Savitribai Phule Pune University, Pune

(Formerly, University of Pune)

Two Years Post Graduate Degree Program in Botany

(Faculty of Science & Technology)

Revised Syllabi as per National Education Policy (2020) for

M.Sc. Botany, Part - II

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

To be implemented from

Academic Year 2024-2025

Framed by

BOARD OF STUDIES IN BOTANY

Savitribai Phule Pune University,

Ganeshkhind, Pune -07.

AIMS AND OBJECTIVES

The Board of Studies in Botany, Savitribai Phule Pune University, Pune believes that curriculum designed as per NEP 2020, the employability oriented diversified course content and rigorous as well as critical assessment of educational achievements by the students play complementary roles in shaping their education. The current curriculum revised as per the guidelines of NEP 2020 for the postgraduate programme of Botany (M.Sc. Botany) proposes up-to-date higher education as a combination of subject cored generalized as well as skill oriented specialized education by introducing in-depth learning concepts. The students will achieve lifelong learning goals and become confident enough by illustrating courtesy to the immense world of basic and applied knowledge of plants and introducing them to the methodology of systematic academic enquiry. Students will receive wide exposure to the applied aspects of various branches of botany and its implication for achieving the sustainable goals of the nation.

PROGRAM OUTCOMES (POS)

The curriculum of Post Graduate degree in Botany (M.Sc. Botany) as per the guidelines of NEP-2020 for the affiliated colleges of Savitribai Phule Pune University, Pune is designed to equip the students of Botany with crucial fundamental as well as advanced subject domain knowledge and 21st century technical, practical and communication skills related to plant world in a universal way. Students would be trained and acquire the basic and progressive knowledge from entrepreneurship-based industry oriented thrust areas of plant sciences through the use of distinctive combination of mandatory major core courses with the in-depth exposure of multidisciplinary components of elective courses, research methodology as well as on job trainings / internship and research projects. This upgraded curriculum shall develop educated outcome-oriented candidature, nurtured with discovery, learning, equipped with practice and skills to deal practical problems and competent with recent pedagogical trends in education including e-learning, flipped class and hybrid learning, experiential learning to develop into responsible citizen with their knowledge gained in the field of plant sciences for nation-building and transforming the country to lead the world in the coming future.

After successful completion of the Post Graduate (M.Sc.) Degree program, the students would be able to:

PO1: Attained thoughtful proficiency in the field of plant sciences.

PO2: Acquired ability to perform in multidisciplinary domains.

PO3: Attained ability to exercise intelligence of scientific knowledge for investigation and innovation and sustenance of the world.

PO4: Learnt value based ethical practices and principles and should be committed to professional ethics.

PO5: Incorporated 21st century skill oriented self-directed and life-long learning.

PO6: Obtained ability to inculcate the knowledge of plant science in diverse contexts with global perspective.

PO7: Attained maturity to harness the destiny and responds to one's calling.

PROGRAM SPECIFIC OUTCOMES (PSOS)

PSO1: Recall the diversity, classification, evolution and developmental changes among the plants with reference to lower and higher plant groups and create a knowledge base in understanding the basis of plant diversity, economic values and taxonomy of plants.

PSO2: Understand the advanced concepts of physiology, biochemistry and molecular biology of plants and its implementation for the improvement of crop productivity.

PSO3: Acquire and utilize the skills of post-harvest techniques, landscape designing and various plant processing technologies for developing the economy to the growing world.

PSO4: Know about the importance of Medicinal plants and its useful parts, economically important plants in our daily life and also about the traditional medicines and herbs, and its relevance in modern times.

PSO5: Inculcate the methodology followed in plant breeding, pharmacognosy, herbal drug technology, plant protection, propagation and improvement.

PSO6: Adapt methods of scientific research in plant improvement program and create entrepreneurships, employment to the society.

PSO7: Analyze the impact of scientific and technological advances on the environment and society and understand the importance of biodiversity conservation, green cover development, carbon sequestration and utilize the knowledge for sustainable development.

PSO8: Explore the knowledge of biotic and abiotic stress tolerance, plant microbe interaction and Integrate pest management for making the revolution in the agriculture.

PSO9: Enrich the ability of critical thinking, development of scientific attitude, handling of problems and generating solutions, improve practical skills, and enhance communication skill.

PSO10: Apply the fruitful knowledge of plant sciences and plant resources for the sustainable development, betterment of society and environment by recognizing the ethical values.

PSO11: Becomes competent enough in various analytical and 21st century technical skills related to plant sciences for their exploration.

PSO12: Exhibit the potential to effectively accomplish tasks independently and as a member or leader in diverse teams, and in multidisciplinary settings.

PSO13: Employ critical thinking based problem solving and practical skills pertaining to botanical techniques and computational knowledge and apply strategies for environmental conservation.

PSO14: Demonstrate knowledge and scientific understanding to identify research problems, design experiments, use appropriate methodologies, analyze and interpret data and provide solutions. Exhibit organizational skills and the ability to manage time and resources.

1. Title of the Course: M. Sc. Botany

Syllabus revised 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 M. Sc., Part - I (Semester I and Semester II), from August 2023.
For M. Sc., Part - II (Semester III and Semester IV), from August 2024.

4. Preamble -

Plants produce all types of ecosystems, making them the only supreme foundation for all scientific fields, they are essential to the survival and existence of all other life forms on earth. The study of botany has great potential to help the country achieve its sustainable goals through both basic and applied research. The world's overpopulation of people, combined with the daily growing problems of environmental pollution brought on by unfavourable climatic changes, global warming, and natural disasters, is having an alarming impact on the growth, development, and productivity of food (especially plants).

Botany is the only supreme foundation of all disciplines of sciences, because only the plants being the producers of all kinds of ecosystems are playing pivotal role in survival and existence of all other living things on the earth. Botany subject has tremendous capacity through its exploitation at basic and applied levels to accomplish the sustainable goals of the nation. In the current scenario, the overgrowing human population of the world as against the day-by-day increasing problems of environmental pollution associated with the adverse climatic changes, global warming, natural calamities, are severely affecting the growth, developments and productivity of the produce (especially plants) to alarming levels. Students with backgrounds in the life sciences should be encouraged to pursue higher education in plant sciences, with a focus on creating solutions for sustainable development through the application of the most cutting-edge information, knowledge, and skills of fundamental and applied branches. With this in mind, the curriculum for the M.Sc. in Botany has been created to give students the information and abilities they will need to manage issues relating to the demands and concerns of the human population and the environment. All efforts are made to ensure high standards of education in order to achieve these objectives by putting into practice various measures to improve the teaching-learning process, examination and evaluation techniques, and ensuring that students are developed holistically in accordance with the objectives and standards of National Education Policy 2020. The well-designed M.Sc. Botany curriculum combine a thorough understanding of the subject's essential concepts with an emphasis on disciplines related to advanced agriculture, the plant-based industry, and pharmaceutical companies. This will encourage

and draw students of life sciences to pursue graduate degrees in botany (M.Sc. and Ph.D.) in order to become successful businesspeople, skilled employees, or advanced farmers who can solve societal and environmental problems as a component of sustainable development.

The National Education Policy (NEP-2020), which is being implemented by the Ministry of Higher Education, the Government of India, and the University Grants Commission (UGC), offers opportunities for developing 21st century advanced skills based on the Indian knowledge system through research internships with renowned and esteemed faculty and researchers at their own or other HEIs / research institutes. Additionally, it acknowledges, pinpoints, and nurtures each student's distinct talents in order to support their overall growth and strengthen the country. This will empower Indian youngsters in the field of plant sciences globally and assist the country establish a solid foundation on the global market. Our nation boasts the highest percentage of young people, who, after receiving a top-notch education, have the potential to govern the world in the years to come.

The M.Sc. Botany curriculum provides a comprehensive theoretical and practical knowledge base for solving issues related to plant sciences, including environmental pollution control, biodiversity conservation, green belt and green crediting, carbon sequestration, organic farming, soil health, plant nutrition, plant wealth and plant-based resource management, plant and microorganism interactions, plant pathogens and diseases. Students will be able to stand independently and confidently in the voyage of plant sciences.

5. Eligibility Criteria -

The basic criteria for first year Post Graduate Degree in Botany (M.Sc. Botany, Part - I) admission will be B.Sc. degree with Botany as Major / Principal subject OR B.Sc. degree with Botany as subsidiary subject OR Graduate from any subjects of Life Sciences, Plant Sciences, Biotechnology, Microbiology, Environmental Sciences, Agricultural Sciences and Pharmaceutical Sciences. 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.

A student from other university shall be eligible for admission to Post Graduate degree, who scores minimum 55% marks or B+ Grade in the subject at graduate level with Botany as a principal subject.

The basic criteria for second year Post Graduate Degree in Botany (M.Sc. Botany,

Part - II) admission will be the students, who have completed the first year of Post Graduate Degree (M.Sc. Botany, Part – I) or B.Sc. Honors (04 years) with the Botany as Major or Principal subject.

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

7. Duration of the Course – Total 02 years (Part I and Part II)

8. No. of semesters – Four semesters

Part I – Semester I and II and **Part II** – Semester III and IV

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 is equal to15 clock hours (Teaching 1 hour per week for each credit, 12 hours Actual Teaching + 3 hours Continuous Internal Evaluation – Assignments, Tutorials, Practice, Problem solving sessions, Group discussion, Seminars and Unit Tests.

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

One Credit = 30 clock hours (24 hours' Actual Table work + 6 hours for journal competition, and Continuous Internal Evaluation of each practical).

d. Practical for each course comprises of 02 Credits = 60 clock hours and 04 credits = 120 clock hours.

Therefore,

- Minimum 12 laboratory (for 02 credits)/24 laboratory (for 04 credits) sessions of 04 clock hours must be conducted in one semester.
- 03 clock hours (for 02 credits) /06 clock hours (for 04 credits) will be considered for continuous evaluation.
- In case of short practical, two practical should conduct in one session.
- Each practical of 04 clock hours in the laboratory should consist of Table performance for concerned practical, careful observations, calculation, writing results and conclusion, and submission of practical in written form.
- Pre-laboratory reading and post laboratory assignments should be given on each practical as a part of continuous internal evaluation.

11. Examination Pattern (For each Semester): The examinations will be conducted semester wise for both the Theory as well as Practical courses.

- **Theory Paper of 04 Credits -**
  - Internal Exam (30 M) + University Theory Exam (70 M) = Total 100 M
  - Duration: For Internal exam = 01 hour and for University Exam = 03 hours.

- **Theory Paper of 02 Credits -**
  - Internal Exam (15 M) + University Theory Exam (35 M) = Total 50 M
  - Duration: For Internal exam = 40 Min. and for University Exam = 02 hours.
- **Practical Paper of 2 Credits -**
  - Internal Exam (15 M) + University Practical Exam (35 M) = Total 50 M
  - Duration: For Internal exam = 40 Min. and
    For University Exam = More than 04 hours.
- **Practical Paper of 4 Credits -**
  - Internal Exam (30 M) + University Practical Exam (70 M) = Total 100 M
  - Duration: For Internal exam = 01 hour and
    For University Exam = More than 04 hours.

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

13. ATKT Rules: As per the norms given by SPPU, Pune.

14. Important Note:

a. On Job Training /Internship / Field Project: Every student should go through On Job training OR Internship OR Field Project Work after second semester and submit the Report as the part of evaluation.

b. There shall be at least a short tour (up to 3 days) and a long tour (not exceeding 10 days) per year for all M. Sc. I and M. Sc. II students. The long tour may be arranged to a region out of the state covering various Botanical Regions/ Research Institutes/ Centers and Universities. Tours are the part of curriculum and are 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 has 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.

c. 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 report duly signed by the concerned practical In charge and Head of the Department.
- Any submissions / assignments, etc. based on the practical course.

15. Question paper pattern for 2 Credit courses

- In the University Theory Examination, a student will have to solve the question paper

of 35 marks for the courses of 02 Credits.

- The paper setter should set the paper on entire syllabus for total of 60 marks, including optional questions.
- For 02 Credits course (30 clock hour lectures), paper setter should allot 02 marks per lecture and accordingly, questions should be set for 30 lectures, 60 marks on entire syllabus of the course.

16. Question paper pattern for 4 Credit courses

- In the University Theory Examination, a student will have to solve the question paper of 70 marks for the courses of 04 Credits.
- The paper setter should set the paper on entire syllabus for total of 82 marks, including optional questions.
- For 04 Credits course (60 clock hour lectures), paper setter should allot 04 marks per lecture and accordingly, questions should be set for 60 lectures, 82 marks on entire syllabus of the course.

Question paper pattern

Time: 2 Hours] **[Maximum Marks: 35**

Note: All questions are compulsory.

Que. 1) Answer the following questions. (01 Mark each) **5M**

a)

b)

c)

d)

e)

Que. 2a) Explain in brief any one of the following. **6M**

i.

ii.

Que. 2b) Describe any one of the following. **4M**

i.

ii.

Que. 3a) Explain in brief any one of the following. **6M**

i.

ii.

Que. 3b) Describe any one of the following. **4M**

i.

ii.

Que. 4) Write notes on (Any four, 2.5 marks for each question). **10M**

a.

b.

c.

d.

e.

f.

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Question paper pattern

Time: 2 Hours] **[Maximum Marks: 70**

Note: Instruction to the candidate

1) ***Questtion 1. is compulsory.***
2) ***Attempt any five questions from Q2. to Q7.***
3) ***Q2 to Q7. carry equal marks.***

Que. 1) Solve any five of the following. (02 Mark each) **10M**

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

Que. 2 a) Short Answer Question. **5M**
Que. 2 b) Long Answer Question. **7M**

Que. 3 a) Short Answer Question. **5M**
Que. 3 b) Long Answer Question. **7M**

Que. 4 a) Short Answer Question. **5M**
Que. 4 b) Long Answer Question. **7M**

Que. 5 a) Short Answer Question. **5M**
Que. 5 b) Long Answer Question. **7M**

Que. 6 a) Short Answer Question. **5M**
Que. 6 b) Long Answer Question. **7M**

Que. 7) Write Short notes on (Any 2). **12M**

a.
b.
c.

