, variables, and sampling strategies used in scientific investigations.
3. Apply descriptive statistical methods to summarize and represent biological datasets effectively.
4. Understand probability concepts and statistical distributions relevant to biological phenomena.
5. Design simple biological experiments using principles of randomization, replication, and control.
6. Perform and interpret basic statistical tests such as t-test, chi-square test, correlation, and ANOVA.
7. Analyse and visualize real biological datasets using jamovi for scientific interpretation.

COURSE OUTCOMES (COS):

- CO1:** Explain fundamental biostatistical concepts and terminology used in biological sciences.
- CO2:** Classify and organize biological data and present it through tables, graphs, and statistical summaries.
- CO3:** Evaluate biological variation using measures of central tendency and dispersion.
- CO4:** Apply appropriate probability models and hypothesis testing methods to biological problems.
- CO5:** Conduct and interpret statistical comparisons between experimental groups.
- CO6:** Examine relationships among biological variables using correlation and regression analysis.
- CO7:** Perform data analysis and generate scientific outputs using jamovi, enabling evidence-based biological conclusions.

Sr. No.	Topic Details	No. of Lectures
	CREDIT I	15 L
1.	Introduction to Computational Botany 1.1 Definition and concept 1.2 Role in biological and botanical research 1.3 Applications in computational botany 1.4 Population v/s Sample 1.5 Parameter v/s Statistic 1.6 Variables and attributes 1.7 Qualitative v/s Quantitative data 1.8 Discrete and continuous variables	04

2.	Data Collection and Classification, Types of Biological Data 2.1 Primary v/s Secondary data 2.2 Classification of biological data 2.3 Frequency distribution 2.4 Class intervals 2.5 Types of Biological Data - Measurement scales, Nominal, Ordinal, Interval, Ratio	03
3.	Sampling Methods 3.1 Definitions - Population, sample, parameter, statistic 3.2 Need of sampling, Advantages 3.3 Simple random sampling - with and without replacement 3.4 Stratified and systematic sampling - applications in plant science 3.5 Non-random sampling 3.6 Sampling errors or outliers in biological studies	04
4.	Tabular and Graphical Representation 4.1 Tables, parts of table and frequency tables 4.2 Histogram and Frequency polygon 4.3 Line graph, Bar chart and Stacked Bar chart 4.4 Pie diagram 4.5 Scatter plot and Radar Plot	04
CREDIT II		15 L
5.	Measures of Central Tendency and Dispersion 5.1 Definition and concept of Mean (Arithmetic Mean), Median, Mode 5.2 Interpretation of Mean, Median, Mode 5.3 Mean-Median-Mode relationship 5.4 Range 5.5 Mean Deviation 5.6 Variance 5.7 Standard Deviation (SD) 5.8 Coefficient of Variation (CV) 5.9 Importance of variability in plant modelling	03
6.	Probability and Probability Distributions 6.1 Random experiments, events – simple, compound, mutually exclusive, independent (only concepts) 6.2 Definitions of probability, types- classical and empirical 6.3 Basic probability distributions – Binomial, Poisson, Normal (concepts and applications) 6.4 Standard deviation and probability area	02
7.	Hypothesis Testing and Experimental Design 7.1 Null and Alternate hypothesis; Types of errors - Type I and Type II with one suitable example each; Degrees of freedom (concept), level of significance, critical region, p-value 7.2 Experimental Design- Completely Randomized Design (CRD), Randomized Block Design (RBD), Factorial design, 7.3 Key types of experimental Errors - Random Error, Systematic Error, Blunders	02

8.	Statistical Tests for Biological Data Tests of Significance 8.1 Z test: only concept 8.2 Student's t-test: One sample, independent and Paired - one example each 8.3 Chi-square test - Goodness of fit, Test of independence - one example each 8.4 Introduction to ANOVA, Types: One-way ANOVA, Two-way ANOVA with one example each 8.5 F test - only concept 8.6 Post-hoc comparison (basic idea) e.g. Tukey's HSD - only concept	04
9.	Correlation and Regression 9.1 Definition of correlation, types, scatter diagram. 9.2 Karl Pearson's coefficient of correlation and Spearman's rank correlation coefficient. Their test of significance. 9.3 Linear regression (concept), equations, definition and properties of regression 9.4 Comparison of regression and correlation coefficients.	03
10.	Computational Biostatistics using JAMOV 13.1 Introduction to JAMOV 13.2 Needs of software in modern biology 13.3 Installation and interface of JAMOV	01

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T.Y.B.Sc. Botany [Semester - V]**Course Category – Major Elective Course****Course Code – BOT-313-MJ-P****Course Title: Practical based on BOT-310-MJ-T****[No. of Credits: 2 C]****[No. of Lectures: 60 L]****COURSE OBJECTIVES:**

1. To understand the concept and models of Agro-tourism in India.
2. To study the planning and management of Agro-tourism enterprises.
3. To learn the preparation of feasibility reports and business plans for Agro-tourism.
4. To understand marketing strategies and digital promotion of Agro-tourism.
5. To study sustainable and eco-friendly practices in Agro-tourism development.
6. To develop field-based knowledge through surveys, visits, and project preparation.

COURSE OUTCOMES (COS):**C01:** Students will explain different Agro-tourism models and their applications.**C02:** Students will prepare feasibility reports and business plans for Agro-tourism centres.**C03:** Students will design farm-based tourist activities and eco-friendly infrastructure layouts.**C04:** Students will apply digital marketing tools for Agro-tourism promotion.**C05:** Students will analyse tourist behaviour and sustainable rural tourism practices.**C06:** Students will prepare field reports and project proposals related to Agro-tourism.

Sr. No.	Title of the Practical	No. of Practical
1.	Study of different Agro-tourism models in India – Case study based analysis.	1 P
2.	Preparation of a feasibility report for starting an Agro-tourism centre - site selection, resources and market analysis.	1 P
3.	Designing a farm experience activity for tourists - hands-on farming, crop harvesting, dairy activities etc.	1 P
4.	Preparation of a basic Agro-tourism business plan.	1 P
5.	Cost-benefit analysis of a small Agro-tourism enterprise.	1 P
6.	Study of Government schemes and subsidies available for Agro-tourism development in Maharashtra and India.	1 P
7.	Designing eco-friendly infrastructure layout for an Agro-tourism farm.	1 P
8.	Preparation of a digital marketing plan for Agro-tourism using social media platforms.	1 P
9.	Study of online tourism platforms and booking systems used in Agro-tourism.	1 P
10.	Survey of tourists' preferences and behaviour in rural tourism.	1 P
11.	Study of sustainable practices in Agro-tourism - organic farming, waste management, renewable energy.	1 P
12.	Documentation of rural traditions, local food systems and cultural activities for tourism promotion.	1 P
13.	Visit to an Agro-tourism centre and submission of a detailed field report.	2 P

14.	Preparation and presentation of an Agro-tourism project proposal	1 P
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T.Y.B.Sc. Botany [Semester - V]**Course Category – Major Elective Course****Course Code – BOT-314-MJ-P****Course Title: Practical based on BOT-311-MJ-T****[No. of Credits: 2 C]****[No. of Lectures: 60 L]****COURSE OBJECTIVES:**

1. To study the morphology and economic importance of major crop plants.
2. To understand the nutritional and industrial uses of cereals, millets, pulses, and oil yielding plants.
3. To learn phytochemical screening and analysis of medicinal plants.
4. To study nutraceutical and therapeutic properties of economically important plants.
5. To understand processing, value addition, and utilization of plant resources and forest products.
6. To develop field-based knowledge of medicinal and economically important plants.

COURSE OUTCOMES (COS):**CO1:** Students will identify important economic plants based on their morphology and uses.**CO2:** Students will compare nutritional values of cereals and millets.**CO3:** Students will perform phytochemical screening of medicinal plants.**CO4:** Students will evaluate nutraceutical and therapeutic properties of plant extracts.**CO5:** Students will explain processing and value addition methods of plant products.**CO6:** Students will document and assess economically important plant species during field visits.

Sr. No	Title of the Practical	No. of Practical
1.	Comparative morphological and economic analysis of selected cereals and millets w.r.t. external morphology, diagnostic characters, and economic significance of any two cereal and millet crops.	1 P
2.	Investigation of vegetative and reproductive morphology, nutritional and industrial uses of any two species of pulses and oil yielding plants.	1 P
3.	Comparative quantitative and qualitative assessment of nutritional components to evaluate dietary significance of Cereals and Millets – <i>Oryza sativa</i> , <i>Triticum aestivum</i> , <i>Zea mays</i> , <i>Sorghum bicolor</i> , <i>Pennisetum glaucum</i> .	2 P
4.	Functional assessment of nutraceutical properties w.r.t. evaluation of antioxidant and therapeutic properties of plant extracts of <i>Curcuma longa</i> , <i>Phyllanthus emblica</i> , <i>Allium sativum</i> , <i>Zingibe officinale</i> .	1 P
5.	Phytochemical screening and bioactive compound analysis w.r.t. qualitative detection of major phytoconstituents such as alkaloids, glycosides, tannins, and essential oils of medicinal plants <i>Azadirachta indica</i> , <i>Withania somnifera</i> , <i>Rauvolfia serpentina</i> .	2 P
6.	Study of fibre morphology, extraction techniques, and industrial importance of Fibre Yielding Plants - <i>Gossypium hirsutum</i> , <i>Corchorus capsularis</i> , and <i>Cocos nucifera</i> .	1 P

7.	Survey, field-based documentation and economic assessment of plant resources – <i>Ocimum tenuiflorum</i> , <i>Aloe vera</i> , and <i>Tinospora cordifolia</i> in field/herbal garden conditions.	1 P
8.	Processing and quality analysis of latex and rubber (<i>Hevea brasiliensis</i>) w.r.t. latex extraction, coagulation, processing, and product evaluation.	1 P
9.	Post-harvest handling and value addition w.r.t. evaluation of preservation techniques and value-added product development of Fruits and Spices – <i>Elettaria cardamomum</i> , <i>Piper nigrum</i> , <i>Curcuma longa</i> , <i>Foeniculum vulgare</i> , <i>Trigonella foenum-graecum</i> .	2 P
10.	Sustainable utilization and conservation assessment w.r.t. conservation strategies, sustainable harvesting, and economic importance of Plant Resources - <i>Tectona grandis</i> , <i>Shorea robusta</i> , <i>Azadirachta indica</i> .	1 P
11.	Evaluation of Timber and Non-Timber Forest Products (NTFPs) w.r.t. physical properties and uses of one timber specimen along with gums and resins of economic importance.	1 P
12.	Visit to Herbal Garden / Natural Vegetation. (Documentation, identification, and ecological assessment of medicinal and economically important plant species during field visit.)	1 P

T.Y.B.Sc. Botany [Semester - V]**Course Category – Major Elective Course****Course Code – BOT-315-MJ-P****Course Title: Practical based on BOT-312-MJ-T****[No. of Credits: 2 C]****[No. of Lectures: 60 L]****COURSE OBJECTIVES:**

1. To understand the basics of biological data analysis using jamovi.
2. To learn data visualization techniques for biological research.
3. To study methods for testing normality and statistical significance of biological data.
4. To understand parametric tests such as t-test and ANOVA.
5. To learn correlation and regression analysis in biological studies.
6. To understand non-parametric statistical tests used in biological research.

COURSE OUTCOMES (COS):**C01:** Students will perform biological data analysis using JAMOVI.**C02:** Students will create graphical representations of biological data.**C03:** Students will apply t-tests and Chi-square tests for data interpretation.**C04:** Students will analyze biological data using one-way and two-way ANOVA.**C05:** Students will perform correlation and regression analysis on biological datasets.**C06:** Students will apply non-parametric tests for analysis of biological research data.

Sr. No.	Title of the Practical	No. of Practical
1.	Introduction to Biological Data Analysis using JAMOVI.	1 P
2.	Data Visualization for Biological Research.	1 P
3.	Testing Normality of Biological Data.	1 P
4.	Student t-Test using Biology data set - One sample and independent.	1 P
5.	Student t-Test using Biology data set - Paired t-Test.	1 P
6.	Chi-Square Test in Biological Data.	1 P
7.	One-way ANOVA for Biological Data set.	1 P
8.	Two-way ANOVA for Biological Data set.	2 P
9.	Post-Hoc Analysis (Tukey post-hoc test).	1 P
10.	Correlation analysis using biology data set.	1 P
11.	Regression analysis using biology data set.	1 P
12.	Non-Parametric test in biological research Mann-Whitney U.	1 P
13.	Non-Parametric tests in biological research Wilcoxon Signed Rank.	1 P
14.	Non-Parametric tests in biological research Kruskal-Wallis.	1 P

Note: The above-mentioned practical should perform using JAMOVI software.