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CREDIT FRAMEWORK FOR M.Sc. BOTANY, Part – II, SEMESTER – III (Level 6.5)

Course details	Course Type	Course Code	Course Title	Credits
Mandatory Theory Papers (10 C)	Core	BOT 601A MJ	Advanced Taxonomy of Angiosperms - I	4 C
	Core	BOT 601B MJ	Cyto-Genetics and Plant Breeding - I	4 C
	Core	BOT 601C MJ	Plant Physiology – I	4 C
	Core	BOT 601D MJ	Herbal Drug Technology – I	4 C
	Core	BOT 601E MJ	Seed Science and Seed Technology - I	4 C
	Core	BOT 601F MJ	Applied Ecology and Environment - I	4 C
	Core	BOT 601 G MJ	Advanced Mycology and Plant Pathology - I	4 C
	Core	BOT 602 MJ	Advanced Tools and Techniques in Plant Sciences	4 C
	Core	BOT 603 MJ	Intellectual Property Rights (IPR)	2 C
Mandatory Practical Papers (4C)	Core	BOT 604 MJP	Practical Based on BOT 601 MJ A/B/C/D/E/F/G	4 C
Research Project (4C)	Core	BOT 631 RP	Minor Research Project	4 C
Elective Paper (4C = 2T + 2P)	Elective Theory (Any One)	BOT 610 MJ	Advanced Horticultural Techniques	2 C
		BOT 611 MJ	Nursery and PTC Techniques	
	Elective Practical (Only One)	BOT 612 MJP	Practical Based on BOT 610 MJ	2 C
		BOT 613 MJP	Practical Based on BOT 611 MJ	

CREDIT FRAMEWORK FOR M.Sc. BOTANY, Part – II, SEMESTER – IV (Level 6.5)

Course details	Course Type	Course Code	Course Title	Credits
Mandatory Theory Papers (08 C)	Core	BOT 651A MJ	Advanced Taxonomy of Angiosperms - II	4 C
	Core	BOT 651B MJ	Cyto-Genetics and Plant Breeding - II	4 C
	Core	BOT 651C MJ	Plant Physiology – II	4 C
	Core	BOT 651D MJ	Herbal Drug Technology - II	4 C
	Core	BOT 651E MJ	Seed Science and Seed Technology - II	4 C
	Core	BOT 651F MJ	Applied Ecology and Environment - II	4 C
	Core	BOT 651 G MJ	Advanced Mycology and Plant Pathology - II	4 C
	Core	BOT 652 MJ	Bioinformatics and Bio-Statistics	4 C
Mandatory Practical Papers (4C)	Core	BOT 653 MJP	Practical Based on bot 651 MJ A/B/C/D/E/F/G	4 C
Research Project (6C)	Core	BOT 681 RP	Major Research Project	6 C
Elective Paper (4C = 2T + 2P)	Elective Theory (Any One)	BOT 660 MJ	Organic Farming and Soil Health Technology	2 C
		BOT 661 MJ	Green Nano-Technology	
		BOT 662 MJ	Mushroom Cultivation Technology	
	Elective Practical (Any One)	BOT 663 MJP	Practical Based on BOT 660 MJ	2 C
		BOT 664 MJP	Practical Based on BOT 661 MJ	
		BOT 665 MJP	Practical Based on BOT 662 MJ	

Syllabus for M. Sc. Botany, Part- II

Semester – III

As Per National Education Policy (2020)

National Education Policy 2020

M.Sc. Botany, Part - II (Semester - III)

Mandatory Major Core Theory Course

Course Code – BOT 601A MJ

Title of the Course: ADVANCED TAXONOMY OF ANGIOSPERMS - I

[No. of Credits: 4 Credit] **[Total 60 Lectures]**

Course objectives:

1. To study scope and importance of classification in Angiosperms.
2. To study primitive and advanced groups of Angiosperms.
3. To study taxonomic structure of Angiosperms.
4. To study different system of classification

Course outcomes:

1. Students are acquainted with the importance of classification in Angiosperms.
2. They will get the knowledge of primitive and advanced groups of Angiosperms.
3. This course helps to make them aware of taxonomic structure of Angiosperms.
4. Different systems of classification will be studied by them.

Credit - 1 **15 L**

Unit-1 : Angiosperm Taxonomy:

Angiosperm: Definition, characteristic features and probable causes of their evolutionary success. Taxonomy: Definition, scope, principles, aims and objectives of taxonomy. History of botanical explorations in Maharashtra.

Unit – 2: Taxonomic literature:

Floras, Monographs, Revisions, Journals, Periodicals, Manuals, Herbarium, Botanical gardens and websites. Taxonomic characters: Heterobathmy, Analytic versus Synthetic characters, Qualitative versus Quantitative characters.

Credit – 2 **15 L**

Unit – 1: Phylogeny of Angiosperms:

Origin of angiosperms, age of angiosperms, molecular dating, monophyletic and polyphyletic origin of angiosperms, possible ancestors and theories (pseudanthium and transitional-combinational). Origin of monocot, basal living angiosperms. Basic evolutionary trends in angiosperms with respect to stamen and carpel. Fossil angiosperms.

Unit -2: Plant speciation:

Plant speciation: Allopatric, sympatric, parapatric, hybrid, apomictic speciation, isolating

mechanism. Species radiations.

Credit – 3 **15 L**

Unit - 1 Developing Classification:

Phenetic versus Phylogenetic systems. Principles of Taxometrics. Cladistic in taxonomy-Phylogenetic terms, Plesiomorphic and apomorphic characters, homology and analogy, parallelism and convergence, monophyly, polyphyly, phylogenetic diagram, numerical taxonomy.

Unit – 2 Phylogenetic classifications:

Criteria used for classifications; brief history of phylogenetic systems of classifications; brief account, outline, merits and demerits of Cronquist's system and Takhtajan's system of classification. Brief history of APG system of classification.

Credit – 4 **15 L**

Unit - 1: Study of plant families:

Distinguishing characters, classification and economic importance of following orders as per Cronquist's system of classification: Piperales, Urticales, Caryophyllales, Malvales, Rosales, Scrophulariales, Hydrocharitales, Pandanales, Commelinales, Zingiberales and Liliales.

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National Education Policy 2020

M.Sc. Botany, Part - II (Semester - III)

Mandatory Major Core Theory Course

Course Code – BOT 601B MJ

Title of the Course: CYTO-GENETICS AND PLANT BREEDING - I

[No. of Credits: 4 Credit] **[Total 60 Lectures]**

Course Objectives:

1. To Study the Scope and Importance of genetics in plant Science.
2. To understand the different impact of chromosomes on the traits.
3. To Apply the basic techniques commonly used in the cytogenetics laboratory.
4. To Identify chromosome variations and abnormalities,

Course Outcome:

1. Explain the organization and complexity chromosome.
2. Understand the nature of chromosomal abnormalities.
3. Know the principle and procedure of breeding in plant science.

Cytogenetics:

Unit-1: Introduction to Cytogenetics **3L**

1.1 Historical background and significance.

1.2 Chromosomal theory of inheritance.

1.3 Applications of cytogenetics and Techniques of cytogenetics

Unit-2: Structural Chromosomal Aberrations- Deletion, Duplication, Inversions and Translocations. **12L**

2.1 Origin, Occurrence, Production and types of Deletion

2.2 Meiosis and Breeding behavior of Deletion.

2.3 Origin, Occurrence and Production of Duplication.

2.4 Crossing over in duplication heterozygotes.

2.5 Duplication in Plant Breeding

2.6 Pericentric and Paracentric Inversions.

2.7 Role of Inversions in Evaluation and Karyotype Reconstruction.

2.8 Natural origin, Occurrence and Artificial induction of Translocations.

2.9 Cytological Behavior of Translocations.

2.10 Variation in chromosome morphology: Isochromosomes, ring chromosomes and Robertsonian translocation.

Unit-3: Numerical Chromosomal Aberrations - Euploidy and Aneuploidy **10L**

3.1 Numerical changes in chromosomes- Euploidy and Aneuploidy,

3.2 Euploidy-Monoploidy, Origin and production, morphology and uses.

3.3 Polyploidy -Concept and Characteristics of polyploids.

3.4 Autopolyploidy- Origin and production, effects of autopolyploidy, uses.

3.5 Allopolyploidy- Concept, synthesized allopolyploidy (wheat and cotton), Evolutionary significance of polyploidy.

3.6 Aneuploidy, Monosomy and nullisomy- origin and cytology, Trisomy in Datura and humans

Unit-4: Apomixis **5L**

4.1 Cytogenetic basis of Apomixis
4.2 Classification and Detection of Apomixis,
4.3 Cytology of Apomicts
4.4 Genetic basis of Apomixis

Plant Breeding

Unit-5: Introduction of Plant Breeding **3L**

5.1 Definition, history of plant breeding,
5.2 Aims and general objective of plant breeding.
5.3 Indian plant breeders and their contribution.
5.4 Plant breeding Major achievements, Future Prospects
5.5 Merits and Demerits of Plant Breeding.

Unit-6: Self incompatibility (SI) **4L**

6.1 Definition and classification.
6.2 Heteromorphic SI and its features, distyly, tristyly.
6.3 Homomorphic SI and its types i.e. gametophytic SI and sporophytic SI, its features.
6.4 Mechanism of SI
6.5 Biochemical basis of SI

Unit-7: Male sterility (MS) **4L**

7.1 Definition and Classification/types.
7.2 Genetic MS.
7.3 Transgenic MS.
7.4 Cytoplasmic MS,
7.5 Cytoplasmic Genetic MS

Unit-8: Plant Breeding- Selection Methods **4L**

8.1 Concept,
8.2 Types of selections- Mass selection, Pure line selection and Clonal selection.
8.3 Advantage and Disadvantages of Selection.
8. 4 Achievements of Selection Breeding

Unit-9: Plant Breeding -Pedigree methods **2L**

9.1 Detailed procedure of pedigree method,
9.2 Its merits, demerits, achievements

Unit-10: Plant Breeding- Bulk method **6L**

10.1Concept of bulk method and its application,
10.2 Procedure of bulk method,
10.3 Merits and demerits

Unit-11: Plant Breeding- Back cross method **5L**

11.1 Definition of backcross and its objective.
11.2 Requirements and applications of backcross method.
11.3 Procedure for transfer of dominant gene Back cross method.
11.4 Procedure for transfer of recessive gene Back Cross Method.
11.5 Merits, demerits and achievements of backcross method

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4. Russel, P.J. 1998. Genetics (Fifth Edition). The Benjamin/Cummings Publishing Company IND., USA.
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7. Sarin C 2004 (Sixth Edition) Genetics. TATA McGraw-Hill Publishing Company Ltd., New Delhi.
8. Ahluwalia K.B 2005 (First Edition). Genetics. New Age International Private Ltd. Publishers, New Delhi.
9. Burus and Bottino 1989. (Sixth Edition). The Science of Genetics. Macmillan Publishing Company, New York (USA).
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14. Verma and Agarwal, Genetics, S. Chand Co, New Delhi.
15. Singh B.D 2004. Genetics. Kalyani Publication, Ludhiana.
16. Gupta P.K Genetics and Cytogenetics, Rastogi Publications.
17. Gupta P. K. Genetics Rastogi Publications.
18. Phundan Singh Genetics, Kalyani Publications.
19. Verma P.S and Agarwal V.K. (2006) Cell Biology, Genetics, Molecular Biology, Evolution, Ecology. S. Chand and Company, New Delhi.
20. Shukla R.S. & Chandel P.S. Cytogenetics, Evolution & Biostatistics. S.Chand Publications.
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M.Sc. Botany, Part - II (Semester - III)

Mandatory Major Core Theory Course

Course Code – BOT 601C MJ

Title of the Course: PLANT PHYSIOLOGY – I

[No. of Credits: 4 Credit] **[Total 60 Lectures]**

Course Objectives:

1. To understand the relation between water and plant
2. To know the mechanism of Photosynthesis and efficiency of food production by plants.
3. To study the physiology behind the flowering and seed development in plants.

Course Outcomes:

1. Understand important water relation of plants with respect to various physiological processes.
2. Student will know the significance of Photosynthesis, Structure and properties of water, Bioenergetics, Nutrient uptake
3. Student will learn about the process of plant growth and their mechanism. Also, will know about the basic principles of plant growth and development, metabolism.
4. Student will know about the flowering and seed physiology.
5. Understand the concepts and applications of photoperiodism and vernalization.

Credit-I	**Structure and properties of water, Bioenergetics, Nutrient uptake**	**15L**
Unit-1	Biological significance of water, Ionization of water, pH, buffers	1L
	Water uptake, transport and transpiration, Stomatal physiology, molecular mechanism and regulation of guard cell, anti-transpirants and their role	2L
	Free energy, changes in free energy during chemical reactions, entropy and enthalpy, high energy compounds, synthesis of ATP, activation energy	3L
	Cation-anion exchange capacity of soil, types of ion transporters, passive and active transport, primary and secondary active transport, Role of membrane potential in ion transport, high and low affinity transporters, Aquaporins	4L
	Nitrogen uptake, assimilation and remobilization of nitrogen in plants, Biological nitrogen fixation by free living and symbiotic organisms, mechanism of nitrogen fixation.	3L
	Introduction to mineral salt absorption- chemical potential of solute- Nernst equation- passive uptake- diffusion, ion exchange-Donnan Equilibrium, mass flow of ions	2L
Credit-II	**Photosynthesis**	**15L**
Unit- II	Photosynthesis– Photosynthetic pigments, organization of photosynthetic electron transport system in thylakoid membranes. Charge separation and electron transport, fluorescence and photochemistry, oxygen evolution, NAPD reduction, Z-scheme	5L
	Reduction of carbon dioxide - RuBPcase and Calvin cycle, photorespiration. CO2 concentrating mechanisms in C4and CAM plants.	4L

	Respiration – Glycolysis, citric acid cycle, pentose phosphate pathway.	6L
	Organization of mitochondrial electron transport system, ATP synthesis.	
	Respiratory control, Anaerobic respiration, Cyanide resistant pathway	
Credit-III	**Plant growth**	**15L**
Unit-3	Structure, biosynthesis metabolism and physiological role of auxins, cytokinins, gibberellins, abscisic acid and ethylene. Tropism,	7L
	Interrelationship between primary and secondary metabolites.	8L
	Biosynthesis and types of Terpenoids, phenolics, alkaloids and pigments.	
	Role of secondary metabolites in plant stress	
Credit-IV	**Flowering and Seed Physiology**	**15L**
Unit-4	Regulation of Photoperiodism, Florigen and phytochrome forms, Cryptochromes, Vernalization	3L
	Mechanism of seed development and different developmental stages	3L
	Synthesis mobilization and accumulation of stored reserves forms and their localization	3L
	Sink drawing ability (SDA) and its relevance in seed growth and development	3L
	Role of plant hormones in seed growth and development and SDA	3L

Reference books:

1. Berg J.M., Tymoczko J.L., Stryrer L. (2002) Biochemistry. 5th Ed. Wlt. Freeman and Company, New York.
2. Buchanan B.B., Gruissem W., Jones R.L. (2000) Biochemistry and Molecular Biology of Plants. IK International, Mumbai.
3. Davis P. J. (Eds.).(2004) Plant Hormones. Kluwer Academic Publishers, Dordrecht, Netherlands.
4. Goodwin T.W., Mercer E.I. (1998) Introduction to Biochemistry. CBS Publishers, New Delhi.
5. Heldt H. W. (2004) Plant Biochemistry. Academic Press, California.
6. Lawlor D.W. (2001) Photosynthesis in C3 and C4 Pathway.3rd Ed. Viva. New Delhi.
7. Nelson David and Cox Michael. (2007) Lehninger Principles of Biochemistry.W.H.Freeman and Company. New York.
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M.Sc. Botany, Part - I (Semester - I)
Mandatory Major Core Theory Course
Course Code – BOT 601D MJ
Title of the Course: HERBAL DRUG TECHNOLOGY-I

[No. of Credits: 4 Credit] **[Total 60 Lectures]**

Course Objectives:

- To understand the different classes of Phyto-constituents, their biosynthetic pathways, their properties, extraction and general process of natural product drug discovery.
- To understand phytochemical fingerprinting and structure elucidation of Phyto-constituents.
- To study and practice of Advances in the cultivation and production of drugs.
- To acquire knowledge of various Phyto-pharmaceuticals and their source, its utilization and medicinal value.
- To gain the knowledge of Drugs of marine origin.

Course Outcomes:

1. Know the different types of plant constituent.
2. Understand the importance, types and properties of Phyto-constituents.
3. Isolate the Phyto-constituent from plant.

Credit- I: **15 L**

1. **Plant drug cultivation**:
   General aspects involved in cultivation of medicinal plants. Scope and limitations of plant drugs cultivation. Factors affecting the cultivation of crude drugs.(I) Exogenous (II) Endogenous factors — 4 L
2. Systemic method of Cultivation and post-harvest technology of medicinal plant, cultivated in India 1) Senna 2) Opium 3) Aswaghandha 4) Ispaghula 5) Turmeric. Conservation of medicinal plants - Ex-situ and In-situ conservation of medicinal plants. — 8 L
3. Diseases management of medicinal plants, Pest management, Use and scope of environment friendly pesticides — 2 L

Credit-II: **15 L**

1. **Methods of investigation of biosynthetic pathways & tracer techniques:** General methods of purification and characterizations with some examples of natural compounds. — 5 L
2. **Phytochemical studies, extraction methods and Chromatography**: General methods, types and principles of extraction. Selection of solvents for extraction and purification of extracts using chromatographic methods including HPLC, HPTLC. — 5 L
3. Study of advanced methods of extractions and isolation with successive and exhaustive extraction and other methods of extraction viz. Super critical fluid extraction, microwave assisted extraction — 5 L

Credit-III: **15 L**

1. **Isolation and analytical profiles of herbal drugs**: Applications of HPTLC & — 7 L

LCMS/GCMS of occurrence, isolation and analytical profile of drugs.

2. **Drug constituents and biosynthetic pathways**: Study of Biosynthesis and isolation of following phytopharmaceuticals containing drugs: a) Flavanoids: Quercetin b) Carotenoids: β-Carotene. c) Alkaloid: Nicotine d) Antibiotics: Tannin- Tannic Acid. 8 L

Credit-IV: 15 L

1. **Adulteration and evaluation of natural products**: Type of adulteration, cause and measures of adulterations, pesticide residues and microbial contamination for evaluation of natural drugs. Detection of heavy metals, pesticide residues, phytotoxins. 10 L
2. **Marine pharmacognosy**: General methods of isolation and purification of marine natural products. Study of some marine toxins with its advantages and disadvantages. 5 L

Recommended Books:

1. Textbook of Pharmacognosy by Trease & Evans.
2. Textbook of Pharmacognosy by Tyler, Brady & Robber.
3. Pharmacognosy by Kokate, Purohit and Gokhale
4. Essential of Pharmacognosy by Dr. S. H. Ansari
5. Pharmacognosy & Phytochemistry by V. D. Rangari
6. Pharmacopeial standards for Ayurvedic Formulation (Council of Research in Indian Medicine & Homeopathy).
7. Mukherjee, P.W. Quality Control of Herbal Drugs: An Approach to Evaluation of Botanicals.
8. Business Horizons Publishers, New Delhi, India, 2002.

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M.Sc. Botany, Part - II (Semester - III)

Mandatory Major Core Theory Course

Course Code – BOT 601E MJ

Title of the Course: SEED SCIENCE & TECHNOLOGY-I

[No. of Credits: 4 Credit] **[Total 60 Lectures]**

Course Objectives:

1. To know the morphological characters of field crops
2. To learn the concept of organic farming
3. To understand the use of botanical, bacterial and fungal pesticides
4. To utilize different methods for weed management

Course Outcomes:

1. Students will be able to identify the field crops
2. The concept of organic farming will be useful for ecofriendly agriculture
3. Botanical, bacterial and fungal pesticides will be useful to produce organic food
4. Use of synthetic herbicides will be avoided
5. Vegetable seed production concept will be helpful for students in seed industries

Credit-I: MORPHOLOGY OF FIELD CROPS		**15L**
Unit-1	Study of Morphological characters of field crops w.r.t. root, stem, leaf, inflorescence, flower, fruit and seed. Cereals: Wheat, Maize Oil Seeds: Groundnut, Sunflower Pulses: Pigeon pea, Horse gram Fiber: Cotton Fruit Vegetable: Brinjal, Chilli Leafy Vegetable: Fenugreek	15L
Credit-II	**ORGANIC FARMING**	**15L**
Unit-2	**Introduction** Definition, Basic concept, Scope and need of Organic farming, History & Development, Advantages & disadvantages Relevance of organic farming to Maharashtra, India, Global agriculture and future prospects and barrier	2L
Unit-3	**Organic Farming in India** Role of Soil in Organic farming Factors affecting plant growth (light, Heat, Water, humidity, pH and nutrition) C:N ratio of good fertile soil Components used for enriching soil fertility: FYM, Slurry, Green Manures, Compost, Bone Meal, Fish Meal, Biofertilizers-Rhizobium, Mycorrhiza, BGA	6L

Unit-4 **Botanical, Bacterial and fungal pesticides** 5L

Definition and concept

Biological control agent and their characteristic

Bacterial, fungal biopesticides and Botanical biopesticides and their preparations

Unit-5 **Weed Management** 2L

Definition, classification and types

Losses due to weeds

Methods of weed management (Cultural, Mechanical, Biological)

Credit-III: BASICS OF VEGETABLE SEED PRODUCTION **15L**

Unit-6 **Unit-I: Introduction to Vegetables** 2L

Definition

Classification of vegetables

1. Based on nature of pollination
2. Based on planting response
3. Based on nature of vegetables
4. Based on breeding systems
5. Based on growing season

History of Vegetable Seed Production

Climatic factors affecting production program

Unit-7 **Principles of Vegetable Seed Production** 4L

Genetic deterioration

Maintenance of genetic purity (Seed Certification, GOT etc.)

Crop rotation

Isolation

Roughing in Seed Crop

Agronomic practices

1. Site Selection
2. Soil and its preparation
3. Manures and Fertilizers
4. Selection of varieties
5. Seed Sowing
6. Nursery
7. Transplanting
8. Irrigation
9. Inter-culture
10. Crop protection-insect pest, diseases
11. Weed Management
12. Harvesting, Threshing, Grading

Unit-8 **Techniques for Hybrid Seed Production in Vegetables** 5L

Concept and criteria for hybrid seed production in vegetables

Types of Crossing

1. Emasculation and pollination
2. Removal of male plants
3. Detasseling

4. Use of self-incompatible lines
5. Use of Male sterile lines
6. Use of gametocides

General procedure for hybrid seed production in vegetables

1. Selection of parents
2. Emasculation
3. Pollen collection
4. Pollination
5. Bagging
6. Tagging
7. Fruit harvesting with few examples
8. Seed Collection with few examples

Unit-9: Release of New Variety 4L

Introduction

Evaluation

1. Station trails
2. Multi-location trails
3. National trails
4. Adoptive trails
5. Minikit trails
6. Trails on disease and insect pest
7. Trails on quality test

Identification of Hybrids

Release and notification

Credit-IV: APPLICATION OF VEGETABLE SEED PRODUCTION 15L

Unit -10: Vegetable seed production w.r.t. land requirement, field inspection, field standards (Isolation, specific requirement, seed standards), Brief cultural practices- Time of sowing, preparation of land, source of seed, seed rate, sowing in nursery (If applicable), fertilizers, spacing, transplanting, Irrigation, crop protection, weed management, roughing, Harvesting Threshing, Seed collection, Seed Yield, variety/hybrid characteristics etc. (Any one from each family) 15L

Family: Malvaceae- Okra

Family: Solanaceae-Tomato

Family: Cruciferae- Cauliflower

Family: Liliaceae- Onion

Family: Fabaceae- Cowpea

Family: Chenopodiaceae- Spinach

Family: Umbeliferae- Coriander

Family: Cucurbitaceae- Cucumber

Family: Compositae- Lettuce

References:

1. Sreenivas Y. S., 2009. Seed Production of Commercial vegetables, Oxford Book, Company, Jaipur, India

2. Khedkar O. P., Singh R.V. Sinsinwar Y. K., and Ved Prakash, 2013. Seed Production Technologyin filed crops, Pointer Publishers, Jaipur
3. Prabhakar Singh, B. S. Asati, 2008. Seed Production Techniques of Vegetables, Astral International (P) Ltd., New Delhi
4. Hand Book of Agricultural safety- Anil Kumar Kaushal, Wisdom Press
5. Botanical Pesticides in Agriculture- Anand Prakash and Jagadishwari Rao, Star Publication
6. Biofertilizers, Biopesticides and Bioinsecticides- S. N. Pandey, Alfa Publication
7. Organic farming and Mycorrhizae in Agriculture-Pravin Chandra Trivedi, IK International
8. Hand book of Biological Control and Horticultural Crops- J. S. Bohra, Agrotech Press
9. Vegetables-B. R. Choudhary, 2014. Kalyani Publishers, New Delhi
10. Handbook of Agriculture- Indian Council of Agricultural Research, New Delhi •
11. Plant breeding-B.D Singh, Kalyani Publishers, New Delhi
12. Essentials of Plant Breeding- Phundan Singh, 2008
13. Experimental Seed Science and Technology -Umarani et. al. 2006., Agrobios, Jodhpur
14. Plant Breeding: Principles and Methods- Phundan Singh, 2009. Kalyani Publishers, New Delhi
15. Seed Technology- Agrawal, 2005. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi
16. Principles of crop production-Reddy, 2008. Kalyani Publishers, New Delhi

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M.Sc. Botany, Part - II (Semester - III)

Mandatory Major Core Theory

Course Course Code – BOT 601F MJ

Title of the Course: APPLIED ECOLOGY & ENVIROMENT

[No. of Credits: 4 Credit] **[Total 60 Lectures]**

Course Objective:

1. To acquire the importance of ecology and resources.
2. To understand the concept of Ecosystem, Population and community.
3. To know the importance of conservation and their types.

Course Outcomes:

1. Comprehend Fundamental Ecological Principle.
2. Analyze Population and Community Ecology.
3. Evaluate Environmental Pollution and Its Mitigation.
4. Promote Biodiversity and Conservation Strategies.

1. Structure and Function of Ecosystem - **15 L**

Principles of Ecology:

- Ecology: Definition, development and scope. Ecology as an experimental science.
- Concept of Ecosystem; Biosphere as an ecosystem; its ecological processes and life support systems.
- Ecotone, and Role of biological processes in remedial measures and Restoration.

Fundamental Concepts of Ecology.

- Ecosystems: components and functioning.
- Energy Fixation (photosynthesis and chemosynthesis) and energy flow through food chains (grazing and detrital) and webs (include Y shaped energy flow model).
- Ecological efficiencies and pyramids. Trophic levels.
- Influence of environmental factors (including temperature, light, moisture, soil, nutrients) on organisms and their adaptations in response to them.

2. Ecology of Populations and Communities. **15 L**

Population Ecology:

- Factors determining the abundance and distribution of a species
- Factors leading to the commonness, rarity and vulnerability of extinction of a species.
- Population Dynamics: Patterns of survival, age distribution, dispersal and rates of change. Attributes of K- selected and r-selected species, Population Growth.

Community Ecology:

- Competition, Exploitation (including herbivore, predation, parasitism), Mutualism (including commensalism, cooperation, symbiosis)

- Food webs and concepts of niche and keystone species.
- Nutrient cycling and retention: Biogeochemical cycles (Carbon, Nitrogen, Phosphorus), limiting factors and their tolerance.
- Succession, development, climax and stability of ecosystems (EXCLUDING Climax Theories),

3. Pollution and Causes **15 L**

Air Pollution: Causes and Effects:

- Definition, Composition of air, Classification of air pollution, Sources, Effect of gaseous and particulate pollutants on animals, plant and human health, Economic effects of air pollutants, Vehicular Pollution, Industrial Pollution.
- Role of Plants in Air Pollution mitigation

Water Pollution: Causes and Effects:

- Definition, Sources and Types, effect of Water pollution on living organisms, water pollution linked to human diseases
- Groundwater pollution, heavy metal and their effect on biota.
- Role of Plants in Water Pollution mitigation.