SEMESTER - V

COURSE DETAILS	COURSE CODE	COURSE TITLE	CREDITS
Vertical - 2 (V2)			
Minor Courses - (1 T = 2 C) (Any one from basket)	BOT-341-MN-T	Vegetable Seed Production	2 C
	BOT-342-MN-T	Nursery Management, Landscape Designing and Gardening	
	BOT-343-MN-T	Feed and Fodder Production Technology	

T.Y.B.Sc. Botany [Semester - V]**Course Category – Minor Course (MN)****Course Code – BOT-341-MN-T****Course Title: Vegetable Seed Production****[No. of Credits: 2 C]****[No. of Lectures: 30 L]****COURSE OBJECTIVES:**

1. To understand the basic knowledge of different aspects of vegetable seed production.
2. To imbibe the knowledge of hybridization techniques.
3. To impart the knowledge about breeding and recent advances of vegetable seed production.
4. To make the students aware of the vegetable crops.
5. To gain the knowledge regarding Vegetable Nursery Management.

COURSE OUTCOMES (COS):**CO1:** Students will learn about concept of different aspects of vegetable seed production.**CO2:** Students are able to learn pollination, emasculation, Bagging and tagging.**CO3:** Understand recent advances in vegetable seed production of hybridization techniques.**CO4:** Get knowledge of aware about the breeding and recent advances of vegetable seed Production.**CO5:** They will gain the knowledge regarding plant Population Improvement.

Sr. No.	Topic Details	No. of Lectures
	CREDIT I	15 L
1.	Introduction to Vegetable Seed Production 1.1 Concept and objectives of vegetable Seed production 1.2 History of vegetable seed production 1.3 Present status and importance of vegetable seed production 1.4 Top five vegetable seed industries in India.	03
2.	Classification of vegetable crops 2.1 Classification based on botanical family 2.2 Classification based on growing season 2.3 Classification based on life cycle - Annual, Biennials and Perennials 2.4 Classification based on plant part used for consumption 2.5 Classification based on Method of Cultivation - Direct sown crops and Transplanted crops.	03
3.	Vegetable Farming 3.1 Introduction 3.2 Types: Home or Kitchen garden, Market garden, Truck garden 3.3 Processing of Vegetable: Primary Processing, Secondary Processing and Value-added processing.	04

4.	Hybridization techniques in Vegetable crops 4.1 Introduction and objectives 4.2 Use of male sterility and self-incompatibility in hybrid seed production. 4.3 Steps involved in hybridization: Selection of parents, Emasculation, Pollination, Bagging and tagging; Collection of seeds. 4.4 Important breeding methods used to develop improved varieties and hybrids - Simple, Back cross and Test cross. 4.5 True potato seed (TPS) production technique. 4.6 Advantages of hybridization techniques in vegetable crops.	05
CREDIT II		15 L
5.	Vegetable Nursery Management 5.1 Introduction 5.2 Types of Nursery beds: 5.2.1 Raised bed 5.2.2 Flat bed 5.2.3 Hi-tech Nursery and Soil less raising of seedlings 5.3 Transplantation technique of seedlings 5.4 Precautions in raising healthy seedlings	03
6.	Breeding methods in Vegetable crops 6.1 Introduction 6.2 Selection methods 6.2.1 Pure line selection 6.2.2 Pedigree selection 6.2.3 Bulk method	03
7.	Population Improvement 7.1 Introduction 7.2 Objectives of population improvement 7.3 Methods of population improvement: 7.3.1 Mass Selection 7.3.2 Progeny Selection 7.4 Application and achievements of Population Improvement.	04
8.	Seed Production Technique in Vegetables 8.1 Seed production procedure in the plants - Brinjal, Tomato, Bitter guard and Onion with reference to.... 8.1.1 Land requirement 8.1.2 Isolation 8.1.3 Nursery management 8.1.4 Cultural practices 8.1.5 Rouging 8.1.6 Plant protection 8.1.7 Harvesting 8.1.8 Seed extraction method 8.1.9 Seed drying 8.1.10 Storage	05

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2. Handbook of Agriculture- Indian Council of Agricultural Research, New Delhi
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T.Y.B.Sc. Botany [Semester - V]
Course Category –Minor Courses (MN)
Course Code – BOT-342-MN-T

Course Title: Nursery Management, Landscape Designing and Gardening
[No. of Credits: 2 C] [No. of Lectures: 30 L]

COURSE OBJECTIVES:

1. To understand the fundamental concepts, infrastructure requirements, and operational techniques of plant nurseries.
2. To gain practical knowledge of sexual and asexual plant propagation methods.
3. To learn the aesthetic and ecological principles of landscape designing.
4. To acquire skills in garden planning, execution, and maintenance.
5. To explore the entrepreneurial scope in commercial nursery and landscaping businesses.

COURSE OUTCOMES (COS):

CO 1: Proficiency in various plant propagation methods and technique.

CO 2: Design and manage nursery infrastructure.

CO 3: Apply aesthetic principles to landscapes.

CO 4: Categorize and select ornamental flora.

CO 5: Develop Technical Maintenance Skills.

CO 6: Formulate entrepreneurial strategies.

Sr. No.	Topic Details	No. of Lectures
	CREDIT I – Nursery Management	15 L
1.	Introduction and Infrastructure of Nursery 1.1 Definition, objectives, scope, and types of nurseries. 1.2 Site selection and layout for a nursery site - Allocation of space for different activities. 1.3 Importance and design of polyhouses, net houses, mist chambers, and cold frames. 1.4 Types of potting media - soil, coco peat, perlite, vermiculite, sphagnum moss 1.5 Sterilization of media 1.6 Types of containers required in nursery management	04
2.	Plant Propagation Techniques 2.1 Sexual Propagation: Seed viability, seed dormancy - types and breaking methods; seed treatment, and sowing techniques. 2.2 Vegetative/Asexual Propagation: Cuttings - root, stem, leaf; Layering - simple, air layering/gootee; Grafting - approach, veneer, cleft; and Budding - T-budding, patch budding. 2.3 Micropropagation: Brief introduction to commercial tissue culture applications in nurseries.	05
3.	Nursery Operations and Maintenance 3.1 Pruning, training, repotting, and hardening of plants.	04

	3.2 Irrigation and Nutrition: Types of irrigation – drip and sprinkler; water management; application of organic manures and inorganic fertilizers. 3.3 Common nursery pests, fungal, and bacterial diseases. 3.4 Integrated Pest Management (IPM) and safe use of agrochemicals.	
4.	Economics and Marketing 4.1 Management: Cost analysis, budgeting, and essential record-keeping in nursery business. 4.2 Marketing: Supply chain management, packaging of plants, marketing strategies, and exploring online retail platforms.	02
	CREDIT II: Landscape Designing and Gardening	15 L
5.	Introduction and Principles of Landscaping 5.1 Definition, scope, and objectives of landscape architecture. 5.2 Role of a botanist/horticulturist in landscaping. 5.3 Core Principles of landscaping: Unity; balance - symmetrical and asymmetrical; proportion; rhythm; focal point/accent; and harmony. 5.4 Colour Theory in landscaping.	04
6.	Elements of Landscape Design 6.1 Soft Elements: Trees - Avenue, Shade, Flowering; Shrubs; Climbers; Creepers; and Ground covers - Palms, Ferns, and Cacti/succulents. 6.2 Hard Elements: Paths, walkways, fences, pergolas, trellises, arches, and water features – fountains and ponds. 6.3 Lawn Management: Selection of grass species; Site preparation; Planting methods - Turfing, Dibbling, Sprigging; and maintenance - Mowing, Weeding, and Rolling.	05
7.	Types of Gardens and Special Gardening 7.1 Garden Styles: Features of Formal (e.g., Mughal, Persian), Informal (e.g., English, Japanese), and Free-style gardens. 7.2 Specialized Gardens: Terrace/Roof gardens, Vertical gardens (green walls), and Rock gardens. 7.3 Indoor Gardening: Selection of indoor plants, light and humidity requirements, Bonsai, Terrariums, and Kokedama.	04
8.	Execution and Maintenance 8.1 Irrigation required for landscaping. 8.2 Maintenance and management of landscape plants.	02

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T.Y.B.Sc. Botany [Semester - V]
Course Category – Minor Course (MN)
Course Code – BOT-343-MN-T

Course Title: Feed and Fodder Production Technology

[No. of Credits: 2 C]

[No. of Lectures: 30 L]

COURSE OBJECTIVES:

1. To understand basic concepts and the importance of feed and fodder.
2. To study classification and types of feeds.
3. To learn feed processing, preservation, packaging, and marketing.
4. To identify important cereal and legume fodder crops.
5. To understand scientific fodder production practices.

COURSE OUTCOMES (COS):

CO 1: Explain the role of feed and fodder in livestock production.

CO 2: Classify feeds and describe their nutritional importance.

CO 3: Understand feed manufacturing and preservation methods.

CO 4: Identify major fodder crops and their characteristics.

CO 5: Apply basic fodder production and marketing practices.

Sr. No.	Topic Details	No. of Lectures
	CREDIT I – Feed Production Technology	15 L
1.	Introduction to Feed 1.1 Introduction, definition and characteristics of Feed 1.2 Importance in the livestock, fishery and poultry industry 1.3 Importance and scope of feed 1.4 Feed: role in food security and rural economy	03
2.	Classification and types of feeds 2.1 Basic Classification of Feeds - Roughages, Concentrates and Supplements 2.2 Roughages: Types - Green fodder, Dry fodder, Silage and hay with examples and nutritional significance 2.3 Concentrates: Energy feeds - cereals; Protein feeds - oilseed cakes and meals; Importance in ration formulation 2.4 Supplements and feed additives: Mineral mixtures; Vitamin supplements; Feed additives - probiotics, enzymes, and antibiotics. 2.5. Role in balanced ration	05
3.	Feed & Mineral Mixture Manufacturing Process 3.1. Introduction to the principles of material handling, Processing of feeds and forages. 3.2. Feed Processing methods: grinding, mixing, pelleting, crumbling, flaking, popping, extrusion. Roughage processing methods, dry processing methods, wet processing methods. 3.3. Principles of mixing and compounding feeds.	04

	3.4 Preservation of feeds	
4.	Packaging and Marketing 4.1. Introduction–importance of packaging. Packaging materials: characteristics of basic packaging materials - paper board, corrugated paper, and fibre board; Glass, metal, plastics, foils and laminates, retort pouches, earthen pots, wood, and leaves, Package forms. 4.2. Legal requirements of packaging materials and product information, Coding and labelling of packages. 4.3. Principles and methods of packaging, 4.4 Disposal of waste packaging materials. 4.5 Market price determination under perfect competition in the short and long run.	03
	CREDIT II – Fodder Production Technology	15 L
5.	Introduction to Fodder 5.1 Introduction and characters of fodder and forage 5.2 Indigenous and exotic fodders and by-products 5.3 Importance and scope of fodders	03
6.	Important grasses as a Fodder 6.1 Introduction of cereals as a fodder 6.2 Study of the following cereal fodders with respect to botanical name, family name, common name, centre of origin, morphological diagnostic characters, fodder value, importance of forage and its by-products: Elephant grass and Maize	03
7.	Important Legumes as a Fodder 7.1 Importance of legumes as fodder 7.2 Study of the following legume fodders with respect to botanical name, family name, common name, centre of origin, morphological diagnostic characters, forage and its by-products: Berseem and Lucerne (alfalfa)	04
8.	Fodder Crop Production Practices 8.1 Concept and advantages of mixed fodder cropping: Cereal-legume fodder mixtures 8.2 Land preparation, sowing methods and seed rate 8.3 Fodder production through hydroponics with any one example 8.4 Storage and Marketing	05

REFERENCES:

1. Ranjhan, S.K. (1998). *Animal Nutrition and Feeding Practices in India*. Indian Council of Agricultural Research, New Delhi.
2. Reddy, D.V. (2001). *Principles of Animal Nutrition and Feed Technology*. Oxford & IBH Publishing Co. Pvt. Ltd, New Delhi.
3. Kellems, R.O. & Church, D.C. (2010). *Livestock Feeds and Feeding*. Prentice Hall, USA.
4. Banerjee, G.C. (2013). *A Textbook of Animal Husbandry*. Oxford & IBH Publishing Co. Pvt. Ltd, New Delhi.

5. McDonald, P., Edwards, R.A., Greenhalgh, J.F.D., Morgan, C.A., Sinclair, L.A. & Wilkinson, R.G. (2011). *Animal Nutrition* (7th Ed.). Pearson Education Ltd.
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7. FAO (2011). *Guide to Feed Manufacturing and Quality Assurance*. Food and Agriculture Organization, Rome.
8. Singh, C., Singh, P. & Singh, R. (2012). *Modern Techniques of Raising Field Crops*. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
9. Chatterjee, B.N. & Maiti, S. (2014). *Principles and Practices of Forage Crop Production*. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
10. ICAR (2013). *Handbook of Agriculture* (Latest Edition). Indian Council of Agricultural Research, New Delhi.
11. Kumar, D. & Singh, N.P. (2017). *Forage Crops and Their Management*. Indian Grassland and Fodder Research Institute (IGFRI), Jhansi.
12. Yadav, R.C. (2003). *Fodder Production and Conservation*. Indian Council of Agricultural Research, New Delhi.
13. FAO (2018). *Hydroponic Fodder Production Manual*. Food and Agriculture Organization, Rome.
14. Kachru, R.P. (2014). *Post-Harvest Technology of Agricultural Crops*. Daya Publishing House, New Delhi.
15. Acharya, S.S. & Agarwal, N.L. (2011). *Agricultural Marketing in India*. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.