4. Biodiversity and Conservation **15 L**

- Introduction, Concept, Definition, Types, Importance and threats of Biodiversity
- Concept of Hotspots and Hotspots in India.
- Strategies of Biodiversity conservation- In-situ, Ex- situ and In-vitro conservation
- National Parks, Sanctuaries, protected Areas and Sacred groves in India.
- Concept of Restoration Ecology.
- Extinct, Rare, Endangered, and Threatened flora and Fauna of India

References:

1. Canter, L.W., "Environmental Impact Assessment", McGraw Hill, New York. 1996
2. Lawrence, D.P., "Environmental Impact Assessment – Practical solutions to recurrent problems", Wiley-Interscience, New Jersey. 2003
3. World Bank –Source book on EIA
4. Cutter, S.L., "Environmental Risk and Hazards", Prentice-Hall of India Pvt. Ltd., New Delhi, 1999.
5. Kolluru Rao, Bartell Steven, Pitblado R and Stricoff "Risk Assessment and Management Handbook", McGraw Hill Inc., New York,1996.
6. K. V. Raghavan and A A. Khan, "Methodologies in Hazard Identification and Risk Assessment", Manual by CLRI, 1990.
7. Sam Mannan, Lees' Loss Prevention in the Process Industries, Hazard Identification, Assessment and Control, 4th Edition, Butterworth Heineman, 2012.
8. E. P. Odum (1996) Fundamentals of Ecology, Nataraj Publisher, Dehra Dun.
9. K.M.M. Dakshini (1999) Principle and Practices in Plant Ecology, CRC, Boston.
10. M.C. Dash (1994) Fundamentals of Ecology, Tata McGraw Hill, New Delhi.
11. M.C. Molles Jr. (1999) Ecology- Concepts and Application, McGraw Hill, New Delhi.
12. V. Ingegnoli (2002) Landscape Ecology: a widening foundation, Springer, Bonn.
13. E.J. Kormondi (1999) Concepts of Ecology, Prentice Hall of India, New Delhi.

14. Chapman, J.L. and Reiss M.J. (2005) Ecology Principles and Applications, Cambridge University Press, London.
15. E.P. Odum and G. W. Barrett (2005) Fundamentals of Ecology, Thomson Asia Pvt. Ltd., Singapore.
16. S.V.S. Rana (2005) Essentials of Ecology and Environmental Sciences, Prentice Hall of India, New Delhi.
17. R.Rajagopalan, Environment And Ecology-EAS105/EAS 205-

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M.Sc. Botany, Part - II (Semester - III)

Mandatory Major Core Theory

Course Course Code – BOT 601G MJ

Title of the Course: ADVANCED MYCOLOGY AND PLANT PATHOLOGY - I

[No. of Credits: 4 Credit] **[Total 60 Lectures]**

Course Objectives

1. **Understanding Fungal Biology:** Gain a comprehensive understanding of the general characteristics of fungi including their ultrastructure, cell wall composition, nutritional strategies, reproductive mechanisms, and evolutionary trends in sexuality.
2. **Taxonomy and Phylogenetics**: Explore modern trends in fungal classification and phylogenetic relationships among different fungal groups, including an overview of classification systems proposed by prominent mycologists such as Alexopoulos, Mims, Blackwell, and Kirk et al. Also, examine the significance of fossil fungi in understanding fungal evolution.
3. **Ecological and Physiological Specialization:** Investigate the ecological roles and physiological adaptations of fungi in various environments, including their roles in wood decay, leaf litter decomposition, nematode predation, and adaptation to extreme environments like thermotolerance, psychrotolerance, xerotolerance, and osmotolerance.
4. **Life Cycles and Reproductive Strategies:** Explore the diversity of fungal life cycles and reproductive strategies across different fungal groups, including detailed examinations of specific phyla such as Myxomycotina, Mastigomycotina, Zygomycotina, Ascomycotina, Basidiomycotina, and Deuteromycotina. Understand the distinguishing characters, thallus structures, modes of reproduction, and life cycle patterns in each group.

Course outcomes

CO-1 Understand different aspects of fungi i.e. structure, nutrition, systematics, phylogeny, ecology, physiology etc.
CO-2 Classify the fungi in accordance with their distinguishing characters, thallus structure, reproduction and life cycle.
CO-3 Recognise various concepts of plant pathology.
CO-4 Explain host parasite interaction and genetics of disease resistance.

Credit – I **15 lecture**

- General characteristics of Fungi: Ultrastructure of Fungal cell, Composition of fungal cell wall; Fungal Nutrition, fungal modifications
- Reproduction and Somatic recombination in fungi: Heterothallism, Evolution of sex in Fungi, Sex hormones in fungi, parasexual cycle
- Classification: Recent trends in fungal classification with reference to vegetative and reproductive structures; Outline of classification as per Alexopolous Mims and Blackwell (1996), Kirk et al., (2008).
- Systematics and phylogenetic relationship among different groups of fungi; modern trends in identification and classification of fungi, fossil fungi – occurrence and significance.
- Ecological and physiological specialization in fungi: Wood decaying fungi; Decomposition of leaf litter, Nematophagous fungi, Fungi of extreme environments – Thermotolerant, psychrotolerant, Xerotolerant and osmotolerant fungi, Entomogenous fungi.

Credit – II **15 lectures**

- Myxomycotina - Distinguishing characters, structure of thallus and reproductive bodies, general life cycle pattern in Stemonitis
- Mastigomycotina - Distinguishing characters, Evolution of thallus structure and reproduction (Asexual and sexual), Life cycle pattern in Chytridiomycetes
- Zygomycotina - Distinguishing characters, Thallus structure, Heterothallism and sexual reproduction, Evolution of Asexual reproduction, Life cycle pattern in *Rhizopus*

Credit – III **15 lectures**

- Ascomycotina - Distinguishing characters, Thallus structure, Evolution of sexuality, Fructifications, Life cycle pattern in Hemiascomycetes and Euascomycetes.
- Basidiomycotina – Distinguishing characters, Thallus structure, Types and Structure of Basidia and basidiocarps, life cycle pattern in Teliomycetes, Hymenomycetes and Gasteromycetes
- Deuteromycotina – Distinguishing characters, Thallus structure, fructifications, Types of conidia, Conidial ontogeny.

Credit – IV **15 lectures**

Principles of Plant Pathology

- Importance, definitions and concepts of plant diseases, biotic and abiotic causes of plant diseases.
- Growth, reproduction, survival and dispersal of important plant pathogens, role of environment and host nutrition on disease development.
- Host parasite interaction, recognition concept and infection, symptomatology, disease development- role of enzymes, toxins
- Defense strategies- oxidative burst; Phenolics, Phytoalexins, PR proteins, Elicitors.
- Genetics of resistance; 'R' genes; mechanism of genetic variation in pathogens; molecular basis for resistance; marker-assisted selection; genetic engineering for disease resistance.

References:

1. George N. Agrios., Plant Pathology, Elsevier 2005.
2. Ainsworth, Sussman and Sparrow (1973). The fungi. Vol IV A & IV B. Academic Press.
3. Alexopolous C.J., Minms C.W. and Blackwell M. (1999). (4th edn) Introductory Mycology. Willey, New York, Alford R.A.
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6. Kirk et al. (2001). Dictionary of fungi, 9th edn, Wallingford: CABI, ISBN: 085199377X.
7. Mehrotra R.S. and Aneja K.R. (1990). An introduction to mycology. New Age Publishers, ISBN 8122400892.
8. Matthew Dickinson, Molecular Plant Pathology. Garland Science. 2003.
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11. Sanjay Kharte, Advanced Mycology and Plant Pathology. Academic Guru Publishing House, 2023.

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M.Sc. Botany, Part - II (Semester - III)

Mandatory Major Core Theory Course

Course Code – BOT 602 MJ

Title of the Course: ADVANCED TOOLS AND TECHNIQUES IN PLANT SCIENCES

[No. of Credits: 4 Credit] **[Total 60 Lectures]**

Course Objectives:

1. To provide students with a thorough understanding of advanced tools and techniques used in plant sciences, including microscopy, spectroscopy, separation techniques, and radiolabeling methods.
2. To equip students with practical skills necessary to operate and interpret data from advanced instruments such as confocal laser scanning microscopy, HPLC, NMR spectroscopy, and radioactive labeling equipment.
3. To enable students to apply these techniques effectively in various research settings, including plant biology, biotechnology, and environmental science, for studying plant structures, compositions, functions, and interactions.
4. To develop students' ability to critically analyze experimental protocols, troubleshoot technical issues, and interpret complex data obtained from advanced plant science techniques, fostering independent and analytical thinking.

Course outcomes:

1. Students will demonstrate proficiency in operating a range of advanced instruments and techniques, including microscopy, chromatography, spectroscopy, electrophoresis, and radiolabeling, ensuring accurate data acquisition and analysis.
2. Students will be able to integrate knowledge from various disciplines such as physics, chemistry, biology, and engineering to understand the principles underlying advanced plant science techniques and their applications in interdisciplinary research.
3. Graduates will possess the necessary skills to design, execute, and analyze experiments using advanced plant science techniques, contributing to the advancement of knowledge in areas such as plant physiology, biochemistry, genetics, and environmental science.
4. Students will be aware of the ethical considerations and safety protocols associated with the use of advanced tools and techniques in plant sciences, ensuring responsible conduct in research and minimizing risks to themselves, others, and the environment.

CREDIT-I **(15L)**

1. **Advanced Microscopy Techniques:** Confocal Laser Scanning Microscopy (CLSM); Atomic Force Microscopy (AFM); Fluorescence Lifetime Imaging Microscopy (FLIM); Electron microscopy (SEM TEM and STEM), Flow cytometry **7L**
2. **Separation Techniques:** Methods of separations, General principles and classification**;** Principle, techniques and applications of Thin layer, Paper, affinity, gel permeation, and ion exchange chromatography; Advanced techniques- GLC, HPLC, UHPLC **8L**

CREDIT-II **(15L)**

1. **Spectroscopic Techniques:**
   Introduction, Beer and Lambert's Law, Molar extinction coefficient, Concept and properties of Electromagnetic radiations, Wavelength, Frequency, Electromagnetic spectrum, Light absorption and excitation of spectra **7L**
   Principle, Working and Applications: UV-Visible spectroscopy, Fluorescence spectroscopy, Nuclear Magnetic Resonance (NMR) spectroscopy, X-ray crystallography, Circular dichroism (CD) spectrophotometer, Atomic absorption spectroscopy (AAS), Mass spectroscopy (MS), Infra-red (IR) Spectroscopy
2. **Centrifugation techniques: -** Principles, Rotors, Speed and Unit, Factors affecting centrifugation, ultra-centrifugation, Density Gradient Centrifugation **2L**
3. **Electrophoretic techniques: -**History, Principles, Horizontal and Vertical Electrophoresis: Principle, Working and Application: Agarose gel electrophoresis, Pulsed Field Gel Electrophoresis, Polyacrylamide Gel Electrophoresis (PAGE/ Native), Sodium Dodecyl Sulphate polyacrylamide gel electrophoresis (SDS-PAGE/ Denaturing), Isoelectric focusing, 2-Dimensional Gel Electrophoresis (2-D method) **6L**

CREDIT-III **(15L)**

1. **Cytological methods:** Pretreatment and procedures of Dissection, Maceration, Squash, Peeling and Whole-mount, Micrometry **3L**
2. **Histochemical and Cytochemical techniques:** Localization of specific Compounds/ reactions/ activities in tissues and cells, Microtomy **3L**
3. **Electrochemical techniques**: - Electrical conductivity, pH meter, Oxygen electrode **1L**
4. **Herbarium Techniques-** Digital herbarium **1L**
5. **Environmental monitoring and Remote Sensing**
   Drones and UAVs: Equipped with multispectral and hyperspectral cameras for remote sensing of crops and vegetation. **2L**
   Satellite Imagery: Monitoring large-scale agricultural landscapes and natural ecosystems for changes in vegetation cover and health. **2L**
   Soil Sensors: Measuring soil moisture, temperature, and nutrient levels to optimize agricultural practices. **2L**

CREDIT-IV **(15L)**

Radiolabeling techniques

1. Radioisotopes used in biology and their properties, Types of radioactive decay, Radioactive decay and half-life; **3L**
2. Quantification of Radioactivity: Activity unit, Absorbed dose unit, Exposure unit and biologically effective dose unit; Geiger Muller counter, Scintillation counter **5L**
3. Metabolic tracer techniques: Shikimic acid Pathway, Mevalonic Pathway, Acetate pathway **5L**
4. Non-radioactive labels, labelling and detection methods using fluorescent molecules. **2L**

References:

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4. Krishnamurthy K.V. (1999). Methods in Cell Wall Cytochemistry. CRC Press. LLC.
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7. Khasim S.M. (2002). Botanical Microtechniques: Principles and Practice. Capital Publishing Company.
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11. Egerton R.F. Physical Principle of Electron Microscopy: An Introduction to TEM, SEM and AEM.
12. Bisen P.S. Mathur S. (2006). Life Science in Tools and Techniques. CBS Publishers, Delhi.
13. Marimuthu R. (2008). Microscopy and Microtechnique. MJP Publishers, Chennai.
14. Sharma V.K. (1991). Techniques in Microscopy and Cell Biology. Tata McGraw- Hill Publishing Company Ltd.
15. Prasad and Prasad (1984). Outline of Microtechnique. Emkay Publications, Delhi.
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17. Annie and Arumugam (2000). Biochemistry and Biophysics, Saras Publishing, Tamilnadu.
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M.Sc. Botany, Part - II (Semester - III)

Mandatory Major Core Theory Course

Course Code – BOT 603 MJ

Title of the Course: INTELLECTUAL PROPERTY RIGHT'S (IPR)

[No. of Credits: 2 Credit] **[Total 30 Lectures]**

Course Objectives:

1. To provide students with a comprehensive understanding of the fundamental concepts, characteristics, origin, development, and necessity of various forms of intellectual property rights (IPR) in the modern world.
2. To equip students with comprehensive knowledge of patents, copyrights, and trademarks, encompassing their definitions, requirements, registration procedures, and the legal rights of holders, ensuring proficiency in the processes and protections of these key IPR areas.
3. To educate students on the concepts, registration procedures, and legal implications of design and geographical indications (GI), including the distinction from trademarks and their role in protecting regional products.
4. To equip students with specialized knowledge on plant variety protection (PVP) and plant breeders' rights (PBR), including international conventions like UPOV, India's PPV&FR Act, 2001, protection procedures, and strategies for managing and commercializing botanical IPR, supplemented by relevant case studies.

Course outcome:

1. To gain comprehensive understanding of various intellectual property laws, including patents, trademarks, copyrights, and trade secrets, with a specific focus on how these laws apply to protecting intellectual property in the context of breeding and agriculture.

2. To acquire knowledge of the principles and mechanisms of breeders' rights systems, including the scope of protection, application procedures, and enforcement mechanisms.

3. To develop the ability to critically evaluate the ethical and socio-economic implications of intellectual property rights and breeders' rights, particularly in relation to issues such as access to genetic resources, biodiversity conservation, farmer's rights, and the rights of indigenous communities.

4. To apply legal principles related to intellectual property rights and breeders' rights to practical scenarios in the context of agriculture, biotechnology, and plant breeding.

Credit – I: **15L**

Unit I: Introduction and the need for intellectual property right (IPR) **1L**

- Concept & Meaning of Intellectual Property
- Nature and Characteristics of Intellectual Property
- Origin and Development of Intellectual Property

Unit II: Patent: **3L**

- Definition and Concept
- Patent Requirement, Limits of Patent
- Procedure for Patenting

Unit III: Copyrights and Trade Marks: **6L**

- Definition and Characteristics of copyrights
- Copyright protection, Author and his Rights
- Definition Trade Marks
- Different kinds of marks (brand names, logos, signatures, symbols, well known marks, certification marks and service marks)
- Registration of Trademarks
- Rights of holder and assignment and licensing of marks

Unit IV: Design and Geographical Indication **5L**

- Design: meaning and concept of novel and original
- Procedure for registration, effect of registration and term of protection
- Geographical Indication (GI): meaning, and difference between GI and trademarks
- Procedure for registration, effect of registration and term of protection

Credit – II: **15L**

Unit I: Plant Variety Protection **3L**

- Meaning and benefit sharing and farmers' rights
- Procedure for registration, effect of registration and term of protection

Unit II: Plant Breeders' Rights (PBR) **8L**

- Definition and significance
- UPOV (International Union for the Protection of New Varieties of Plants) convention
- The Protection of plant varieties and Farmers Right Act, 2001 (PPV&FR) India
- Requirement for PBR
- Process of obtaining PBR
- Case studies of plant varieties protected under PBR
- Benefits and Disadvantages of PBR
- Breeders, researchers and Farmers rights

Unit III: International Convention on Biological Diversity (ICBD) **1L**

Unit IV: Management and Commercialization of IPR **3L**

- Strategies for managing and protecting IPR
- Licensing and commercialization of botanical inventions
- Case studies of successful commercialization of botanical IPR

References:

1. Nithyananda, K V. (2019). Intellectual Property Rights: Protection and Management. India, IN: Cengage Learning India Private Limited.
2. Neeraj, P., & Khusdeep, D. (2014). Intellectual Property Rights. India, IN: PHI learning.
3. Ahuja, V K. (2017). Law relating to Intellectual Property Rights. India, IN: Lexis Nexis.
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6. Journal of Intellectual Property Rights (JIPR): NISCAIR
7. Cell for IPR Promotion and Management (http://cipam.gov.in/)
8. World Intellectual Property Organization (https://www.wipo.int/about-ip/en/)
9. Office of the Controller General of Patents, Designs & Trademarks (http://www.ipindia.nic.in/)
10. Susan K Sell, Private Power, Public Law: The Globalization of Intellectual Property Rights, Cambridge University Press, 2003
11. N.S. Gopalakrishnan & T.G. Ajitha, Principles of Intellectual Property, Eastern Book Company,2nd Edition, 2014
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14. Peter Drahos, A Philosophy of Intellectual Property, Dartmouth Pub Co, 1996
15. Duggal Pavan, Legal Framework on Electronic Commerce & Intellectual Property Rights, Universal Publishing House, 2014
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17. Steven D Anderman, Interface Between Intellectual Property Rights and Competition Policy, Cambridge University Press, 2007.
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M.Sc. Botany, Part - II (Semester - III)

Mandatory Major Core Practical Course

Course Code – BOT 604 MJP

Title of the Course: PRACTICAL BASED ON BOT 601A MJ

[No. of Credits: 4 Credit] **[Total 30 Practicals]**

Practical Based on BOT 601A MJ (Advanced Taxonomy of Angiosperms-I)

1. Description of flowering plants in botanical terms with reference to habit, root, stem, leaves, inflorescence, flower and fruit. 4P
2. To prepare botanical description of any given plant specimen. 3P
3. Study of evolutionary trends in flowers, stamens and carpels of primitive families (Magnoliaceae, Papaveraceae, Nymphaeaceae, Lauraceae) 4P
4. Identification of genus and species of any 05 locally available wild plants. 6P
5. Study of at least one plant family from the orders studied in theory course. 4P
6. Local field visit and preparation of herbariums of any 05 plants species. 1P
7. Botanical excursion to any biodiversity hotspot, preferably outside the State 2P

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M.Sc. Botany, Part - II (Semester - III)

Mandatory Major Core Practical

Course Course Code – BOT 604 MJP

Title of the Course: PRACTICAL BASED ON BOT 601B MJ

[No. of Credits: 4 Credit] **[Total 30 Practicals]**

Practical Based on BOT 601B (Cyto-Genetics and Plant Breeding – I)

1. Preparation of cytological stains, fixatives and preservatives. 1P
2. Demonstration on sporophytic self-incompatibility. 1P
3. Study of different pollination methods. 1P
4. Karyotype analysis of c metaphase chromosomes using photograph and construct Ideogram. 1P
5. Study of metaphase chromosome from suitable plant material using fuchsine and Feulgen stain 2P
6. Study of polyploidy by preparation of C metaphase chromosome of *Allium*. 2P
7. Study of multiple translocation in *Rhoeo*. 2P
8. Study of floral biology and pollen viability of any two major crops. 2P
9. Study of hybridization technique in cotton and maize. 2P
10. Induction of polyploidy in any suitable crop plants using colchicine. Compare the morphological characters using control. 1P
11. Induction of male sterility in suitable plant material. 2P
12. Identification of male sterile and fertile pollen grain, calculate percent male sterility. 2P
13. Demonstration of A, B and R lines in Bajra. 1P
14. Field Report on production of hybrid seeds using any one plant breeding method. 2P
15. Selection of superior individual plants with desirable traits from a population and propagate them separately. 1P
16. Visit to any Plant Breeding Research Centre and submission of Report. 1P

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M.Sc. Botany, Part - II (Semester - III)

Mandatory Major Core Practical Course

Course Code – BOT 604 MJP

Title of the Course: PRACTICAL BASED ON BOT 601C MJ

[No. of Credits: 4 Credit] **[Total 30 Practicals]**

Practical Based on BOT 601C (Plant Physiology-I)

1.	Estimation of soluble proteins in germinating and non-germinating seeds by Lowry and Bradford's method	2P
2.	Estimation of total amino acids in germinating and non- germinating seeds	1P
3.	Determination of chlorophyll a/b ratio in normal and stressed plant	1P
4.	Studies on induction of amylase activity by GA3 in germinating cereal grains	2P
5.	Measurement of respiration and photosynthetic rates using oxygen electrode (demonstration)	1P
6.	Measurement of CO2 uptake using IRGA (Demonstration)	1P
7.	Assay of Nitrate reductase activity	2P
8.	Effect of substrate concentration and pH on enzyme activity.	2P
9.	Qualitative test of alkaloid/ phenolics and terpenoids in plant extract	1P
10.	Separation and measurement of alkaloids/ phenolics/ terpenoids using chromatography	2P
11.	Separation of Anthocyanins from flowers of different stage of maturation.	1P
12.	Effect of abiotic stress (any one) on seed germination and seedling growth	2P
13.	Effect of plant growth hormones on seed germination	2P
14.	Kinetics of seed imbibition; Seed germination test, enzymatic activities and respiration during germination and vigour testing methods etc. (Demonstration)	1P
15.	Measurement of electrical conductivity in seed leachate	1P
16.	Extraction of Cytokinin & Auxins from plant tissue	1P
17.	Demonstration of photoperiodic response of plants in terms of flowering	1P

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M.Sc. Botany, Part - II (Semester - III)

Mandatory Major Core Practical Course

Course Code – BOT 604 MJP

Title of the Course: PRACTICAL BASED ON BOT 601D MJ

[No. of Credits: 4 Credit] **[Total 30 Practicals]**

Practical Based on BOT 601D (Herbal Drug Technology-I)

1. Study of methods of extraction. (Any two methods) 2P
2. Phytochemical screening of any two medicinal plants. 2P
3. Development of fingerprint of selected medicinal plant extracts commonly used in herbal drug industry viz. Ashwagandha, Tulsi, Bael, Amla, Ginger,Aloe, Vidang, Senna, Lawsonia by Paper Chromatography & TLC/HPTLC methods. (Any four) 4P
4. Determination of leaf constants. 2P
5. Determination of volatile oil content. 2P
6. Estimation of flavonoid content in herbal raw materials. 2P
7. Estimation of alkaloid content in herbal raw materials. 2P
8. Monograph analysis of Volatile oil like Clove oil. 2P
9. Identification of bioactive constituents from plant extract. (Any three Plants) 3P
10. Antimicrobial Activity of Plant extract. 2P
11. Visit to medicinal plant cultivation centre and submission of report. 1P

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M.Sc. Botany, Part - II (Semester - III)

Mandatory Major Core Practical Course

Course Code – BOT 604 MJP

Title of the Course: PRACTICAL BASED ON BOT 601E MJ

[No. of Credits: 4 Credit] **[Total 30 Practicals]**

Seed Science and Technology-I

Practicals on Credit-I: MORPHOLOGY OF FIELD CROPS

1. Study of Morphological characters of Cereal crop: Wheat/Maize 1P
2. Study of Morphological characters of Oil Seed crop: Groundnut/Safflower/Soyabean/Sunflower 1P
3. Study of Morphological characters of Pulse crop: Pigeon pea /Cow pea/ Horse gram/Pea 1P
4. Study of Morphological characters of Fiber crop: Cotton 1P
5. Study of Morphological characters of Fruit Vegetable crop: Brinjal/ Tomato/ Chilli 1P
6. Study of Morphological characters of Leafy Vegetable crop: Spinach/Fenugreek 1P

Practicals on Credit-II: ORGANIC FARMING

7. Perform the technique to produce Tricho-cards for insect pest management 1P
8. Perform the technique to produce botanical pesticides with any suitable plant material, calculation of dosage and way of application 1P
9. Isolation and culture of Trichoderma and Rhizobium/BGA 1P
10. Determination of soil organic carbon content 1P
11. Perform the technique for production of vermicompost and vermiwash 1P
12. Preparation of Panchyagavya/ Amrit Jal/ Slurry 1P

Practicals on Credit-III: BASICS OF VEGETABLE SEED PRODUCTION

13. Study different methods of pollination employed in vegetable seed production 1P
14. Study morphological characters of vegetable seeds with any four suitable examples 1P
15. Study different methods of sowing for vegetable crops 1P
16. Preparation of nursery beds for raising healthy seedlings of different vegetable crops 1P
17. Study of different growing seasons for vegetable seeds crops with suitable examples 1P
18. Calculate the doses of fertilizers for a particular vegetable crop 1P

Practicals on Credit-IV: APPLICATION OF VEGETABLE SEED PRODUCTION

19. Study of nursery tools and Equipment 1P
20. Soil-less Media for Nursery Raising 1P
21. Study of crop protection techniques in any two vegetables 1P
22. Calculation of quantity of seed required for sowing Okra, Tomato, Cabbage, Onion, Cucumber, Cowpea 1P
23. Perform techniques of seed extraction in Okra, Tomato, Brinjal, Chilli, Cucumber and Water melon 1P

24.	Visit to a local vegetable nursery/Vermicompost unit/Organic Farm and submit the report at the time of exam	1P

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M.Sc. Botany, Part - II (Semester - III)

Mandatory Major Core Practical Course

Course Code – BOT 604 MJP

Title of the Course: PRACTICAL BASED ON BOT 601F MJ

[No. of Credits: 4 Credit] **[Total 30 Practicals]**

1.	Estimation of chlorophyll content from given plant leaves	1P
2.	Estimation of density and relative abundance of species using quadrates methods	2P
3.	Determining the rate of photosynthesis in an aquatic plant (hydrilla or elodea)	2P
4.	Phytoplankton and zooplankton analysis from freshwater samples	1P
5.	Estimation of species diversity (alpha, beta, gamma)	1P
6.	Study of Extinct, Rare, Endangered, and Threatened flora and Fauna of surrounding area	1P
7.	Determination of pH, Turbidity & Electrical Conductivity, Solids (TS, TDS, TSS).	1P
8.	Determination of Total Alkalinity and Total Hardness of water sample.	2P
9.	Determination of DO and BOD of given water sample.	2P
10.	Determination of COD in given water sample.	2P
11.	Effects of air Pollution on Stomatal responses of Plants.	2P
12.	Productivity Study of ecological adaptations in hydrophytes with any two examples.	2P
13.	Productivity Study of ecological adaptations in xerophytes with any two examples	2P
14.	To estimate the amount of dust (particulate matter) deposition on the leaves of roadside plants.	2P
15.	Field visit to river/lake for Sampling procedure, handling and preservation of samples	1P

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M.Sc. Botany, Part - II (Semester - III)

Mandatory Major Core Practical Course

Course Code – BOT 604 MJP

Title of the Course: PRACTICAL BASED ON BOT 601G MJ

[No. of Credits: 4 Credit] **[Total 30 Practicals]**

Course Objectives:

1. **Understanding Fungal Diversity and Taxonomy**: Develop the ability to identify and classify fungal types such as Physarum, Arcyria, Taphrina, Chaetomium, and Phyllachora, or similar examples based on their systematic position, vegetative structures, and reproductive structures. Gain insight into the diversity of fungi and their roles in ecosystems.
2. **Disease Identification and Pathogen Isolation**: Learn to recognize disease symptoms in plants and understand the causal organisms behind them. Acquire skills in isolating and identifying pathogens from diseased plant materials using appropriate techniques and tools, contributing to effective disease management strategies.
3. **Microscopic Techniques for Fungal Study**: Master staining techniques for fungal mycelia and spores, enabling the visualization and identification of fungal structures under the microscope. Develop proficiency in microscopic observation and interpretation, essential for accurate diagnosis and research in mycology and plant pathology.
4. **Practical Applications in Plant Pathology**: Gain hands-on experience in various practical aspects of plant pathology, such as estimating spore populations and assessing root colonization by mycorrhizal fungi. Learn techniques for extracting enzymes like cellulase and pectinase from diseased plant tissues, facilitating research on fungal pathogenesis and plant-microbe interactions. Additionally, understand and apply Koch's postulates to establish the causal relationship between a pathogen and a disease, enhancing understanding of disease etiology and control.