SEMESTER - V

COURSE DETAILS	COURSE CODE	COURSE TITLE	CREDITS
Vertical - 4 (V4)			
Vocational Skill Courses (VSC) - (1 T/ P= 2 C) (Any one from basket)	BOT-321-VSC-T	Intellectual Property Rights (IPR)	2 C
	BOT-322-VSC-P	Stress Physiology of Agricultural Crops	
	BOT -323-VSC-P	Advanced Plant Biotechnology	

T.Y.B.Sc. Botany [Semester - V]**Course Category – Vocational Skill Courses (VSC)****Course Code – BOT-321-VSC-T****Course Title: Intellectual Property Rights (IPR)****[No. of Credits: 2 C]****[No. of Lectures: 30 L]****COURSE OBJECTIVES:**

1. To understand basic concepts of Intellectual Property Rights (IPR).
2. To introduce students to patents, copyrights, and trademarks in simple terms.
3. To explain protection of plant varieties and farmers' rights.
4. To create awareness about the importance of IPR in agriculture and biodiversity.

COURSE OUTCOMES (COS):**CO 1:** Understand basic types of IPR and their importance.**CO 2:** Identify how inventions and plant varieties are protected.**CO 3:** Explain farmers' rights and biodiversity conservation issues.**CO 4:** Apply basic IPR knowledge in agriculture and plant science.

Sr. No.	Topic Details	No. of Lectures
	CREDIT I	15 L
1.	Introduction to IPR 1.1 Definition and concept of Intellectual Property with examples 1.2 Types of Intellectual Property -Patent, Copyright, Trademark and GI with at least two examples of each 1.3 Importance of IPR in daily life and agriculture with examples 1.4 Basic idea of origin and development of IPR 1.5 National and International IPR Framework	03
2.	Patent 2.1 Definition and concept of Patent 2.2 Categories of Patent with examples - New product, New process or method and Improvement in existing technology 2.3 Basic requirements - Novelty, Usefulness and Non-obviousness 2.4 Simple idea of patent procedure 2.5 Examples related to Plants and Biotechnology – Examples - Pharmaceutical drug formulation, Agricultural machinery such as improved seed drill, etc. 2.6 Overview of Indian Patent Act	04
3.	Copyright and Trademark 3.1 Copyright – Definition, concept and characteristics 3.2 Rights of Author - Rights in Books and Publications, ISBN for Books, ISSN for Journals and Research Articles 3.3 Duration of protection 3.4 Trademark - Meaning and importance 3.5 Types of Trademarks - Brand name, Logo and Symbol with examples	05

	3.6 Basic idea of Registration 3.7 Examples w.r.t. agricultural products and companies 3.7.1 Agricultural product - Aashirvaad Atta, Fortune Sunflower Oil etc. 3.7.2 Agricultural company - Bayer Crop Science, Syngenta etc.	
4.	Design and Geographical Indication (GI) 4.1 Design – Concept of industrial design 4.2 Importance in product appearance 4.3 Geographical Indication (GI) – Concept with examples - Basmati rice, Darjeeling Tea, Alphonso Mango, Nagpur Orange, Kashmir Saffron 4.4 Difference between GI and Trademark 4.5 Importance of GI in agriculture and rural economy	03
	CREDIT II	15 L
5.	Plant Variety Protection (PVP) 5.1 Concept of Plant Variety Protection (Examples - Disease resistant rice variety, High-yield hybrid tomato variety) 5.2 Importance in agriculture 5.3 Farmers rights - saving and using seeds 5.4 Simple idea of registration and protection	04
6.	Plant Breeders' Rights (PBR) 6.1 Concept and Importance 6.2 Basic idea of UPOV (International Union for the Protection of New Varieties of Plants) 6.3 Introduction to PPV and FR Act, 2001 6.4 Rights of Breeders and Farmers 6.5 Advantages and disadvantages of PBR 6.6 Case studies w.r.t. crop varieties	06
7.	Biodiversity and IPR 7.1 Introduction to Convention on Biological Diversity 7.2 Importance of biodiversity conservation (Example - Protection of traditional biological resources: Neem, Turmeric, 7.3 Recognition and protection through Geographical Indications (GI) - Basmati Rice, Darjeeling Tea, 7.4 Protection of new plant varieties through IPR - Pusa Basmati 1121, Sonalika Wheat 7.5 Role of traditional knowledge	02
8.	IPR Management and Awareness 8.1 Importance of protecting inventions 8.2 Basic idea of commercialization - selling ideas and products 8.3 Role of IPR in agriculture and biotechnology 8.4 Case studies w.r.t. medicinal plants and seeds	03

REFERENCES:

1. B.D. Singh – Plant Breeding: Principals and Methods
2. Cell for IPR Promotion and Management <http://cipam.gov.in/>
3. Introductory material from World Intellectual Property Organization
4. Journal of Intellectual Property Rights (JIPR): NISCAIR

5. Neeraj, P., &Khusdeep, D. (2014). Intellectual Property Rights. India, IN: PHI learning.
6. Office of the Controller General of Patents, Designs & Trademarks
<http://www.ipindia.nic.in/>
7. World Intellectual Property Organization <https://www.wipo.int/about-ip/en/>
8. World Intellectual Property Organization. (2004). WIPO Intellectual property Handbook.
https://www.wipo.int/edocs/pubdocs/en/intproperty/489/wipo_pub_489.pdf

T.Y.B.Sc. Botany [Semester - V]**Course Category – Vocational Skill Courses (VSC)****Course Code – BOT-322-VSC-P****Course Title: Stress Physiology of Agricultural Crops****[No. of Credits: 2 C]****[No. of Lectures: 60 L]****COURSE OBJECTIVES:**

1. To understand the principle and working of instruments used in plant physiology and biochemistry.
2. To study the effects of salinity and drought stress on crop plants.
3. To learn physiological and biochemical methods used in stress analysis of plants.
4. To evaluate seed germination and seedling growth under stress conditions.
5. To study biochemical changes such as proline, protein, chlorophyll, and enzyme activity in stressed plants.
6. To develop practical skills through laboratory experiments and institutional visits.

COURSE OUTCOMES (COS):**C01:** Students will operate basic instruments used in physiology and biochemistry laboratories.**C02:** Students will conduct pot culture experiments under salinity and drought stress conditions.**C03:** Students will analyse morphological and physiological responses of stressed plants.**C04:** Students will estimate biochemical parameters such as proline, protein, and chlorophyll content.**C05:** Students will evaluate membrane stability, stomatal characteristics, and relative water content in plants.**C06:** Students will understand research methodologies used in plant stress physiology and biochemistry.

Sr. No.	Title of the Practical	No. of Practical
1.	Principle and working of instruments used in physiology and biochemistry: UV- Visible Spectrophotometer, Electric Conductivity Meter, pH Meter, Hot Air Oven, Centrifuge and Micropipette.	1 P
2.	Setup a pot culture experiment to impose salinity/drought stress in crop plants to study various physiological and biochemical parameters.	2 P
3.	Evaluation of seed germination and seedling growth parameters under Salinity/water stress in relation to control condition.	1 P
4.	Study of comparative morphological parameters in control and stressed crop plants.	1 P
5.	Study of stomatal frequency and stomatal index under stress condition.	1 P
6.	Determination of Relative Water Content (RWC) under drought/ salt stress by Barrs and Weatherley (1962) method.	1 P
7.	<i>In situ</i> localization of superoxide and hydrogen peroxide under stress condition.	1 P
8.	Estimation of proline content in leaves of stressed plants by using Bates <i>et</i>	1 P

	<i>al.</i> (1973) method.	
9.	Estimation of peroxidase activity under stress condition by using Vidyasekharan and Durairaj (1973) method.	1 P
10.	Determination of Membrane Stability Index (Electrolyte Leakage Test) of stressed crop plants by Deshmukh <i>et al.</i> (1991) method.	1 P
11.	Estimation of chlorophyll content under stress condition by Arnon's (1949) method.	1 P
12.	Estimation of chlorophyll stability index in two varieties or species of crops under stress condition.	1 P
13.	Estimation of total soluble protein content in crop plants under stress condition by Lowry <i>et al.</i> (1951) method.	1 P
14.	Visit to National Institute of abiotic stress management/ nearby Krishi Vigyan Kendra / MPKV, Rahuri / Any Agricultural Institute.	1 P

T.Y.B.Sc. Botany [Semester - V]**Course Category – Vocational Skill Courses (VSC)****Course Code – BOT-323-VSC-P****Course Title: Advanced Plant Biotechnology****[No. of Credits: 2 C]****[No. of Lectures: 60 L]****COURSE OBJECTIVES:**

1. To impart hands-on training in plant tissue culture techniques including media preparation, sterilization, callus induction, and micropropagation.
2. To develop skills in handling basic biotechnology laboratory instruments such as autoclave, laminar air flow cabinet, micropipettes, centrifuge, and gel electrophoresis unit.
3. To train students in isolation, purification, quantification, and analysis of plant genomic DNA and plasmid DNA using standard molecular techniques.
4. To provide practical exposure to molecular tools such as PCR, restriction digestion, and molecular marker analysis used in plant biotechnology.
5. To introduce students to basic plant genetic transformation methods and screening of transformants.
6. To cultivate scientific temper through experimental design, data recording, result interpretation, laboratory safety practices, and preparation of practical records/reports.

COURSE OUTCOMES (COS):

- C01:** Demonstrate knowledge of fundamental principles of plant tissue culture, genetic engineering, and molecular plant biotechnology.
- C02:** Prepare culture media, maintain aseptic conditions, and perform in vitro propagation techniques including callus induction and micropropagation.
- C03:** Isolate, quantify, and analyse plant genomic DNA and plasmid DNA using standard molecular biology techniques such as PCR and gel electrophoresis.
- C04:** Apply molecular markers (RAPD/SSR) and basic bioinformatics tools for plant genetic analysis and crop improvement studies.
- C05:** Explain and perform basic plant transformation techniques including *Agrobacterium*-mediated methods and evaluate transgenic confirmation strategies.
- C06:** Develop laboratory skills, data interpretation ability, scientific documentation, and ethical awareness related to plant biotechnology research and applications.

Sr. No.	Title of the Practical	No. of Practical
1.	Preparation of buffers, reagents and stock solutions for Plant Tissue Culture.	1 P
2	Basics and Lab Setup: Lab organization, safety, aseptic techniques, Calibration and use of micropipettes, water bath, centrifuge, shaker, Incubator, Electrophoresis units, Gel-Doc.	1 P
3.	Initiation of callus culture from leaf explants and production of secondary metabolites (production can be interactive).	1 P
4.	Micropropagation: Shoot tip and meristem cultures (banana/rose/coleus).	1 P
5.	Hardening and acclimatization of <i>in vitro</i> plants (Primary and Secondary).	1 P
6.	Demonstration of anther (E.g. <i>Datura</i>), endosperm Culture and Production of	1 P

	Haploids and Triploids (eg. Wheat/Maize) respectively (production can be interactive).	
7.	Isolation of genomic DNA from plant tissues using CTAB method) followed by its quantitative and qualitative analysis using UV spectrophotometry (260:280 ratio).	2 P
8.	Separation of DNA by Agarose Gel Electrophoresis.	1 P
9.	Separation of Proteins by Poly Acrylamide Gel Electrophoresis (PAGE) analysis.	2 P
10.	Introduction to <i>Agrobacterium</i> -mediated transformation methods (can be interactive).	1 P
11.	PCR amplification of plant DNA and marker analysis (RAPD/SSR) (can be interactive).	1 P
12.	Problems on Genetic Engineering (Problem set on Restriction digestion/Vectors).	1 P
13.	Visit to Plant Tissue Culture Laboratory / Research Unit in Biotechnology.	1 P

REFERENCES:

- 1 Bhojwani S. S. & Razdan M. K., *Plant Tissue Culture: Theory and Practice*
- 2 Dodds J.H. & Roberts L.W., *Experiments in Plant Tissue Culture* Caldentey K.M.O. et al., *Plant Biotechnology and Transgenic Plants*
- 3 A Plant Biotechnology Laboratory Manual Kerala Agricultural University Gamborg & Phillips Plant Cell, Tissue, and Organ Culture: Fundamental Methods (Springer)
- 4 Plant Tissue Culture: Techniques and Experiments by Roberta H. Smith: A practical, experiment-based manual.
- 5 Practical Manual for Plant Tissue Culture (Grin Verlag): A practical guide covering basic techniques.
- 6 Plant Tissue Culture: A Lab Manual (by S.K. Dey & S.K. Ghosh): A comprehensive guide designed for UG and PG students.
- 7 Laboratory Manual for Plant Biotechnology by H.S. Chawla: An in-depth manual for biotechnology practices.
- 8 Plant Tissue Culture- A Lab Manual by Dipu Samanta, Debleena Roy.