Course Outcomes:

By studying the course students will able to……

CO-1 Compare different life forms of fungi with respect to their morphology and reproductive characters.
CO-2 Apply mycological techniques for identification of fungi.
CO-3 Analyse plant diseases appearance by using Koch's postulate.
CO-4 Examine the Mycorrhizal association in plant roots.

Practical based on Advanced Mycology and Plant Pathology - I

1. Study of the following fungal types with reference to their systematic position, vegetative and reproductive structures: *Physarum*, *Arcyria*, *Pythium*, *Plasmopara*, *Mucor*, *Rhizopus* (Note- if this material not available you can take any two examples from mentioned classes which can easily available.) 3P
2. Study of the following fungal types with reference to their systematic position, vegetative and reproductive structures: *Taphrina*, *Phyllachora*, *Lycoperdon*, *Agaricus*, *Chaetomium*, *Colletotrichum* (Note- if this material not available you can take any two examples from mentioned classes which can easily available.) 3P
3. Study of bacterial plant disease symptoms and causal organisms. (any 4) 2P

4. Study of fungal plant disease symptoms and causal organisms. (any 4) 2P
5. Study of viral plant disease symptoms and causal organisms. (any 4) 2P
6. Study of mycoplasmal plant disease symptoms and causal organisms. (any 4) 2P
7. Preparation and sterilization of fungal culture media, Staining techniques of mycelia, spore. 2P
8. Isolation and identification of pathogen from diseased plant materials 3P
9. Extraction of cellulase and pectinase from diseased plants 3P
10. Study of Koch's postulate of any two disease 2P

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M.Sc. Botany, Part - II (Semester - III)

Mandatory Research Project

Course Code – BOT 631 RP

Title of the Course: MINOR RESEARCH PROJECT

[No. of Credits: 4 Credit]

GUIDELINES FOR MINOR RESEARCH PROJECTS

Semester	Verticals	Course Type	Course Code	Course Title	Credits	Internal Marks	External Marks
III	Research Project	Core	BOT 631 RP	Minor Research Project	4C	30	70

Research Committee: A research committee is to be constituted in the department with HoD as the Chairman, Research Guide and one faculty related to the subject from the same department/other institute as the members.

Guide: Normally a candidate shall be required to complete his/her minor/major research work under the supervision of the guide allotted to him/her by the department. However, the Research Committee concerned may allow change of guide on the production of a 'No Objection Certificate' from the first guide and an acceptance letter from the new guide.

Outline Preparation: Students are supposed to identify relevant topic for research in concern with the mentors and prepare an outline stating

I. Introduction

- Background and context
- Research question(s) or hypothesis
- Purpose and scope of the study
- Significance and relevance of the research

II. Literature Review

- Overview of relevant theories and concepts
- Summary of previous research on the topic

III. Methodology

- Research design and approach
- Data collection methods (e.g., surveys, interviews, experiments)
- Data analysis methods (e.g., statistical tests, thematic analysis)

IV. Expected Outcomes

- Potential findings and implications
- Contribution to the field of study
- Practical applications and significance

V. Timeline and Milestones

- Research schedule and deadlines
- Expected completion dates

VII. Conclusion

- Summary of the research project and its goals
- Expected impact and significance
- Future directions for research

(Note: This is just a general outline, and the specific sections and details may vary depending on the research project and field of study.)
The outline is to be presented in front of the research committee for topic finalization. Corrections (if any) suggested by the committee to be incorporated, finalized and submitted to the department.

Progress: All the students shall be required to submit the elaborated progress report to the Head, Place of Research, through their research guides every month (Appendix -A). The committee shall scrutinize the progress reports and prepare a brief statement on the progress of the student which will be considered for evaluation.

Submission and Evaluation of Synopsis and Thesis: The submission of synopsis and pre-submission seminar is to be considered for internal evaluation (15 Marks). The synopsis should contain introduction, chapter-wise brief account of the work done and overall conclusions. Student has to publish one research paper in a standard refereed journal before the submission of the thesis or present oral/poster paper in a Conference/Seminar, and produce evidence for the same in the form of acceptance letter/reprint/certificate. At the time of synopsis submission the student shall give a pre-submission seminar in front of the Research Committee.

The submission of the thesis shall be considered for external evaluation (35 Marks). The thesis shall be submitted in compact bound form at the time of final practical exam. Two copies of the abstract shall be submitted at the time of final project evaluation. The final thesis shall be presented in accordance with the following specifications: The paper used for printing shall be of A4 size; Printing shall be in a standardized form on both sides of the paper and in 1.5 line spacing; A margin of 1.5 inches shall be on the left hand side; The card for cover shall not be more than 330 GSM; The title of the thesis, name of the candidate, degree, name of the guide, place of research, the month and year of submission shall be printed on the title page and the front cover; The hard-bound thesis cover shall be of black colour.

The thesis shall include a Declaration by the student, [Appendix-B], Certificate of the guide [Appendix-C], that the work reported in the thesis has been carried out by the student himself/herself and that the material from other sources, if any, is duly acknowledged. The thesis shall be written in English. It should include Acknowledgement, Index, List of Tables/Graphs/Photographs (if any), Introduction, Review of Literature, Materials and Methods, Results and Discussion, Summary and Conclusions, References etc.

Note: Minor and major research projects for semester-III and IV may be correlated so that the candidate will get more time for quality research work and paper publication/presentation.

Appendix-A

FORMAT FOR PROGRESS REPORT SUBMISSION

Name of the student:
Name of the Mentor:
Name of the College:
Class:
Topic:
Academic year:
Progress on Work Done:

Appendix-B

DECLARATION OF THE CANDIDATE

I, [Candidate's Name], hereby declare that:

1. This research work, titled [Title of the Research], is my original work and has not been submitted elsewhere for any degree or diploma.
2. I have conformed to the requirements and regulations of [University/Institution] and the ethical guidelines of the research field.
3. I have acknowledged all sources of information and ideas used in this research, and have properly cited them in the bibliography.
4. This research has been carried out under the supervision of [Supervisor's Name] and their guidance has been invaluable.
5. I have not committed any act of academic dishonesty, such as plagiarism or falsification of data, in the preparation of this research.
6. I am aware that any form of academic misconduct may lead to serious consequences, including failure or withdrawal of the degree.

I hereby declare that this research is my own work, and I am responsible for its content and accuracy.

Signature: _____
Date: _____

Appendix-C

CERTIFICATE OF RESEARCH GUIDANCE

I, [Guide's Name], [Guide's Title/Position], [University/Institution], hereby certify that:
1. I have guided [Candidate's Name] in their research project titled [Title of the Research] for the [Degree] program.
2. I have monitored the progress of the research and have found the work to be original and satisfactory.
3. The candidate has worked under my supervision and has shown dedication and rigor in the conduct of the research.
4. I have verified the data and results presented in the research and find them to be accurate and reliable.
5. The candidate has properly acknowledged my guidance and support in the research.

I recommend this research work for evaluation and consideration for the [Degree] program.

Signature: _____
Date: _____

Name: [Guide's Name]
Title/Position: [Guide's Title/Position]
University/Institution: [University/Institution]"

National Education Policy 2020

M.Sc. Botany, Part - II (Semester - III)

Elective Theory Course

Course Code – BOT 610 MJ

Title of the Course: ADVANCED HORTICULTURAL TECHNIQUES

[No. of Credits: 2 Credit] **[Total 30 Lectures]**

Course objectives:

To impart comprehensive knowledge to the students on cultural and management practices for growing fruits and know the advanced techniques which are incorporated in horticulture science. Development of improved varieties and rootstock is a continuous process which is realized through breeding and genetic approaches and high tech technology development. This is necessary to enhance the productivity and meet ever-changing climatic conditions and market / consumer preferences.

Course outcomes:

1. To understand the importance and horticultural crops
2. Describe the Agro techniques in horticulture.
3. Understanding the micropropagation techniques.
4. Understanding the post-harvest technology

Credit -I

Unit 1 Introduction to Horticulture **2 L**

i) Origin, distribution and importance

ii) Historical perspective and evolution of horticultural practices.

iii) Major species, commercial varieties of regional, national and international importance.

Unit 2 Agro-techniques **5L**

Propagation-

i) Asexual and sexual methods of propagation. Planting systems- Principle and methods of Pruning, Cutting, Layering, Budding and grafting.

ii) Stock and scion and inter stock relationship – graft incompatibility, physiology of rootstock and top working.

iii) Establishment and management Layout of gardens Soil preparation intercropping, nutrient management, water management, fertigation.

iv) Use of PGR- Role of following PGR in horticulture- Auxins, Gibbrelic Acid, Cytokinin, Ethylene.

v) Role of plant growth regulators in Bahar treatment. Use of bio-fertilizers, role of bio-regulators in fruiting.

Unit 3 Micropropagation: **5L**

i) Principles and concepts commercial exploitation in horticultural crops.

ii) Techniques – In-vitro clonal propagation, direct organogenesis, embryogenesis, micro grafting, meristem culture,

iii) Commercial In-vitro production of Banana, Orchids, Ornamental plants. Hardening, packaging and transport of micro-propagules.

Unit 4 Canopy Architecture and Management- **3L**

i) Introduction, Types and Classification, importance and factors affecting canopy development. Spacing and utilization of land area.

ii) Canopy development and management in relation to growth, flowering, fruiting and fruit quality through plant growth regulators.

CREDIT II

Unit 1- Post Harvest technology and storage **5L**

i) Introduction

ii) Protected cultivation and post harvest handling.

iii) Protected cultivation – principles of organic horticulture

iv) Harvesting and post-harvest handling – processing, value addition, storage and marketing of horticultural produce.

Unit 2 International standards for Horticultural Crops trading: **3L**

i) Introduction

ii) Regulatory horticulture, inventory and exchange of fruit and nut germplasm,

iii) Plant quarantine, phyto-sanitary certification, detection of genetic constitution of germplasm and maintenance of core collection.

iv) IPRs, Breeder's rights, Farmer's rights, PPV and FR Act. (Protection of Plant Varieties and Farmers Right Act.)

Unit 3 Controlled Environment Agriculture (CEA) **2L**

i) Introduction to CEA

ii) Vertical farming

iii) Green house, Poly house

iv) Precision irrigation systems

v) Techniques for precise nutrient application

vi) Automation technologies in horticulture

Unit 4 Soil Less Production- **3L**

i) Introduction.

ii) General techniques of Hydroponics, Aeroponics, and Aquaponics

iii) Basics of hydroponics, Aeroponic systems and their applications

iv) Aquaponics and sustainable food production with reference to vegetables

Unit 5 Disease and Pest Management Strategies in Horticulture **2L**

i) Principles of disease management

ii) Diagnostic tools for plant diseases with the help of digital tools.

iii) Integrated Pest Management (IPM)

iv) Biopesticides and their role

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M.Sc. Botany, Part - II (Semester - III)

Elective Theory Course

Course Code – BOT 611 MJ

Title of the Course: NURSERY AND PTC TECHNIQUES

[No. of Credits: 2 Credit] **[Total 30 Lectures]**

Course objectives:

1. To Study Different nursery technique.
2. To understand the importance of Plant Tissue culture
3. To apply the different propagation methods to plants.

Course outcomes:

1. Know the importance of Nursery based business.
2. Develop the in-vitro plants and their significance.
3. Methods of different mode of reproduction in plants.

Credit-I: Nursery **15L**

Unit-1 Introduction: 5L

- Definition, Scope, and Importance

Types of Nurseries:

- Based on Time span
  - Temporary nursery
  - Permanent nursery
- Based on seedlings produced
  - Ornamental
  - Medicinal
  - Floriculture (Flower)
  - Pomoculture (Fruit)
  - Olericulture (Vegetable)
  - Forest
  - Bonsai
- Based on structure
  - Shade net House
  - Polyhouse

Basic facilities for nursery

- Site Selection
- Layout
- Electricity
- Man Pawar
- Irrigation facility
- Climate
- Road
- Marketing

Unit-2 Requirements for Nursery 2L

- Nursery beds and their types
- Growing media (soil and Soil less)
- Nursery Tools and implements
- Containers for growing seedlings

Unit-3 Nursery Plant Propagation 4L

- Sexual propagation
- Vegetative propagation
  - Natural propagation (roots, underground stems, sub aerial stems, aerial shoots, leaves and bulbils)
  - Artificial propagation (Budding, Layering, grafting, and Tissue culture)

Unit-4 Nursery Management 2L

- Routine operation in nursery
- Irrigation
- Weeding
- Fertigation
- Disease and pest control

Unit-5 Nursery Economics 2L

- Economic of plant nursery
- Pricing
- Record Maintenance
- Online and Offline advertisement
- Sales System

Credit-II: Plant Tissue Culture **15L**

Unit-6 Introduction to Plant Tissue culture 2L

- Introduction to Plant Tissue culture,
- Terms and definitions
- Historical background
- Laboratory organization
- Tools and techniques
- Methods of sterilization.
- Laboratory contaminants- it's control and measures.