SEMESTER - V

COURSE DETAILS	COURSE CODE	COURSE TITLE	CREDITS
Vertical - 6 (V6)			
FP / CEP - (2 C)	BOT-331-FP / BOT-331-CEP	Field Project (FP) / Community Engagement Programme (CEP) in Botany	2 C

T.Y.B.Sc. Botany [Semester - V]**Course Category – On Job Training (OJT)****Course Code – BOT-331-FP / BOT-331-CEP****Course Title: Field Project (FP) /****Community Engagement Programme (CEP) in Botany****[No. of Credits: 2 C]****[No. of Lectures: 60 L]****Guidelines for Field Project (FP) in Botany****A. Purpose of Field Project:**

Field projects help students gain practical knowledge of plant science through field observation, data collection, experimentation and environmental study. It enhances scientific thinking, research skills and understanding of biodiversity and ecosystem management.

B. Objectives of Field Project:

1. To develop field-based scientific and observational skills.
2. To understand plant diversity and ecological relationships.
3. To train students in collection, identification and documentation of plant species.
4. To encourage research aptitude and environmental awareness.
5. To provide practical exposure to botanical applications in agriculture, forestry and conservation.

C. Expected Outcomes:

After completion of field project, students will be able to:

1. Conduct botanical field surveys independently.
2. Identify and document plant species scientifically.
3. Analyze ecological and environmental data.
4. Prepare scientific reports and herbarium records.
5. Understand conservation and sustainable utilization of plant resources.

D. Suggested Areas for Field Projects: Students may select projects related to:

- Plant biodiversity assessment
- Medicinal plants survey
- Ethnobotanical studies
- Weed flora analysis
- Pollination ecology
- Nursery and plantation management
- Urban gardening
- Seed germination studies
- Soil and water conservation
- Study of invasive plant species
- Apiculture and bee flora
- Sericulture and host plants
- Mangrove or forest vegetation studies
- Algal or fungal diversity
- Organic farming practices

E. Field Project Activities:

1. Selection of study area/topic.
2. Field survey and plant collection.
3. Identification and classification of plant species.
4. Preparation of herbarium specimens.
5. Recording ecological observations.
6. Collection and analysis of field data.
7. Preparation of charts, maps or photographs.
8. Report writing and presentation.

F. Student Responsibilities:

1. Follow environmental ethics during field visits.
2. Avoid damage to natural habitats.
3. Maintain field notebook and records.
4. Work cooperatively in groups.
5. Follow safety measures during fieldwork.
6. Submit project report within scheduled time.

G. Role of Teacher/Supervisor:

1. Guide students in topic selection and methodology.
2. Monitor field activities and progress.
3. Assist in identification and data interpretation.
4. Evaluate reports and presentations.

H. Evaluation Criteria:

Component	Marks (%)
Field Work and Participation	30%
Data Collection and Analysis	25%
Project Report compilation	25%
Presentation / Viva Voce	20%

Guidelines for Community Engagement Program (CEP) in Botany

A. Purpose of Community Engagement:

Community engagement programs connect students with society through activities related to environmental conservation, sustainable agriculture, medicinal plants, biodiversity awareness and green initiatives.

B. Objectives of Community Engagement Program:

1. To create environmental awareness among the community.
2. To promote sustainable use of plant resources.
3. To encourage social responsibility among students.
4. To apply botanical knowledge for community welfare.
5. To develop communication and leadership skills.

C. Expected Outcomes:

After completion of the program, students will be able to:

1. Apply botanical knowledge for social and environmental benefit.
2. Demonstrate leadership and communication skills.
3. Promote environmental sustainability practices.
4. Develop awareness about conservation of plant resources.
5. Strengthen community participation in green initiatives.

D. Suggested Community Engagement Activities: Students may organize or participate in:

- Tree plantation drives
- Herbal garden establishment
- Medicinal plant awareness campaigns
- Kitchen garden promotion
- Organic farming awareness
- Biodiversity conservation programs
- Plastic-free and green campus campaigns
- Pollinator conservation awareness
- Seed collection and distribution programs
- Water conservation awareness
- Vermicomposting demonstrations
- Awareness on invasive weeds
- Farmer interaction programs
- School awareness activities on plants and environment

E. Implementation Guidelines:

1. Identify community needs and suitable activity.
2. Coordinate with local bodies, NGOs or schools.
3. Prepare activity plan and schedule.
4. Conduct awareness programs using posters, demonstrations and lectures.
5. Encourage community participation.
6. Maintain documentation and feedback records.

F. Student Responsibilities:

1. Participate actively and responsibly.
2. Maintain discipline and teamwork.
3. Respect local culture and community practices.
4. Use eco-friendly materials and practices.
5. Submit activity report with photographs and outcomes.

G. Role of Faculty Coordinator:

1. Guide students in planning and execution.
2. Coordinate with community organizations.
3. Monitor student participation and impact.
4. Evaluate reports and outcomes.

H. Evaluation Criteria:

Component	Marks (%)
Participation and Teamwork	30%
Planning and Execution	25%
Community Interaction	20%
Report and Documentation	25%

SEMESTER - VI

CREDIT FRAMEWORK FOR T.Y.B.Sc. BOTANY, SEMESTER – VI (Level 5.5 / 300)

COURSE DETAILS	COURSE CODE	COURSE TITLE	CREDITS
Vertical – 1 (V1)			
Major Core Courses – (4 T + 2 P) x 2 C = 12 C	BOT-351-MJ-T	Taxonomy of Phanerogams	2 C
	BOT-352-MJ-T	Genetics	2 C
	BOT-353-MJ-T	Plant Pathology and Protection	2 C
	BOT-354-MJ-T	Biochemistry	2 C
	BOT-355-MJ-P	Practical Based on BOT-351-MJ-T and BOT-352-MJ-T	2 C
	BOT-356-MJ-P	Practical Based on BOT-353-MJ-T and BOT-354-MJ-T	2 C
Major Elective Courses – (1 T + 1 P) x 2C = 4 C (Any one from basket)	BOT-360-MJ-T	Phyto-clinical Techniques	2 C
	BOT-361-MJ-T	Agricultural Business Management	
	BOT-362-MJ-T	Botany in relation to Apiculture and Sericulture	
	BOT-363-MJ-P	Practical Based on BOT-360-MJ-T	2 C
	BOT-364-MJ-P	Practical Based on BOT-361-MJ-T	
	BOT-365-MJ-P	Practical Based on BOT-362-MJ-T	
Vertical – 2 (V2)			
Minor Courses – (0 C)	-----		0 C
Vertical – 3 (V3)			
GE / OE - (0 C)	-----	-----	0 C
Vertical – 4 (V4)			
Vocational Skill Courses (VSC) – (1 T/ P = 2 C) (Any one from basket)	VSC-371-BOT-P	Advances in Fermentation Technology	2 C
	VSC-372-BOT-P	Commercial Mushroom and SCP Production Technology	
	VSC-373-BOT-P	Millets for Sustainable Human Welfare	
SEC – (0 C)	-----	-----	0 C
Vertical – 5 (V5)			
IKS - (0 C)	-----	-----	0 C
AEC – (0 C)	-----	-----	0 C
VEC – (0 C)	-----	-----	0 C
Vertical – 6 (V6)			
OJT – (4 C)	BOT-381-OJT	On Job Training (OJT) in Botany	4 C
CC – (0 C)	-----	-----	0 C
Total Credits (V1+V2+V3+V4+V5+V6)			22 C
Total Credits for TYBSC - Semester V (22 C) + Semester VI (22 C)			44 C

SEMESTER - VI

COURSE DETAILS	COURSE CODE	COURSE TITLE	CREDITS
Vertical - 1 (V1)			
Major Core Courses – (4 T + 2 P) x 2 C = 12 C	BOT-351-MJ-T	Taxonomy of Phanerogams	2 C
	BOT-352-MJ-T	Genetics	2 C
	BOT-353-MJ-T	Plant Pathology and Protection	2 C
	BOT-354-MJ-T	Biochemistry	2 C
	BOT-355-MJ-P	Practical Based on BOT-351-MJ-T and BOT-352-MJ-T	2 C
	BOT-356-MJ-P	Practical Based on BOT-353-MJ-T and BOT-354-MJ-T	2 C

T.Y.B.Sc. Botany [Semester - VI]**Course Category – Major Course (MJ)****Course Code – BOT-351-MJ-T****Course Title: Taxonomy of Phanerogams****[No. of Credits: 2 C]****[No. of Lectures: 30 L]****COURSE OBJECTIVES:**

1. To aware students about the origin of the Phanerogams.
2. To equip students with the knowledge and skills to identify, classify and name Phanerogams.
3. To make students aware about the APG system of classification.
4. To make students aware about the species, speciation and endemism.
5. To make students aware about the basic terminologies and concepts in Phylogeny.
6. To make students aware about the gymnosperms and their recent classification and economic importance

COURSE OUTCOMES (COS):**CO1:** Students will be able to identify and classify the Phanerogams.**CO2:** Students will learn about the systems of classifications for Phanerogams.**CO3:** Students will be able to classify the plants based on external morphology.**CO4:** Students will understand the important terms and concepts in phylogeny.**CO5:** Students will understand the concept of Species, speciation and endemism.

Sr. No.	Topic Details	No. of Lectures
	CREDIT I	15 L
1.	Introduction to Gymnosperms 1.1 General Characteristics 1.2 Outline Classification of Gymnosperms by Chamberlain (1934) 1.3 Recent phylogenetic classification 1.4 Economic Importance	03
2.	Study of life cycle of <i>Pinus</i> 2.1 Distribution, Morphology and Anatomy 2.2 Reproduction, Gametophyte, Sporophyte, Seed structure 2.3 Alternation of generations	04
3.	Study of life cycle of <i>Gnetum</i> 3.1 Distribution, Morphology and Anatomy 3.2 Reproduction, Gametophyte, Sporophyte, Seed structure 3.3 Alternation of generations 3.4 Concept of double fertilization with special reference to <i>Gnetum</i>	04
4.	Origin of angiosperms 4.1 Origin of Angiosperms with reference to time, place and ancestry 4.2 Pseudanthial theory 4.3 Transitional-Combinational Theory	04
	CREDIT II	15 L

5.	Species Concepts, Speciation and Endemism 5.1 Species concept w.r.t. Biological, Taxonomic and Phylogenetic Species 5.2 Speciation - Allopatric, Sympatric and Parapatric 5.3 Introduction to Endemism 5.4 Types of endemism - Paleoendemism, Holoendemism and Neoendemism	04
6.	Basic Terms and Concepts of Phylogeny 6.1 Cladistics: Terms and concepts - Primitive and Advanced; Homology and Analogy 6.2 Parallelism and convergence - Monophyly, Paraphyly, Polyphyly, clades and grades 6.3. Methodology of Cladistics, Methods of illustrating evolutionary relationships - phylogenetic tree, cladogram	03
7.	Classification 7.1 Review of Classification systems - Artificial: Linnaeus; Natural: Bentham and Hooker system of classification 7.2 History of APG Classification 7.3 Principles of APG System 7.4 APG IV system of classification: Outline, Merits and Demerits	02
8.	Study of flowering plant families 8.1 Study of following families with reference to systematic position (as per Bentham and Hooker), Diagnostic characters, and any five examples with their economic importance 8.1.1 Brassicaceae and Fabaceae (Papilionaceae) 8.1.2 Asteraceae and Acanthaceae 8.1.3 Nyctaginaceae 8.1.4 Liliaceae and Poaceae	06

REFERENCES:

1. An Introduction to Gymnosperms – Chamberlain, C. J. (1934). *Gymnosperms: Structure and Evolution*.
2. Morphology of Gymnosperms – Sporne, K. R. (1965). *The Morphology of Gymnosperms*. Hutchinson University Library.
3. Plant Systematics – Singh, G. (2019). *Plant Systematics: Theory and Practice*. Oxford & IBH Publishing.
4. Taxonomy of Angiosperms – Singh, V. and Jain, D. K. *Taxonomy of Angiosperms*. Rastogi Publications.
5. An Introduction to Plant Taxonomy – Jeffrey, C. (1982). *An Introduction to Plant Taxonomy*. Cambridge University Press.
6. Plant Taxonomy – Sharma, O. P. *Plant Taxonomy*. Tata McGraw Hill.
7. Plant Systematics – Simpson, M. G. (2019). *Plant Systematics*. Academic Press.
8. The Families of Flowering Plants – Hutchinson, J. *The Families of Flowering Plants*. Oxford University Press.
9. Botany for Degree Gymnosperms – Pandey, B. P. *Botany for Degree Students: Gymnosperms*. S. Chand Publications.

10. Botany for Degree Students Taxonomy of Angiosperms – Pandey, B. P. *Taxonomy of Angiosperms*. S. Chand Publications.
11. Systematic Botany – Sharma, R. N. *Systematic Botany and Economic Botany*.
12. Angiosperm Phylogeny Group – APG IV Classification Reports and Publications.

T. Y. B. Sc. Botany [Semester-VI]
Course Category – Major Core Course (MJ)
Course Code – BOT-352-MJ-T
Course Title: Genetics

[No. of Credits: 2 C]

[No. of Lectures: 30 L]

COURSE OBJECTIVES:

1. To understand fundamental principles of inheritance.
2. To study classical Mendelian genetics and gene interactions.
3. To analyse inheritance patterns using genetic crosses
4. To learn about multiple alleles and special inheritance patterns.
5. To understand applications of genetics in plant science and agriculture.

COURSE OUTCOMES (COS):

- CO1:** Describe and explain the fundamental principles of Mendelian inheritance.
- CO2:** Perform and accurately interpret monohybrid and dihybrid genetic crosses.
- CO3:** Analyse various inheritance patterns, including incomplete dominance, co-dominance, and gene interactions such as epistasis.
- CO4:** Apply probability principles to solve numerical problems involving genetic ratios.
- CO5:** Relate chromosomal behaviour during meiosis to Mendel's laws of inheritance.

Sr. No.	Topic Details	No. of Lectures
	CREDIT I - Mendelian Genetics	15 L
1.	Introduction to Genetics 1.1 History, Concept and Definition 1.2 Genetic Terminologies - Heredity, Inheritance, Variation, Gene, Genome, Allele, Locus, Traits, Genotype, Phenotype, Dominant, Recessive, Codominance, Homozygous, Heterozygous 1.3 Applications of Genetics.	02
2.	Mendelian Genetics - I 2.1 Monohybrid Cross 2.2 Law of Dominance and Law of Segregation 2.3 Incomplete Dominance 2.4 Co-Dominance	03
3.	Mendelian Genetics - II 3.1 Dihybrid Cross 3.2 Law of Independent Assortment 3.3 Back Cross 3.4 Test Cross	04
4.	Neo - Mendelism 4.1 Allelic and non-allelic interactions 4.2 Complementary genes (9:7) 4.3 Epistasis: definition and Concept - Recessive epistasis (9:3:4); Dominant epistasis (12:3:1)	04

	4.4 Inhibitory gene interaction (13:3) 4.5 Duplicate gene interaction (15:1)	
5.	Multiple Alleles 5.1 Introduction, Definition and Concept 5.2 Characteristics of Multiple Alleles 5.3 Self-Incompatibility in <i>Nicotiana</i> 5.4 ABO Blood Group in Humans.	02
	CREDIT II - Inheritance and Mutation	15 L
6.	Cytoplasmic Inheritance 6.1 Introduction, Definition and Concept 6.2 Chloroplast: Variegation in Four O 'Clock Plant 6.3 Mitochondrial Inheritance-Petite mutant in Yeast	02
7.	Quantitative Inheritance 7.1 Introduction, Definition and Concept 7.2 Example: Cob Length in Maize 7.3 Difference between Quantitative and Qualitative Traits	02
8.	Linkage and Crossing Over 8.1 Linkage: Definition and Concept 8.2 Types- Complete and Incomplete Linkage 8.3 Crossing Over: Definition and Concept 8.4 Types- Single and Double Crossing Over 8.5 Gene Mapping, Two point and three point test cross	03
9.	Sex linked Inheritance 9.1 Definition and Concept 9.2 Sex Chromosomes and Autosomes 9.3 Inheritance of X-linked Genes: Color blindness in Humans. 9.4 Inheritance of Y-Linked Genes: Hypertrichosis. 9.5 Sex influenced gene: Definition, Concept and example 9.6 Sex limited gene: Definition, Concept and example	03
10.	Mutation 10.1 Introduction, Definition and Concept 10.2 Types: Spontaneous and Induced Mutations 10.3 Application of mutation in crop improvement 10.4 Structural and Numerical Changes in Chromosomes 10.4.1 Structural Changes in chromosomes: Definition and Types - Deletions, Duplications, Inversions and Translocations. 10.4.2 Numerical changes in chromosomes: Definition and Types - Euploidy: Monoploidy, Diploidy and Polyploidy (Auto and Allopolyploidy); Aneuploidy: Monosomy, Nullisomy, Trisomy, and tetrasomy	05

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5. Phundan Singh Genetics, Kalyani Publications.
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10. Ahluwalia K.B 2005 (First Edition). Genetics. New Age International Private Ltd.Publishers, New Delhi.
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13. Strickberger 2005. (Third Edition). Genetics. Prentice Hall of India Pvt. Ltd, New Delhi.

5.	Fungal Plant Diseases 5.1 Study of Fungal diseases w.r.t. causal organism, signs, symptoms and disease management of – 5.1.1 Red Rot of Sugarcane, 5.1.2 Head smut of Jowar, 5.1.3 Tikka disease of groundnut, 5.1.4 Powdery mildew of cucurbits / grapes.	04
CREDIT II		15 L
6.	Viral Plant Diseases 6.1 Study of Viral diseases w.r.t. causal organism, signs, symptoms and disease management of – 6.1.1 Little Leaf of Brinjal 6.1.2 Tomato leaf curl virus	03
7.	Non parasitic Diseases 7.1 Abiotic factors responsible for injury or disease 7.2 Study of diseases - Black Heart of Potato, Chlorosis in Spinach and Mango Necrosis.	04
8.	Defence strategies 8.1 Defence by plants – Pre-existing and Induced 8.2 Structural and enzymatic defence 8.3 Role of Phenolics, Phytoalexins, and Elicitors	03
9.	Disease Management strategies 9.1 Disease Forecasting 9.2 Cultural, Physical, Biological and Chemical methods 9.3 Role of Fungicides and bactericides in control 9.4 Microbial pesticides 9.5 Integrated Disease Management (IDM)	05

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- Sanjay Kharte, Advanced Mycology and Plant Pathology. Academic Guru Publishing House, 2023.
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T.Y.B.Sc. Botany [Semester - VI]**Course Category –Major Core Course (MJ)****Course Code – BOT-354-MJ-T****Course Title: Biochemistry****[No. of Credits: 2 C]****[No. of Lectures: 30 L]****COURSE OBJECTIVES:**

1. Understand the chemical basis of life.
2. Describe the structure and function of major biomolecules.
3. Explain enzyme action and regulation.
4. Understand basic metabolic pathways.
5. Recognize the biochemical basis of health and disease.

COURSE OUTCOMES (COS):

- C01:** Students will be able to explain the origin of life and basic concepts of biomolecules and biochemistry.
- C02:** Students will learn to describe the structure, properties, and biological importance of water.
- C03:** Students will know classify amino acids and proteins and relate their structure to functions and disorders.
- C04:** Students will understand enzyme structure, mechanism of action, and factors affecting enzyme activity.
- C05:** Students will be able to study nucleic acids and classify carbohydrates and lipids and describe their functions and applications.
- C06:** Students will summarize the roles of vitamins and plant secondary metabolites.

Sr. No.	Topic Details	No. of Lectures
	CREDIT I	15 L
1.	Foundation of Biochemistry 1.1 From molecules to the first cell (origin of a cell) 1.2 Miller and Urey experiment 1.3 Biomolecules of a cell 1.4 Functional groups in biomolecules 1.5 Conformations and configurations of biomolecules 1.6 Scope and importance of Biochemistry in - agriculture, medicine, and biotechnology.	03
2.	Water - The solvent of life 2.1 Physical properties of water 2.2 Structure of water molecule, 2.3 Polarity of water molecule, 2.4 Weak interactions in aqueous solutions	02
3.	Amino acids and Proteins 3.1 Structure, classification, properties and functions of amino acids. 3.2 Structure (primary, secondary, tertiary and quaternary), properties	05

	and functions of proteins 3.3 Biological disorders of amino acid metabolism 3.4 Commercial applications	
4.	Carbohydrates 4.1 Definition, classification and properties of carbohydrates. 4.2 Monosaccharides: Aldoses and Ketoses, basic structure, D and L configuration, and linear and cyclic (ring) forms. 4.3 Oligosaccharides: Formation of glycosidic bonds, reducing and non-reducing sugars with examples such as sucrose, lactose and maltose. 4.4 Polysaccharides: Homopolysaccharides (starch, glycogen, cellulose) and heteropolysaccharides, their basic structures, distribution and biological roles. 4.5 Biological functions and major commercial applications of carbohydrates.	05
	CREDIT II	15 L
5.	Nucleic Acids 5.1 Definition and importance of nucleic acids, 5.2 Structure of nucleotides - nitrogenous base, pentose sugar, phosphate group), 5.3 Types of nucleic acids: DNA and RNA, 5.4 Structure of DNA as per the Watson and Crick, 5.5 Biological functions of nucleic acids.	02
6.	Enzymes 6.1 Definition, nature of enzymes and co-factors, 6.2 Classification and properties of enzymes, active site. 6.3 Mechanism of enzyme action: free energy, activation energy, binding energy, transition state, lock and key hypothesis, induced fit theory. 6.4 Factors affecting enzyme activity: pH, temperature, substrate concentration, enzyme concentration. 6.5 Enzyme inhibition: Competitive, uncompetitive, non-competitive, Reversible and irreversible inhibition, feedback inhibition. 6.6 Enzyme Kinetics: Definition and importance of enzyme kinetics, basic concept of the Michaelis-Menten equation.	06
7.	Lipids 7.1 Definition and classification of lipids: simple, conjugate and derived lipids, 7.2 Properties and functions of lipids. 7.3 Biological disorders of lipid metabolism. 7.4 Commercial applications.	04
8.	Vitamins 8.1 Definition, classification of vitamins 8.2 Source and functions of vitamins 8.3 Secondary metabolites in plants: Alkaloids, terpenoids, phenolics, flavonoids, 8.4 Biological and ecological significance of secondary metabolites	03

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4. Jain, J. L., Jain, S. & Jain, N. (2020) *Fundamentals of Biochemistry*, Revised edition, S. Chand Publishing
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T.Y.B.Sc. Botany [Semester - VI]**Course Category –Major Core Course (MJ)****Course Code – BOT-355-MJ-P****Course Title: Practical Based on BOT-351-MJ-T and BOT-352-MJ-T****[No. of Credits: 2 C]****[No. of Lectures: 60 L]****COURSE OBJECTIVES:**

1. To understand the fundamental principles of inheritance proposed by Gregor Mendel.
2. To study Mendel's laws – Law of Segregation and Law of Independent Assortment through practical experiments.
3. To perform monohybrid and dihybrid crosses using suitable experimental materials (e.g., pea plant traits or simulated data).
4. To analyse phenotypic and genotypic ratios obtained from experimental crosses.
5. To interpret patterns of dominant and recessive inheritance.
6. To develop skills in recording, tabulating, and interpreting genetic data.

COURSE OUTCOMES (COS):**CO1:** Explain the basic concepts of heredity and Mendelian principles.**CO2:** Perform and analyse monohybrid and dihybrid cross experiments.**CO3:** Calculate expected ratios and compare them with observed results.**CO4:** Construct Punnett squares to predict offspring genotypes and phenotypes.**CO5:** Distinguish between dominant and recessive traits.**CO6:** Develop analytical and problem-solving skills in classical genetics.

Sr. No.	Title of the Practical	No. of Practical
	CREDIT I – Practical Based on BOT 351-MJ-T	
1.	Preparation and identification of at least Four herbarium specimens using available resources (Literature, herbaria, e-resources, taxonomic keys) and classify up to family level (according to Bentham and Hooker's System of classification).	1 P
2.	Study of families with reference to systematic position (according to Bentham & Hooker System of Classification) Diagnostic characters, floral formula, floral diagram. (Any-04 including all group) Polypetalae: Brassicaceae and Fabaceae (Papilionaceae) Gamopetalae: Asteraceae and Acanthaceae Monochlamydeae: Nyctaginaceae Monocotyledoneae: Liliaceae and Poaceae	4 P
3.	Study of life cycle of Pinus - Morphology (Long and Dwarf Shoots, Male and Female Cones), Whole mount of Dwarf Shoot, T.S. of Needle, L.S/ T.S. Male Cone, Whole mount Microsporophyll, Whole mount Microspores, L.S Female Cone (Permanent Slide).	1 P
4.	Study of life cycle of Gnetum - Morphology (Long and Dwarf Shoots, Male and Female Cones), T.S. of Stem, L.S/ T.S. Male Cone, Whole mount Microsporophyll, Whole mount Microspores, L.S Female Cone	1 P

	(Permanent Slide).	
5.	Botanical excursion; Preparation and submission of visit report and any ten correctly identified digital herbarium.	1 P
	CREDIT II – Practical Based on BOT 352-MJ-T	
6.	Study of monohybrid and dihybrid crosses with suitable example.	1 P
7.	Study multiple alleles with suitable example.	1 P
8.	Study quantitative inheritance with Cob length in maize.	1 P
9.	Induction of Tetraploidy in Onion Root Tip Cells.	1 P
10.	Study of Multiple Translocation in <i>Rhoeo</i> .	1 P
11.	Study two point test cross with suitable example.	1 P
12.	Study three point test cross with suitable example and construct a gene map.	1 P

T.Y.B.Sc. Botany [Semester - VI]**Course Category –Major Core Course (MJ)****Course Code – BOT-356-MJP****Course Title: Practical Based on BOT-353-MJ-T and BOT-354 MJ-T****[No. of Credits: 2 C]****[No. of Lectures: 60 L]****COURSE OBJECTIVES:**

1. To introduce students to the principles of plant pathology and microbiological techniques used in identification and study of plant diseases.
2. To develop practical skills in preparation of culture media, microbial isolation, inoculation, and culture techniques used in laboratory investigations.
3. To familiarize students with biochemical analysis methods including qualitative and quantitative estimation of biomolecules and enzyme activities.
4. To provide hands-on experience in laboratory techniques such as chromatography, spectrophotometry, and biochemical assays for plant and microbial studies.
5. To enhance observational and analytical skills through field visits, disease identification, and study of molecular biology concepts such as DNA structure.