Unit-7 Media and Culture Preparation 4L

- Role of Micro and macro nutrients
- Vitamins and carbon source in tissue culture
- Types of Media
- Media preparation- pH, Temperature, Solidifying agents, Slant Preparations etc. Maintenance of cultures, Environmental Conditions

Unit-8 Types of plant tissue culture 4L

- Meristem culture
- Callus culture
- Anther culture
- Embryo culture
- Ovary culture
- Ovule culture
- Pollen culture

Unit-9 Micro propagation 3L

- Selection of suitable material
- Stock plant selection
- Preparation of explants
- Inoculation
- Incubation
- Sub-culture
- Multiplication
- Shooting and Rooting

- Hardening

Unit-10 Benefits of plant tissue culture 2L

- Rapid multiplication of clones
- Genetic uniformity
- Aseptic condition
- Controlled environment

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M.Sc. Botany, Part - II (Semester - III)

Elective Practical Course

Course Code – BOT 612 MJP

Title of the Course: PRACTICAL BASED ON BOT 610 MJ

[No. of Credits: 2 Credit] **[Total 15 Practicals]**

Advance Horticulture Techniques

1. Study of plant propagation method by cutting, budding grafting Bench layering with suitable examples 1P
2. Propagation of various concentration of PGR (ppm, % solution, molar solution 1P
3. Study of effect of bio-fertilizers on fruit crops 2P
4. Study of production of bio-pesticides. 1P
5. Study of in vitro cultivation of Banana/Orchids with the help of locally available plant material 2P
6. To study of water automation techniques in playhouse or green house 1P
7. To study the harvesting method of suitable horticultural crops with reference to processing, value addition, storage marketing etc. 2P
8. Demonstration of the tools and equipment used in horticulture 1P
9. Visit to Horticulture institute/Research institute/High-tech nurseries/University department etc. and submission of its report 1P

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M.Sc. Botany, Part - II (Semester - III)

Elective Practical Course

Course Code – BOT 613 MJP

Title of the Course: PRACTICAL BASED ON BOT 611 MJ

[No. of Credits: 2 Credit] **[Total 15 Practicals]**

Nursery and PTC Technique

Practical's on Credit-I: Nursery

1.	Prepare nursery layout for any one type of nursery	1P
2.	Perform the experiment to raise nursery seedlings using flat beds, raised beds, sunken beds and trays/polythene bag beds	2P
3.	Perform the experiment to raise nursery saplings using cutting and layering	1P
4.	Perform the experiment to raise nursery saplings using budding and grafting	1P

Practical's on Credit-II: PTC Technique

5.	Different technique used for Sterilization of Glassware and equipment's	1P
6.	Techniques in Plant Tissue Culture: Preparation of Culture Medium and Sterilization of Explants.	1P
7.	Aseptic inoculation and incubation of selected explants	1P
8.	Preparation of callus from banana explants.	1P
9.	Micro propagation of ornamental plants.	1P
10.	Production of Pollen, Anther and ovule culture.	1P
11.	Visit of Plant tissue culture unit, preparation and submission of report	1P

Syllabus for M. Sc. Botany, Part – II

Semester – IV

As Per New Education Policy 2020

National Education Policy 2020

M.Sc. Botany, Part - II (Semester - IV)

Mandatory Major Core Theory Course

Course Code – BOT 651A MJ

Title of the Course: ADVANCED TAXONOMY OF ANGIOSPERMS - II

[No. of Credits: 4 Credit] **[Total 60 Lectures]**

Course objectives:

1. To study scope and importance of classification in Angiosperms.
2. To study nascent and progressive indications of Angiosperms.
3. To study taxonomic tools used in Angiosperms.
4. To study APG system of classification

Course outcomes:

1. Identify and classify the plants.
2. Handle the laboratory based molecular tools for the taxonomy.
3. Prepare the herbaria for documentation.

Credit – 1 **15 L**

Unit -1 Taxonomic evidences:

Data of taxonomic significance from anatomy, embryology, palynology, cytology, Phyto-chemistry and molecular biology. Taxonomic tools: Serological and molecular techniques, GIS, GPS, Use of computers in angiosperms taxonomy (Use of computer and data bases for identification of plants with the help of website.

Unit-2 Tools of Taxonomy

Molecular tools in taxonomy: Application of DNA hybridization, RFLP, RAPD, AFLP & DNA sequencing in solving taxonomic problems. DNA Barcoding: Overview of DNA Barcoding, Role of chloroplast DNA and mitochondrial DNA taxonomy, PCR and PCR primer designing, molecular markers.

Credit – 2 **15 L**

Unit 1: Herbarium and its techniques:

Objectives and function of herbarium. Types of herbaria, role of herbarium in taxonomy, Floristic, Teaching, Research, Assessment and documentation of Phyto diversity and Public Education. Techniques of herbarium preparation. Pests in herbarium and its control. Major herbaria of the World and India and their contributions.

Unit 2: Botanic Gardens:

Definition, criteria, history and role of botanic gardens. Types of botanic gardens: Arboretum, Pineatum, Orchidarium, Bambusetum, Fernary. Important Botanic Gardens in India and World.

Credit – 3 **15 L**

Unit 1: Phytogeography

Phytogeography, phytogeographic regions of India. Endemism, hotspots and hottest hot spots of

the world. Endemism in Western Ghats. Plant exploration, invasion and introductions. Biodiversity assessment and conservation strategies, Principles of Conservation, Extinctions, Strategies for *in-situ* and *ex-situ* conservation.

Credit – 4 **15 L**

Unit 1: Advances in taxonomy

Overview of APG IV system of classification. Families of angiosperms: Characteristic features, interrelationships and economic importance of following clades:

ANA Grade: Nymphaeaceae
Magnoliids: Myristicaceae
Monocots: Asparagaceae
Eudicots: Ranunculaceae
Core Eudicots: Dilleniaceae
Superrosids: Crassulaceae
Rosids-I: Cucurbitaceae
Rosids-II: Rutaceae
Superasterids: Santalaceae
Euasterids-I: Rubiaceae
Euasterids-II: Asteraceae

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M.Sc. Botany, Part - II (Semester - IV)

Mandatory Major Core Theory Course

Course Code – BOT 651B MJ

Title of the Course: CYTO-GENETICS AND PLANT BREEDING - II

[No. of Credits: 4 Credit] **[Total 60 Lectures]**

Course objectives:

1. To study cell cycle progression and their checkpoints.
2. To understand the structure and function of chromosomes.
3. To know the nuclear content organization.
4. To study the growth elevation against the biotic and abiotic stress

Course outcomes:

1. Understand the cell cycle progression.
2. Know the importance of structure and function of chromosome.
3. Handle the molecular technique for genetic mapping.
4. Explain the importance of hybridization.

Cytogenetics

1	**Cell Cycle and Cell Division** Definition, Phases of Cell Cycle, Checkpoint of Cell cycle, Stages of Mitosis and Meiosis, Molecular Basis of Cell cycle	05
2.	**Chromosome Structure and Function** Chromosome number, karyotype, Euchromatin and heterochromatin, special types of chromosomes- Polytene, Lampbrush, Salivary gland and B chromosomes; Banding Patterns- G, Q, C, R, Modified C Banding, Combined C and N Banding.	05
3.	**Nuclear DNA Content and Its Organization** Chromosomal DNA Content and C Value Paradox Chromosomal DNA Vs. Chromosome Length / area / Volume Chromosomal DNA and Evolution DNA Content and Adaptability	05
4.	**Mapping Using Molecular Marker** Restriction Mapping, Genetic Map Using RFLP, Genetic maps using RAPDs generated through PCR, VNTR and SSR. Physical Map Using Molecular Marker: In-situ Hybridization, Chromosome Walking.	10

6. **Practical Applications in Cytogenetics** 05

Laboratory techniques in cytogenetics

Chromosome handling and identification

Experimental design and data analysis in cytogenetic studies

Plant Breeding

7. **Mutation Breeding** 03

Introduction and History

Mutagens; Types of Mutagens (Physical and Chemical Mutagens).

Natural and Induced mutation Methods.

8. **Breeding for Abiotic Stress** 04

A. Drought: Sources (Cultivated Varieties, Land Races, Wild Species and Transgene), Developmental methods of Resistant Varieties: Drought escape, Dehydration avoidance, dehydration tolerance

B. Salinity: Approaches for management of salt affecting soil: reclamation; Sources, Breeding approaches for salinity resistance, Problem in Breeding for salinity Resistance.

9. **Breeding for Biotic Stress** 04

A. **Disease resistance:** Losses, Disease Escape, Mechanism of Disease Resistance and Methods of Breeding for Disease Resistance.

B. **Insect resistance:** Losses, Sources, Methods (Introduction, Selection, Hybridization, Genetic engineering), and Advantages of Insect resistance

10. **Breeding for Quality** 04

Quality Traits: Morphological, Organoleptic, Nutritional, Biological and other quality traits.

Protein: Quality traits of Selected Crops: Rice, Wheat, Cotton, and Tomato.

Oil: Quality traits of Selected Crops: Coconut, Soybean, Mustered, Sunflower, and Groundnut.

11.. **Biotechnology in Crop Improvement** 01

Introduction, Scope and Importance

12. **Plant Tissue Culture** 03

Techniques of Plant Tissue Culture**,** Embryo Culture, Meristem Culture and Anther Culture, Applications of Plant Tissue Culture

13. **Somatic Hybridization** 03

Protoplast Isolation and fusion, Selection of Hybrid and Regeneration of hybrid plant, Cybrids, Application of Somatic Hybridization.

14. **Recombinant DNA Technology** 03

    Identification and isolation of gene, Insertion of Gene, Introduction of Recombinant DNA into Host, Selection of Transform Host Cell, Expression of Clone Gene.

15. Genetic Engineering in Plants 03

    Methods of gene Transfer, Reporter Gene, Expression of the transfer gene, Applications of genetic Engineering.

16. Achievement and Future Prospective of Plant Breeding 02

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M.Sc. Botany, Part - II (Semester - IV)

Mandatory Major Core Theory Course

Course Code – BOT 651C MJ

Title of the Course: PLANT PHYSIOLOGY - II

[No. of Credits: 4 Credit] **[Total 60 Lectures]**

Course objectives:

1. To study importance of mineral nutrient for the plants.
2. To understand the relation of anabolism and catabolism in plants.
3. To recognize the efficiency of plant for the production of different metabolites.

Course outcomes:

1. Understand the role of macro- and micronutrients, their mode of availability to the plants, deficiency and toxicity symptoms.
2. Recognize the importance of Carbon assimilation in Photorespiration.
3. Generalize the concepts of transport of water, minerals, and organic substances.
4. Student will learn about water relations, mineral nutrition and crop physiology, Photosynthesis, Respiration.
5. Interpret the biology of Nitrogen fixation.
6. Know about the basic principles of plant growth and development, metabolism.
7. Familiarize the basic understanding of physiology of seed dormancy and Germination, Growth and Photo-physiology Physiology of Fruit Ripening

15L

Credit I: Water relations, mineral nutrition and crop physiology

Unit-1	Forces involved in water uptake and transpiration, stomatal physiology, hydraulic conductance, regulation of Aquaporins.	2L
	Energising transporters, role of ATPases and PPases, role of chelators in mineral uptake and transport. Low and high affinity transporters. Mechanism of uptake and transport of Potassium, Calcium, Magnesium, Iron, Zinc, Copper, Sulphur. Hydroponic media and applications.	6L
	Crop growth - Relative growth rate, Leaf area index and net assimilation rate	2L
	Allocation of resources to storage organs, fruits and seeds (endosperm, cotyledons). Harvest Index	2L
	Biotic and abiotic factors affecting on phenology and yield of crop plant	2L
	Water and nitrogen use efficiency of crop plants.	1L

15L

Credit 2: Photosynthesis

Unit-2	Chlorophyll fluorescence kinetics and determination of PSI, PSII efficiency. Photosynthesis measurements. Light saturation curves, CO2response curves and CO2compensation point. Canopy photosynthesis, Carbon sequestration by plants	4L
	Photo-inhibition and protection mechanisms. Water-water cycle,	3L

	photorespiration	
	Evolution and diversity of photosynthetic systems. Bacterial photosynthesis, Algal photosynthesis	3L
	Regulation of photosynthesis in response to changing climate conditions.	2L
	Partitioning of photosynthetic assimilates, long distance transport, phloem loading and unloading	3L
		15L

Credit 3: Respiration, Growth and Photo-physiology

Unit 3	Comparative account of energy release efficiency of Glycolysis, TCA cycle and PPP. Alternative pathways in plants, alternate oxidase, regulation of different pathways, GABA shunt	3L
	Mitochondrial electron transport system, inhibitors and uncouplers, Diverse electron transport systems in plant mitochondria, Oxidative phosphorylation, respiratory control and measurements	4L
	Interdependence of mitochondria and chloroplasts. Protective effects of mitochondrial respiration on photosynthesis	3L
	Role of respiration in plant carbon balance	2L
	Dormancy of seed and seed germination	3L
		15L

Credit 4: Physiology of Fruit Ripening

Unit 4	Physiology of fruit development in plant	2L
	Physiological and molecular mechanisms of fruit ripening.	2L
	Postharvest deterioration of fruits; factors regulating fruit deterioration; hormonal and environmental aspects of reducing post-harvest deterioration of fruits	4L
	Physiological and Molecular approaches to regulate fruit ripening and shelf life	3L
	Role of Ethylene and Ethylene response factors regulating specific processes of fruit ripening; Approaches to regulate specific shelf life characters.	4L

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M.Sc. Botany, Part - II (Semester - IV)

Mandatory Major Core Theory Course

Course Code – BOT 651D MJ

Title of the Course: HERBAL DRUG TECHNOLOGY - II

[No. of Credits: 4 Credit] **[Total 60 Lectures]**

Course objectives:

1. Use the biotechnological techniques for obtaining and improving the quality of natural products/medicinal plants.
2. To Understand concept of Ethnobotany and Ethno-pharmacology and its role in drug development.
3. Various nutraceuticals/herbs and their health benefits.
4. The requirements for setting up the herbal/natural drug industry.
5. The guidelines for quality of herbal/natural medicines and regulatory issues.
6. The patenting/IPR of herbals/natural drugs and trade of raw and finished materials.