COURSE OUTCOMES (COS):

CO1: Demonstrate knowledge of plant diseases and apply Koch's postulates for identification of pathogenic organisms.

CO2: Prepare culture media and perform microbial culture techniques including streak plate, pour plate, spread plate, and serial dilution methods.

CO3: Identify and differentiate fungal, bacterial, viral, and non-parasitic plant diseases along with commonly used plant protection chemicals and microbial pesticides.

CO4: Perform qualitative and quantitative biochemical experiments for carbohydrates, proteins, amino acids, lipids, reducing sugars, vitamin C, and enzyme activities using standard laboratory methods.

CO5: Apply analytical techniques such as spectrophotometry, paper chromatography, and molecular model studies to interpret biological and biochemical data effectively.

Sr. No.	Title of the Practical	No. of Practical
CREDIT I – Practical Based on BOT-353-MJ-T		
1.	Study of Koch's postulates using appropriate material.	1 P
2.	Preparation of PDA culture media and inoculation using serial dilution method.	1 P
3.	Culture Technique- Streak Plate method, Pour plate method and Spread plate method	1 P
4.	Study of any two Fungal and Bacterial plant diseases from the theory.	1 P
5.	Study of any two Viral and Non-Parasitic plant diseases as per theory.	1 P
6.	Demonstration: One popular fungicide, One Popular bactericide and One Microbial pesticide.	1 P
7.	Field visit to nearby locality, collection and submission of any 5-plant disease Photographs observed during visit other than the syllabus.	1 P

	CREDIT I – Practical Based on BOT-354-MJ-T	
8.	Qualitative tests for Carbohydrates, Proteins, Amino Acids and Lipids using standard solutions.	1 P
9.	Estimation of total free amino acids by spectrophotometry.	1 P
10.	Demonstrate the activity of catalase and study the effect of pH and enzyme concentration.	1 P
11.	Estimation of soluble proteins by Lowery <i>et. al</i> method.	1 P
12.	Separation of amino acids by paper chromatography.	1 P
13.	Estimation of reducing sugars by DNSA method.	1 P
14.	Estimation of Vitamin C (Ascorbic acid) from plants.	1 P
15.	Study of DNA structure (Watson–Crick model) using charts or molecular models.	1 P

SEMESTER - VI

COURSE DETAILS	COURSE CODE	COURSE TITLE	CREDITS
Vertical - 1 (V1)			
Major Elective Courses – (1 T + 1 P) x 2C = 4 C (Any one from basket)	BOT-360-MJ-T	Phyto-clinical Techniques	2 C
	BOT-361-MJ-T	Agricultural Business Management	
	BOT-362-MJ-T	Botany in relation to Apiculture and Sericulture	
	BOT-363-MJ-P	Practical Based on BOT-360-MJ-T	2 C
	BOT-364-MJ-P	Practical Based on BOT-361-MJ-T	
	BOT-365-MJ-P	Practical Based on BOT-362-MJ-T	

T.Y.B.Sc. Botany [Semester - VI]**Course Category –Major Elective Courses****Course Code –BOT-360-MJ-T****Course Title: Phyto-Clinical Techniques****[No. of Credits: 2 C]****[No. of Lectures: 30 L]****COURSE OBJECTIVES:**

1. To introduce students to the fundamental concepts and scope of Phytochemistry and its clinical applications.
2. To familiarize students with the principles and procedures involved in the collection, processing, and preservation of plant materials for analysis.
3. To provide a comprehensive understanding of various solvent systems and extraction techniques used to isolate bioactive compounds from plants.
4. To enable students to learn different chromatographic and spectroscopic methods for the separation, purification, and characterization of phytoconstituents.
5. To impart knowledge on the techniques used for evaluating the quality, safety, and efficacy of herbal drugs, including pharmacopoeia standards.
6. To develop a foundational understanding of clinical trial phases and regulatory guidelines (like AYUSH, WHO) for herbal product development.

COURSE OUTCOMES (COS):

- CO1:** Explain the fundamental principles of Phytochemistry and the classification of plant-based drugs.
- CO2:** Demonstrate the correct procedures for the collection, drying, preservation, and authentication of plant material for scientific analysis.
- CO3:** Apply appropriate solvent systems and extraction techniques (conventional and modern) to isolate phytoconstituents from plant matrices.
- CO4:** Perform preliminary phytochemical screening to identify the major classes of secondary metabolites present in a given plant extract.
- CO5:** Utilize basic chromatographic (TLC, Column) and spectroscopic (UV-Vis) techniques for the separation, purification, and preliminary characterization of compounds.
- CO6:** Evaluate the quality and purity of herbal drugs by determining pharmacopoeia parameters.

Sr. No.	Topic Details	No. of Lectures
	CREDIT I	15 L
1.	Introduction 1.1 History, scope and importance of medicinal plants in Indian culture. 1.2 Classification of crude drugs - Taxonomical, Morphological, Chemical, and Pharmacological 1.3 Definition and fundamental principles of the major Indigenous Medical Sciences (IMS): Ayurveda, Siddha, Unani and Ethnobotany	02
2.	Indigenous Herbal Formulations (Galenicals) 2.1 Definition and significance of Galenicals in IMS	05

	2.2 Extraction processes in traditional medicine: 2.2.1 Swarasa (Juice) 2.2.2 Kalka (Paste) 2.2.3 Kwatha (Decoction) 2.2.4 Hima (Cold infusion) 2.2.5 Phanta (Hot infusion) 2.2.6 Taila (Medicated oil) 2.2.7 Asava-Arishta (Fermented formulations)	
3.	Collection, Processing, and Preservation of Plant Material 3.1 Good Agricultural and Collection Practices (GACP) 3.2 Authentication of plant material – Organoleptic and Microscopic evaluation 3.3 Protocols for collection - Season, Age, and Time of day. 3.4 Drying methods - Shade drying, Oven drying, and Lyophilisation 3.5 Preservation and storage of raw plant materials	04
4.	Preliminary Phytochemical Screening 4.1 Chemical tests for the identification of major phytoconstituents: 4.1.1 Alkaloids - Dragendorff's, Mayer's, and Wagner's tests, 4.1.2 Glycosides - Legal's and Baljet's tests 4.1.3 Terpenoids and Steroids - Salkowski's, and Lieberman Burchard tests 4.1.4 Phenolics and Tannins - Ferric Chloride and Gelatin test 4.1.5 Flavonoids - Shinoda test	04
	CREDIT II	15 L
5.	Quality Control and Standardization of Herbal Drugs 5.1 Importance of standardization 5.2 Parameters for quality control as per WHO and Pharmacopoeia guidelines (e.g., Ayurvedic Pharmacopoeia of India) 5.3 Determination of ash values, extractive values, moisture content, and heavy metal analysis 5.4 Detection of adulteration in herbal drugs	03
6.	Separation and Purification Techniques 6.2 Chromatography: Principle and applications 6.2 Thin Layer Chromatography (TLC): Principle; mobile and stationary phases; preparation of TLC plates; development techniques; detection of spots (R _f value calculation). 6.3 Column Chromatography: Principle, packing methods, elution techniques, and fraction collection. 6.4 Introduction to Paper Chromatography and HPLC (High-Performance Liquid Chromatography).	04
7.	Clinical Applications of Herbal Medicines 7.1 Phytomedicine for Gastrointestinal Health: Review of Formulations and their herbal combinations (e.g., Triphala, Hingwashta kchurna). 7.2 Phytomedicine for Respiratory Health: Herbal remedies for respiratory diseases (Sitopaladi Churna, Trikatu Churna, Kantakari Avaleha)	05

	7.3 Phytomedicine for Antipyretic (Fever): Herbal remedies for Fever and Inflammation (Giloy – <i>Tinospora cordifolia</i> Decoction, Sudarsana Churna / Vati.	
8.	Clinical Techniques and Regulatory Activities 8.1 Introduction to clinical trials: Phases of clinical trials - Preclinical, Phase I, II, III, IV. 8.2 Overview of regulatory guidelines for herbal drugs (AYUSH, WHO, FDA). 8.3 Safety evaluation: Evaluation of safety and efficacy of herbal products.	03

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T.Y.B.Sc. Botany [Semester - VI]**Course Category –Major Elective Course (MJ)****Course Code –BOT-361-MJ-T****Course Title: Agricultural Business Management****[No. of Credits: 2 C]****[No. of Lectures: 30 L]****COURSE OBJECTIVES:**

1. To introduce students to the fundamentals of agribusiness and its role in agriculture.
2. To develop understanding of farm management and agribusiness operations.
3. To familiarize students with marketing, finance, and entrepreneurship in agriculture.
4. To build skills for decision-making in agricultural enterprises.

COURSE OUTCOMES (COS):

After completing the course, students will be able to:

CO1: Understand the structure and functioning of agribusiness systems.

CO2: Apply farm management principles for decision-making.

CO3: Analyze agricultural marketing systems and price behavior.

CO4: Identify financial sources and manage risks in agriculture.

CO5: Develop basic business plans for agribusiness ventures.

CO6: Understand supply chain and value addition in agriculture.

Sr. No.	Topic Details	No. of Lectures
	CREDIT I	15 L
1.	Introduction to Agribusiness 1.1 Concept, scope, and importance of agribusiness 1.2 Components of agribusiness system (input, production, processing, marketing) 1.3 Agribusiness in India: structure and status 1.4 Role of agribusiness in rural development 1.5 Emerging trends in agribusiness	05
2.	Farm Management Principles 2.1 Meaning, objectives, and scope of farm management 2.2 Factors of production (land, labor, capital, management) 2.3 Types of farming systems 2.4 Cost concepts and farm income measures 2.5 Farm planning and budgeting 2.6 Decision-making in farm management	06
3.	Agricultural Marketing 3.1 Concepts and functions of agricultural marketing 3.2 Marketing channels and intermediaries 3.3 Price determination and market structure 3.4 Regulated markets and e-NAM 3.5 Storage, grading, and standardization 3.6 Problems and reforms in agricultural marketing in India	04

	CREDIT II	15 L
4.	Agribusiness Finance and Risk Management 4.1 Importance of finance in agribusiness 4.2 Sources of agricultural finance (institutional and non-institutional) 4.3 Credit planning and repayment 4.4 Risk and uncertainty in agriculture 4.5 Crop insurance and risk management strategies	05
5.	Agripreneurship and Enterprise Development 5.1 Concept of agripreneurship 5.2 Characteristics of successful agripreneurs 5.3 Business plan preparation 5.4 Government schemes for agribusiness development (e.g., PMFME, Agri-startups)	05
6.	Supply Chain and Value Addition 6.1 Concept of supply chain management in agriculture 6.2 Value chain and value addition 6.3 Post-harvest management and processing 6.4 Role of cooperatives and Farmer Producer Organizations (FPOs)	05

REFERENCES:

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2. Subba Reddy, S. et al. – *Agricultural Economics* – Oxford & IBH
3. Acharya, S.S. & Agarwal, N.L. – *Agricultural Marketing in India* – Oxford & IBH
4. Kahlon, A.S. & Tyagi, D.S. – *Agricultural Marketing and Price Policies* – Allied Publishers
5. Pandey, U.K. – *Agricultural Economics* – CBS Publishers
6. Singh, R.K.P. – *Farm Management* – Scientific Publishers
7. Government of India – *Economic Survey (Agriculture Chapter)*
8. NABARD Publications – *Agriculture and Rural Development Reports*
9. FAO – *Agribusiness Handbook Series*
10. ICAR – *Handbook of Agriculture*.

T.Y.B.Sc. Botany [Semester - VI]**Course Category – Major Elective Courses****Course Code – BOT-362-MJ-T****Course Title: Botany in relation to Apiculture and Sericulture****[No. of Credits: 2 C]****[No. of Lectures: 30 L]****COURSE OBJECTIVES:**

1. To provide knowledge of the botanical basis of apiculture and sericulture.
2. To understand bee flora and pollination biology in relation to crop productivity.
3. To study mulberry cultivation and host plant management for silkworm rearing.
4. To develop awareness about economic importance and entrepreneurship opportunities in apiculture and sericulture.
5. To introduce students to sustainable agricultural practices associated with bee and silk industries.

COURSE OUTCOMES (COS):

After successful completion of the course, students will be able to:

C01: Identify important bee flora and host plants used in apiculture and sericulture.

C02: Explain the relationship between plants, pollinators, and crop productivity.

C03: Understand botanical and ecological requirements for beekeeping and silkworm rearing.

C04: Describe cultivation practices of mulberry and other host plants.

C05: Apply basic knowledge for small-scale entrepreneurship in apiculture and sericulture sectors.

Sr. No.	Topic Details	No. of Lectures
	CREDIT I: BOTANY IN RELATION TO APICULTURE	15 L
1.	Introduction to Apiculture 1.1 Definition and scope of apiculture 1.2 Types of Honey bees and their characteristics 1.3 Components and life stages of honeybee colony 1.4 Equipment of beekeeping and requirements to start beekeeping 1.5 Role of bees in agriculture and biodiversity	03
2.	Bee Flora and Pollination Biology 2.1 Definition and characteristics of bee flora 2.2 Nectar and pollen producing plants 2.3 Pollination mechanisms in flowering plants 2.4 Role of bees in cross pollination and crop improvement	03
3.	Botanical Aspects of Honey Production 3.1 Seasonal flowering plants 3.2 Medicinal and commercial plants useful for honey production 3.3 Honey flow and dearth periods 3.4 Factors affecting visit of honeybees to flower 3.4.1 Color of the flowers 3.4.2 Motion of flowers	04

	3.4.3 Quantity and/or quality of pollen and nectar 3.4.5 Day Light 3.4.6 Climate change 3.4.7 Pesticides use 3.4.8 Habitat loss 3.5 Importance of plant diversity in apiculture	
4.	Plant-Bee Interaction and Ecology 4.1 Co-evolution of flowering plants and bees 4.2 Floral adaptations for pollination 4.3 Ecological significance of pollinators 4.4 Conservation of pollinator-friendly plants 4.5 Diseases and enemies of Bees: 4.5.1 Bee diseases – Protozoan, Bacterial, Viral, Fungal – with two examples. 4.5.2 Bee pests – Wax moth (Greater and Lesser), Wax beetle. 4.5.3 Bee Enemies – Bee eater, King crow, Wasp, Lizard, Bear, Man.	03
5.	Bee Products and Economic Botany 5.1 Honey, beeswax, royal jelly, propolis and pollen 5.2 Medicinal and commercial applications of bee products 5.3 Entrepreneurship opportunities in apiculture 5.4 Government schemes and support for beekeeping in agriculture	02
	CREDIT II: BOTANY IN RELATION TO SERICULTURE	15 L
6.	Introduction to Sericulture 6.1 Definition and scope of sericulture 6.2 History and importance of silk industry 6.3 Types of silkworms and silk 6.4 Life cycle of silkworm (<i>Bombyx mori</i>) 6.5 Host plants of silkworms - Mulberry and non-mulberry	03
7.	Mulberry Botany and Cultivation 7.1 Taxonomy and morphology of mulberry (<i>Morus</i> spp.) 7.2 Climatic and soil requirements 7.3 Propagation methods 7.4 Major diseases and pests of mulberry 7.5 Organic and eco-friendly management practices 7.6 Harvesting of mulberry: a) Leaf plucking; b) Branch cutting; c) Whole shoot cutting 7.7 Nutritional importance of mulberry leaves for silkworms 7.8 Importance of healthy host plants in cocoon quality	04
8.	Rearing Techniques and Environmental Conditions 8.1 Introduction, Types of rearing 8.2 Rearing house and equipment 8.3 Temperature, humidity and ventilation requirements 8.4 Feeding of silkworms with mulberry leaves 8.5 Care during larval stages 8.6 Rearing Process: 8.6.1 Brushing and early age rearing	05

	8.6.2 Late age rearing methods 8.6.3 Bed cleaning and spacing 8.6.4 Mounting and cocoon formation 8.7 Preventive hygiene measures 8.8 Disinfection methods	
9.	Economic Botany and Entrepreneurship in Sericulture 9.1 Value-added products from sericulture 9.2 Rural employment opportunities 9.3 Sustainable sericulture practices	03

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2. Caron, D.M. & Connor, L.J. – Honey Bee Biology and Beekeeping.
3. Harizanis, P. – Sericulture Handbook.
4. Ganga, G. & Subchana Chetty, J. – An Introduction to Sericulture.
5. Shukla, G.S. & Upadhyay, V.B. – Economic Zoology.
6. Pandey, B.P. – Economic Botany.
7. Vashishta, P.C. – Botany for Degree Students.
8. Singh, S. – Bee Keeping in India.
9. Krishnaswami, S. – New Technology of Silkworm Rearing.
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11. Singh, S. (1962). Beekeeping in India. Indian Council of Agricultural Research, New Delhi.
12. Rahman, A. & Singh, S. (2014). Beekeeping and Pollination. Scientific Publishers, Jodhpur.
13. Research journals:
 - Journal of Apicultural Research
 - Indian Journal of Sericulture
14. Ganga, G. & Subchana Chetty, J. – An Introduction to Sericulture.
15. Krishnaswami, S. – Silkworm Rearing Manual.
16. Dandin, S.B. et al. – Handbook of Sericulture Technologies.
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T.Y.B.Sc. Botany [Semester - VI]**Course Category – Major Elective Courses****Course Code – BOT-363-MJ-P****Course Title: Practical Based on BOT-360-MJ-T****[No. of Credits: 2 C]****[No. of Lectures: 60 L]****COURSE OBJECTIVES:**

1. To provide hands-on training in the authentication of crude plant drugs using organoleptic and microscopic methods.
2. To develop skills in the preparation of traditional herbal formulations (Galenicals) as per classical texts.
3. To enable students to perform preliminary phytochemical screening for the identification of major secondary metabolites.
4. To impart practical knowledge of chromatographic techniques (TLC, Column) for the separation and purification of plant constituents.
5. To train students in the determination of pharmacopoeial quality control parameters for the evaluation of herbal drugs.

Course Outcomes (COs):

- CO1:** Authenticate and evaluate the quality of crude plant drugs based on organoleptic and physical parameters.
- CO2:** Prepare various traditional herbal formulations and demonstrate an understanding of their significance.
- CO3:** Perform systematic phytochemical analysis to identify the presence of alkaloids, glycosides, flavonoids, and other secondary metabolites in a given plant sample.
- CO4:** Apply thin-layer and column chromatography for the separation and partial purification of phytoconstituents.
- CO5:** Determine key quality control parameters like ash values, extractive values, and Rf values to assess the purity and standard of herbal materials.

Sr. No.	Title of the Practical	No. of Practical
1.	Collection, authentication, and evaluation of crude drugs based on organoleptic characters (color, odor, taste, and texture).	1 P
2.	Determination of physico-chemical parameters of any two crude drugs – Ash values (Acid-insoluble, Water-soluble ash).	2 P
3.	Preparation of Swarasa (juice) and Kalka (paste) from fresh plant material (e.g., <i>Adhatoda vasica</i> , <i>Tinospora cordifolia</i>).	1 P
4.	Preparation of Kwatha (decoction) and Phanta (hot infusion) from coarse plant powders (e.g., <i>Zingiber officinale</i> , <i>Terminalia chebula</i>).	1 P
5.	Demonstration of Soxhlet extraction and Cold Maceration techniques.	1 P
6.	Preliminary Phytochemical Screening for Alkaloids (Mayer's, Dragendorff's, Wagner's tests); Glycosides (Legal's test); Terpenoids and Steroids (Salkowski's test); Phenolics/Tannins (FeCl ₃ test); Flavonoids (Shinoda test); and Carbohydrates.	2 P

7.	Histochemical analysis of crude drugs.	1 P
8.	Determination of extractive values (Alcohol-soluble, Water-soluble) and loss on drying (moisture content).	1 P
9.	Study of powder microscopy of a crude drug (e.g., Senna leaf, Cinnamon bark) to detect adulterants/characters.	1 P
10.	Study of the behaviour of crude drug powders (e.g., <i>Curcuma longa</i> , <i>Withania somnifera</i>) under UV and ordinary light after treatment with different reagents.	2 P
11.	Botanical Excursion / Field Report: Collection, identification, and submission of a brief report on 5 locally available medicinal plants with details on their clinical uses and submission of botanical excursion report.	2 P

T.Y.B.Sc. Botany [Semester - VI]**Course Category – Major Elective Courses****Course Code – BOT-364-MJ-P****Course Title: Practical Based on BOT-361-MJ-T****[No. of Credits: 2 C]****[No. of Lectures: 60 L]****COURSE OBJECTIVES:**

1. To understand the different components of the agribusiness system.
2. To study farm management, cost of cultivation and farm income measures.
3. To learn basic budgeting and farm planning techniques.
4. To understand agricultural marketing, grading, and standardization practices.
5. To develop knowledge of agricultural finance, insurance, and agribusiness planning.

Course Outcomes (COs):**CO1:** Students will identify and classify different agribusiness enterprises.**CO2:** Students will calculate cost of cultivation and farm income measures.**CO3:** Students will prepare simple farm plans and partial budgets.**CO4:** Students will analyse agricultural marketing channels and price spread.**CO5:** Students will prepare basic business plans for agribusiness enterprises.

Sr. No.	Title of the Practical	No. of Practical
1.	To study different components of agribusiness system (input, production, processing, marketing).	1 P
2.	To identify various agribusiness enterprises in the local area and classify them.	1 P
3.	To study the structure and functioning of an agribusiness firm (case study method).	1 P
4.	To study factors of production in a farm (land, labor, capital, management).	1 P
5.	To calculate cost of cultivation of a selected crop.	1 P
6.	To estimate different farm income measures (gross income, net income, family labor income).	1 P
7.	To prepare a simple farm plan for a small farm.	1 P
8.	To perform partial budgeting for farm decision-making.	1 P
9.	To study marketing channels for major agricultural commodities.	1 P
10.	To analyze price spread of a selected commodity.	1 P
11.	To visit a regulated market / APMC and study its functioning...	1P
12.	To study grading and standardization practices of agricultural produce.	1 P
13.	To identify sources of agricultural finance in the locality (banks, cooperatives, SHGs).	1 P
14.	To study crop insurance schemes and calculate premium/claims (case example).	1 P
15.	To prepare a simple business plan for an agribusiness enterprise (e.g., nursery, dairy, food processing unit).	1 P

T.Y.B.Sc. Botany [Semester - VI]**Course Category – Major Elective Courses****Course Code – BOT-365-MJ-P****Course Title: Practical Based on BOT-362-MJ-T****[No. of Credits: 2 C]****[No. of Lectures: 60 L]****COURSE OBJECTIVES:**

1. To provide hands-on knowledge of important bee flora and silkworm host plants.
2. To develop practical skills in identification of nectar, pollen and mulberry plants.
3. To understand basic techniques used in apiculture and sericulture practices.
4. To familiarize students with pollination biology and plant–insect interactions.
5. To impart knowledge about cultivation and management of host plants used in sericulture.
6. To encourage field-based learning and entrepreneurship awareness in apiculture and sericulture sectors.

COURSE OUTCOMES (COS):

After successful completion of the practical course, students will be able to:

C01: Identify economically important bee forage plants and silkworm host plants.

C02: Demonstrate basic practical skills related to beekeeping and silkworm rearing.

C03: Examine floral characteristics associated with pollination by bees.

C04: Perform basic cultivation and propagation techniques of mulberry plants.

C05: Recognize common pests and diseases affecting bee flora and mulberry plants.

C06: Prepare herbarium specimens and maintain field observation records.

C07: Understand the role of plants in enhancing honey and silk production.

C08: Apply practical knowledge for small-scale income generation and sustainable agricultural practices.

Sr. No.	Title of the Practical	No. of Practical
CREDIT I: PRACTICAL'S BASED ON APICULTURE		
1.	To visit botanical garden and enlist the flowering plants with distinguishing characters.	1 P
2.	To survey honey bee colonies in the college campus and create geo-tag photo album.	1 P
3.	To study external morphology of worker bee.	1 P
4.	To study equipment used in beekeeping.	1 P
5.	To study bee products - Honey, Wax, Royal jelly, Propolis, Venom.	1 P
6.	To estimate the protein concentration in the pollen grain by Lowry's method.	1 P
7.	Observation of the natural honey under microscope.	1 P
8.	Awareness rally in any one village regarding importance of Honeybees.	1 P
9.	Visit to the local commercial apiary.	1 P

CREDIT II: PRACTICAL BASED ON SERICULTURE		
10.	Study of morphology of mulberry plant (<i>Morus</i> spp.).	1 P
11.	Propagation of mulberry by stem cutting method.	1 P
12.	Observation of life cycle stages of silkworm (<i>Bombyx mori</i>).	1 P
13.	Demonstration of mulberry leaf harvesting techniques.	1 P
14.	Study of common pests and diseases of mulberry plants.	1 P
15.	Visit to a sericulture farm or silk rearing unit and preparation of field report.	1 P

SEMESTER - VI

COURSE DETAILS	COURSE CODE	COURSE TITLE	CREDITS
Vertical - 4 (V4)			
Vocational Skill Courses (VSC) - (1 T/ P = 2 C) (Any one from basket)	VSC-371-BOT-P	Advances in Fermentation Technology	2 C
	VSC-372-BOT-P	Commercial Mushroom and SCP Production Technology	
	VSC-373-BOT-P	Millets for Sustainable Human Welfare	

T.Y.B.Sc. Botany [Semester - VI]**Course Category – Vocational Skill Courses (VSC)****Course Code – VSC-371-BOT-P****Course Title: Advances in Fermentation Technology****[No. of Credits: 2 C]****[No. of Lectures: 60 L]****COURSE OBJECTIVES:**

1. To Understand the Concept and Steps in Fermentation Technology
2. To Inculcate the techniques used for the preparation of Culture Media
3. To prepare the fermented products like Fruit wine, Vinegar, Malt, Citric Acid etc.
4. To identify soil micro-flora and the beneficial microorganisms existing in the soil
5. Nurture the Students to Boost confidence regarding handling of microorganisms

COURSE OUTCOMES (COS):

- CO1:** Students will be able to understand the importance of precautions and safety aids to be taken during performing the fermentation practical.
- CO2:** Students will gain the practical knowledge of the use of starter cultures related to fermentation.
- CO3:** Students will demonstrate competence in microbial processes involved in Fermentation.
- CO4:** Students will understand concepts of Wine, Malt, Vinegar and Citric Acid production.
- CO5:** Students will analyze the actual microbial processes involved in fermentation.
- CO6:** Students will be capable of preparing an Industrial Visit Report in order to understand Scaling up, Hygiene safety and principle of Large Bioreactors.

Sr. No	Title of the Practical	No. of Practical
1.	Laboratory Safety precautions during handling of various instruments and chemicals related to fermentation – Any Five (Autoclave, Laminar Air Flow, Hot Air Oven, Microwave Oven, Fumigation, Sterilization)	1 P
2.	Preparation of any one Culture medium (Potato Dextrose Agar for – Fungi and Nutrient Agar Medium for Bacteria) and inoculation of any one suitable microorganism.	1 P
3.	Preparation of Starter Yeast (Baker's/Brewer's Yeast) medium for the fermentation of Wine and Bread.	1 P
4.	Preparation of Fermented Product - Fruit Wine / Arishta / Kanji / Bread / Idli) from the suitable material.	1 P
5.	Demonstration of Fermented products with respect to Microorganism, and its industrial Applications - Bread, Idli, Vinegar, Fruit Wine, Penicillin, Citric Acid, Rectified Spirit, Asava, and Arishta	1 P
6.	Preparation of Malt using suitable plant material – Wheat / Barley / Oats grains.	2 P
7.	Preparation of Vinegar from any one available fruit – Apple / Plums / Pineapple / Mango / Oranges and Paper chromatographic study of acetic acid formed during the fermentation process.	2 P
8.	Qualitative chemical tests for detection of Organic Acids, Tannins, Flavanoids,	1 P

	Lactic Acid and Carbon dioxide present in the fermented products - Citric Acid, Drakshasava, Butter Milk, Idli Base and Vinegar.	
9.	Isolation of Soil-micro flora from the soil sample using serial dilution technique for development of cultures (Use Potato Dextrose Agar and obtain culture of any five microorganisms).	1 P
10.	Preparation of Effective Microorganisms Starter from the standard EM-1 solution.	1 P
11.	Demonstration Practical – Identify the microorganisms with the help of permanent slides with respect to its industrial applications - Any Five (<i>Saccharomyces cerevisiae</i> , <i>Aspergillus niger</i> , <i>Penicillium notatum</i> , <i>Lactobacillus</i> spp, <i>Streptococcus</i> spp, <i>Trichoderma</i> spp)	1 P
12.	Visit to Wine Industry / Sugarcane Industry Alcohol Plant / Any Relevant Fermentation Industry in nearby area.	2 P

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12. Caroline Gilmartin 2024. The Complete Guide to Making Your Own Vinegar. Crossword Press Ltd ISBN-13: 978-0719843662.
13. John Mallett 2014 – A Practical Guide From Field to Brew House. Brewers Publications ISBN-13: 978-1938469121.
14. Robert Miguel Rodriguez 2023 How to Make Fruit Wines. ISBN-13: 979-8223196105

T.Y.B.Sc. Botany [Semester - VI]**Course Category – Vocational Skill Courses (VSC)****Course Code – VSC-372-BOT-P**

Course Title: Commercial Mushroom and SCP Production Technology
[No. of Credits: 2 C] [No. of Lectures: 60 L]

COURSE OBJECTIVES:

1. To understand the basic biology, cultivation methods, and economic importance of commercial mushrooms.
2. To develop practical skills in pure culture preparation, spawn production, and crop management of mushrooms.
3. To study processing, preservation, value addition, and marketing of mushroom products.
4. To learn the principles and laboratory cultivation of microorganisms used for Single Cell Protein (SCP) production.
5. To understand the nutritional, environmental, and economic significance of SCP in food and feed industries.

COURSE OUTCOMES (COS):

After completion of the course, students will be able to:

C01: Explain the biology, cultivation techniques, and importance of commercial mushrooms.

C02: Perform laboratory techniques such as media preparation, pure culture maintenance, and spawn production.

C03: Apply methods of mushroom cultivation, harvesting, processing, and value addition.

C04: Demonstrate laboratory-scale production and harvesting of Single Cell Protein.

C05: Evaluate the nutritional value and economic potential of mushroom and SCP production.

Sr No.	Title of the Practical	No. of Practical
CREDIT- I: Commercial Mushroom Technology		
1.	Study of types of mushrooms- Edible, medicinal, and poisonous mushroom with two suitable examples.	1 P
2.	Study of infrastructure required for commercial mushroom cultivation and cost assessment for mushroom project.	1 P
3.	Preparation of Potato Dextrose Agar (PDA) medium and production, incubation of master culture of Button/ Milky mushroom.	2 P
4.	Preparation of Grain spawn for button /Milky Mushroom and identification of spoilage.	1 P
5.	Demonstration of <i>Agaricus bisporus</i> (Button Mushroom) cultivation.	1 P
6.	Cultivation of <i>Calocybe indica</i> (Milky Mushroom) mushroom - Preparation of bed from suitable agriculture waste (cleaning, sterilization, bagging etc.) and inoculation of spawn on to the bed	2 P
CREDIT II: Single Cell Protein (SCP) Production		
7.	Study of requirements for commercial <i>Yeast / Spirulina</i> production.	1 P
8.	Isolation of <i>Yeast / Spirulina</i> for SCP production.	1 P
9.	Laboratory-scale production and growth monitoring of <i>Yeast / Spirulina</i>	2 P

10.	SCP biomass harvesting and drying techniques.	1 P
11.	Economic assessment of commercial SCP production and value-added product from spirulina and yeast	1 P
12.	Educational visit to mushroom farm /SCP production unit with report submission.	1 P

REFERENCES:

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T.Y.B.Sc. Botany [Semester - VI]**Course Category – Vocational Skill Courses (VSC)****Course Code – VSC-373-BOT-P****Course Title: Millets for Sustainable Human Welfare****[No. of Credits: 2 C]****[No. of Lectures: 60 L]****COURSE OBJECTIVES:**

1. To understand the nutritional importance and health benefits of millets.
2. To develop practical skills in preparation of millet-based food products.
3. To learn value addition techniques using different millet grains.
4. To promote the use of multigrain and millet foods for healthy diets.
5. To develop knowledge of identification and collection of different millet samples.

COURSE OUTCOMES (COS):**C01:** Students will identify major millets and explain their nutritional value.**C02:** Students will prepare different millet-based food products successfully.**C03:** Students will apply value addition techniques in millet processing.**C04:** Students will understand the role of millets in nutrition and health promotion.**C05:** Students will collect, preserve, and submit different millet samples properly.

Sr. No.	Title of the Practical	No. of Practical
1.	To Demonstrate major millets, nutritive values and benefits.	1 P
2.	Hands on training on preparation of millet bread.	1 P
3.	Hands on training on preparation of millet cookies.	1 P
4.	Hands on training on preparation of flaked jowar.	1 P
5.	Hands on training on preparation of germinated ragi/multigrain drink.	1 P
6.	Hands on training on preparation of multigrain pasta.	1 P
7.	Hands on training on preparation of multigrain halwa.	1 P
8.	Hands on training on preparation of millet based upma.	1 P
9.	Hands on training on preparation of millet pappad.	1 P
10.	Hands on training on preparation of Rajgira ladoo.	1 P
11.	Hands on training on preparation of millet (Ragi) roti.	1 P
12.	Hands on training on preparation of millet muffins.	1 P
13.	Hands on training on preparation of millet noodles.	1 P
14.	Hands on training on preparation of millet Shankarpali (Sweet Diamond Cuts).	1 P
15.	Collection and submission of millet samples 50 grams each (Any Ten).	1 P

SEMESTER - VI

COURSE DETAILS	COURSE CODE	COURSE TITLE	CREDITS
Vertical - 6 (V6)			
OJT - (4 C)	BOT-381-OJT	On Job Training (OJT) in Botany	4 C

T.Y.B.Sc. Botany [Semester - VI]**Course Category – On Job Training (OJT)****Course Code – BOT-381-OJT****Course Title: On Job Training (OJT) in Botany****[No. of Credits: 4 C]****[No. of Lectures: 120 L]****Guidelines for On-Job Training (OJT) in Botany****A. Purpose of On-Job Training:**

On-Job Training (OJT) provides students with practical exposure to real working environments related to botany, plant sciences, agriculture, biotechnology, horticulture, forestry, environmental science, seed technology, apiculture, sericulture and allied industries. It helps students develop technical skills, professional ethics and employability.

B. Objectives of OJT:

1. To provide practical exposure in botanical and plant science fields.
2. To bridge the gap between theoretical knowledge and practical application.
3. To develop technical, analytical and communication skills.
4. To familiarize students with laboratory, field and industrial practices.
5. To encourage problem-solving ability and professional work culture.
6. To create awareness about entrepreneurship and career opportunities in botany.

C. Expected Learning Outcomes:

After completion of OJT, students will be able to:

1. Apply botanical knowledge in practical situations.
2. Demonstrate basic laboratory and field skills.
3. Identify plants, pests and diseases effectively.
4. Maintain scientific records and reports.
5. Work independently and in teams.
6. Understand industrial and research practices in botany.
7. Explore employment and entrepreneurship opportunities in plant sciences.

D. Duration of Training:

- Minimum duration: **4–6 weeks** (as per institutional guidelines)
- Recommended hours: **120 hours**

E. Areas for OJT in Botany: Students may undergo training in:

- Botanical gardens
- Plant nurseries
- Seed industries
- Agricultural farms
- Tissue culture laboratories
- Herbal gardens
- Forestry departments
- Environmental consultancy units

- Sericulture and apiculture centers
- Plant pathology laboratories
- Floriculture units
- Biotechnology industries
- Research institutions and universities
- NGOs working in biodiversity conservation

F. Activities to be performed during OJT:**1. Laboratory-Based Activities:**

- Preparation of slides and specimens
- Herbarium techniques
- Plant tissue culture practices
- Seed testing and germination analysis
- Plant disease identification
- Soil and water analysis

2. Field-Based Activities:

- Plant identification and classification
- Nursery management
- Plantation techniques
- Biodiversity surveys
- Pollination studies
- Pest and disease monitoring
- Organic farming
- Biological control

3. Industry/Extension Activities:

- Production and processing practices
- Quality control procedures
- Packaging and storage
- Farmer interaction and extension activities
- Documentation and record maintenance

G. Student Responsibilities

1. Maintain regular attendance and punctuality.
2. Follow institutional and workplace discipline.
3. Wear proper safety gear wherever necessary.
4. Maintain daily work diary/logbook.
5. Follow safety and ethical guidelines.
6. Respect confidentiality of the organization.
7. Submit training report and presentation after completion.

H. Role of Training Supervisor:

1. Provide orientation and guidance to students.
2. Assign suitable practical tasks.
3. Monitor student performance and attendance.
4. Evaluate technical skills and work ethics.
5. Certify successful completion of training.

I. Evaluation Criteria:

Component	Marks (%)
Attendance and Discipline	20%
Practical Skills	30%
Logbook/Record Maintenance	20%
Training Report	20%
Viva Voce/Presentation	10%

J. Suggested Documentation:

Students should submit:

- Daily logbook
- Attendance certificate
- Training completion certificate
- Final training report
- Photographs of activities (if permitted)
- Presentation/Seminar report