Course Outcomes:

Credit- I:		15 L
1.	**Ethnobotany and Ethno-pharmacology**: Ethnobotany in herbal drug evaluation, Impact of Ethnobotany in traditional medicine, New development in herbals, Bio-prospecting tools for drug discovery, Role of Ethno-pharmacology in drug evaluation, Reverse Pharmacology.	**3 L**
2.	**Medicinal Plant Biotechnology**: Historical prospective and prospects for development of medicinal plant biotechnology. Applications of plant biotechnology in Pharmacy and Allied field, Factors affecting biotransformation on the production of biomedical and its application in pharmacy, Different Methods of cryopreservation and its impact on the production of biomedical, recombinant DNA technology.	9 L
3.	Applications of plant tissue culture in modern Pharmacognosy. Immobilized cell techniques, protoplast fusion, hairy root cultures.	3 L
Credit- II:		15 L
4.	**Herbal cosmetic**s: Herbal cosmetics, advantages and disadvantages of herbal cosmetics, manufacturing and marketing of herbal cosmetics. Preservatives, surfactants, humectants, oils and other additives from natural origins. Herbal cosmetics for the skin - Physiology and chemistry of skin.	3 L
5.	Methods of preparation of herbal cosmetics for skin and hairs: cleansing cream, lotions, vanishing and foundation creams, anti-sunburn preparations, moisturizing cream, deodorants, face powders, face packs, lipsticks, bath products, soaps and baby product.	8 L

6. **Nutraceutical**: Scope of nutraceuticals, formulation and standardization of nutraceuticals in reference to natural health drinks, vitamin and mineral supplements and antioxidants. FSSAI guidelines and regulatory aspects. 4 L

Credit- III: 15 L

7. **Herbal drug industry**: Infrastructure of herbal drug industry involved in production of standardized extracts and various dosage forms. Current challenges in upgrading and modernization of herbal formulations. 5 L
8. Entrepreneurship Development, Project selection, project report, technical knowledge, Capital venture, plant design, layout and construction. Pilot plant scale –up techniques, case studies of herbal extracts. Formulation and production management of herbals. 5 L
9. **Monographs of herbal drugs**: General parameters of monographs of herbal drugs and comparative study in IP, USP, Ayurvedic Pharmacopoeia, American herbal pharmacopoeia, British herbal pharmacopoeia 5 L

Credit- IV:

10. **Herbal remedies**: Herbals vs. conventional drugs, conservation of medicinal plants- Ex-situ and In-situ, efficacy of herbal medicine products. 4 L
11. **Testing of natural products and drugs**: Herbal medicines -clinical laboratory testing. Stability testing of natural products. 3 L
12. **Patents**: Indian and international patent laws, proposed amendments as applicable to herbal/natural products and process. Copyright, Patentable subject maters, novelty, non-obviousness, utility. 4 L
13. Procedure for Indian patent filing, patent processing, grant of patents, rights of patents, cases of patents, opposition and revocation of patents, patent search and literature, Controllers of patents. 4 L

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11. Catia Bastioli, Handbook of biodegradable polymers, iSmithers Rapra
12. Shaikh R., Sial A., "Stability of pharmaceutical formulations", Pak. J. Pharm. Sci., 2nd edition, pp 83-86 1996,.
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M.Sc. Botany, Part - II (Semester - IV)

Mandatory Major Core Theory Course

Course Code – BOT 651E MJ

Title of the Course: SEED SCIENCE AND SEED TECHNOLOGY - II

[No. of Credits: 4 Credit] **[Total 60 Lectures]**

Course Objectives:

1. To acquaint with the definitions of diseases, host and pathogen
2. To apply different aids for varietal identification
3. To understand the methods of seed health testing
4. To get familiarize with Intellectual Property Rights

Course Outcomes:

1. Students will be able to identify the crop diseases and suggest the control
2. Students will be able to identify the varieties
3. Methods of seed health testing will be useful in seed industries
4. Know the plant breeder rights

Credit I: SEED HEALTH TESTING **15L**

Unit-1 **Disease of field crop and their management** 1L

Definition: Disease, Host and Pathogen

Unit-2 **Diseases in Cereals w.r.t causal organism, symptoms and control measures:** 2L

Maize: Leaf blight, Sheath blight

Wheat: Loose smut, Rust of wheat

Unit-3 **Diseases in Fiber crop w.r.t causal organism, symptoms and control measures** 2L

Cotton: *Fusarium* wilt, *Alternaria* leaf spot

Unit-4 **Diseases in Oil seed crop w.r.t causal organism, symptoms and control measures** 2L

Groundnut: Tikka leaf spot

Soybean: Soybean mosaic virus/Rust disease

Unit-5 **Diseases in Pulses w.r.t causal organism, symptoms and control measures** 2L

Chickpea: Gram blight, *Fusarium* wilt,

Unit-6 **Diseases in Vegetable crop w.r.t causal organism, symptoms and control measures** 2L

Tomato: Early blight

Chilli: Root rot

Unit-7 **Seed Health Testing** 4L

Introduction

Definition of seed health and seed health testing

Objectives of seed health testing

Methods of seed health testing:

1. Visual Examination of dry seeds
2. Incubation:
   a) Blotter paper method
   b) Agar plate method
3. Seed washing test

4. Seedling Grow out test
5. Serological test
6. ELISA test
7. Pathogenicity test
8. Embryo Count Method

Credit-II: BASICS OF PLANT BIOTECHNOLOGY **15L**

Unit-8 **Introduction to Plant biotechnology** 2L

Definition, Branches, scope and applications

Unit-9 **Aids to varietal identification** 4L

PCR, SDS-PAGE, RFLP, RAPDs, DNA finger printing, ELISA

Unit-10 **Methods of gene cloning** 4L

1. *In vivo* gene cloning-vectors used in gene cloning (Plasmid vectors, Lamda (λ) phage vectors, cosmids and expression vectors),
2. Selection of vectors
3. DNA polymorphism
4. Use of various enzymes in recombinant DNA technology

Unit-11 **Techniques in restriction mapping, Southern, Northern, Western, Blotting techniques and applications** 5L

Credit-III: APPLIED PLANT BIOTECHNOLOGY **15L**

Unit-12 **Technique of Micro propagation in development of crop plants** 5L

Tissue culture in Banana
Anther culture
Embryo culture
Synthetic seed: Definition, Production and application

Unit-13 **Transgenic** e.g. Bt-cotton and Golden Rice, technique and applications 3L

Unit-14 **Germplasm Conservation and Cryopreservation** 3L

Definition and concept
Germplasm conservation

1. Preservation of cell, tissue, organ, whole organism
2. Concept of Gene Bank, DNA Bank, Seed Bank and Pollen Bank
3. Cold Storage-Long term and short term storage, application

Cryopreservation and technique

Unit-15 **Seed Nanotechnology** 2L

Definition and concept
Role of nanotechnology in

1. Seed Health Testing
2. Seed biotechnology
3. Seed Packaging and Handling
4. Seed Storage

Unit-16 **Intellectual Property Rights (IPR)** 2L

Introduction
History
Intellectual Property
Protection of IPR (Trade secrets, Patents, and copyright.)
Plant Breeder's Rights

Credit-IV **HYBRID SEED PRODUCTION** **15L**

Unit-17 **Introduction** 6L

Definition, Objectives and Advantages and Limitations.
Male Sterility:

1. Genetic male sterility (GMS),

2. Cytoplasmic male sterility (CMS)
3. Cytoplasmic genetic male sterility (CGMS).

Role of A-line, B-line and R-line in seed production

Unit-18 Hybrid Seed Production in different crops 9L

Seed production planning, Land and isolation requirement, Control on Seed Source, Special agronomic practices, Field Inspection, Roughing, Bagging and Tagging, Harvesting, Threshing, seed collection in the following Crops.

1. Maize
2. Cotton
3. Soybean

References:

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11. Seed Technology and Pathology-Ashok Kumar, Discovery Publication House
12. Seed Technology, R. L. Agarwal
13. Seed Technology and Seed Pathology-Archana Sharma, Chaubey, Ram Prakash, Pointer Publication
14. Handbook of Agriculture-ICAR
15. Handbook of Agriculture Science-Dr. S. S. Singh, Kalyani Publication
16. Plant Breeding-B. D. Singh
17. Essentials of Plant Breeding-Phundan Singh
18. Plant Breeding: Principles and Methods- Phundan Singh, Kalyani Publication

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M.Sc. Botany, Part - II (Semester - IV)

Mandatory Major Core Theory Course

Course Code – BOT 651F MJ

Title of the Course: APPLIED ECOLOGY AND ENVIRONMENT - II

[No. of Credits: 4 Credit] **[Total 60 Lectures]**

Course Objectives:

1. To study the impact of ecosystem disturbance.
2. To know the policies for sustainable development.
3. To understand the impact of climate change for life.

Course Outcomes:

4. Understand and Analyze Species Interactions and Ecosystem Classification
5. Evaluate Climate Change, Policies, and Sustainability Measures
6. Explore Environmental Microbial Ecology and Its Applications
7. Conduct Environmental Impact Assessment (EIA) and Environmental Auditing

Credit 1. **Applied Ecology and Environment-II** 15

Species Interactions: Types of interactions, interspecific competition, herbivory, carnivory, pollination, symbiosis.

Ecosystem classification-

Types of Ecosystems, desert (hot and Cold), Forest, Rangelands, Wetlands, Lotic, lentic Estuarine (Mangroves), Oceans.

Biomes

Concept of Biomes, Classification and Distribution: Tundra, Taiga, Grasslands, Deciduous forest biome, Highland icy Alpine Biome, Chapparal, Savanna, Tropical rain forest.

Credit 2. **Climate Change, Policy & Sustainability** 15

Climate Elements and Effects - Climate change, global warming, ozone layer depletion, acid rain, Green House Gases, Sources and Sinks of GHGs, Role and impact of GHGs, Atmospheric Life of GHGs, Global Warming Vs. Global Dimming, Pre- and Postindustrial emissions.

Laws of climate change

Montreal Protocol
United Nations Framework Convention on Climate Change (UNFCCC)
The Kyoto Protocol,
Paris Agreement (2015)
International Solar Alliance

Credit 3. **Environmental Microbial ecology:** 15

1. Classification of microbes and their metabolism and ecology
2. Micro-organisms and their association with man, animals and plants.
3. Role of microbes in bio-remedial processes, ecological restoration and other environmental applications
4. Environmental factors affecting microbes, their cultivation and growth.
5. Concept of bio-indicators, bio-indicators as plants, animals, bio-indicators in

manmade environment, role of bio-indicator in pollution control.

6. Fundamentals of microbial nitrogen fixation and other pathways in terms of enzymology.

Unit 4. **Environmental Auditing** 15

Introduction: Environmental Assessment process, objectives of EIA, Terminology, Concepts related to EIA.

Methods of Impact Analysis, Environmental risk assessment, baseline data collection for EIA

Environmental Audit: Definition of Environment Audit and its importance for industries. Types of audits, General audit methodology and basic structure of audit.

Case studies of EIA for Industries like Oil/ Petrochemical/ iron and steel/ fertilizer/ sugar and distillery/ projects of road, dams and housing etc.

References

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4. Cutter, S.L., "Environmental Risk and Hazards", Prentice-Hall of India Pvt. Ltd., New Delhi, 1999.
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M.Sc. Botany, Part - II (Semester - IV)

Mandatory Major Core Theory Course

Course Code – BOT 651F MJ

Title of the Course: ADVANCED MYCOLOGY AND PLANT PATHOLOGY - II

[No. of Credits: 4 Credit] **[Total 60 Lectures]**

Course Objectives:

1. **Understanding the Economic Importance of Fungi**: Gain insight into the various economic roles of fungi, including their use as sources of vitamins, amino acids, organic acids, enzymes, and proteins. Explore their applications in the food industry, pharmaceuticals, agriculture (such as biofertilizers), and the production of secondary metabolites like mycotoxins.
2. **Comprehensive Knowledge of Lichens and Mycorrhizae**: Develop a deep understanding of lichens, including their general characteristics, distribution, classification, and ecological roles such as pollution monitoring. Explore the economic importance of lichens and their secondary metabolites. Additionally, study mycorrhizae, their classification, types, and significance in agriculture, forestry, and waste biodegradation.
3. **Identification and Management of Plant Diseases**: Learn to identify common fungal, bacterial, mycoplasmal, viral, and nematode diseases of plants based on symptoms, causal organisms, and disease cycles. Understand the principles and methods of disease management, including cultural, physical, biological, chemical, and integrated approaches, as well as disease resistance and molecular techniques.
4. **Understanding Disease Control Measures**: Gain knowledge about the principles, history, and modes of action of various disease control measures, including cultural practices, physical barriers, biological agents, chemical treatments, and integrated pest and disease management strategies. Understand the environmental and health hazards associated with chemical control methods and the importance of safety measures in their application.

Course Outcomes:

By studying the course students will able to……

CO-1 Recognize fungal association with plants, also understand their applied aspects.
CO-2 Apply knowledge of mycology in fields such as industry, food and medical aspects.
CO-3 Understand plant diseases and their managements.
CO-4 Execute the plant disease management through integrate approach.

Credit I: **15 lecture**

1. **Applied Mycology**: Economic importance of fungi, fungi as a source of vitamins, amino acids, organic acids, enzymes and proteins.
2. **Application of fungi in food industry** Flavour & texture, Fermentation, Baking, Organic acids, Enzymes, Mycoproteins
3. **Secondary metabolites:** Pharmaceutical and cosmeceutical preparations; Agriculture - Biofertilizers
4. **Mycotoxins**; Biological control-Mycofungicides, Mycoherbicides, Mycoinsecticides, Myconematicides.
5. **Medical mycology:** Humans- Ringworms, Aspergillosis, Candidiasis, Animals-Mucormycosis, Cryptococcosis, Coccidioidomycosis

Credit II: **15 lecture**

1. **Lichen**: General characteristics distribution, thallus structure and reproduction.
2. Classification and nomenclature of lichens, mechanism of phycobiont and mycobiont interaction.

3. Role of lichen in Succession and monitoring pollutants, Economic importance of Lichen, Secondary metabolites from lichens – Antibiotic, anti-viral, Anti-oxidant

- **Nutritional modes of fungi**-saprotrophs, biotrophs and necrotrophs.
- **Biodegradation of waste:** Solid and liquid waste management through fungi.
- **Mycorrhizae**: Definition, Classification, Types and Importance in agriculture, Application as biofertillizer and bioprotector in forestry and agriculture.

Credit III: 15 lecture

- **Study of Plant diseases with reference to symptoms, causal organism, disease cycle management of diseases of:**
- **Fungal Diseases**: Club root, Damping off, White rust, Early and late Blight, Downy mildew, Powdery mildew, Smut, Rust, Bunt, Blast, leaf spot, Tikka, Anthracnose, Rot, Wilt.
- **Bacterial Diseases**: Citrus canker, Pomegranate Blight and Leaf Spot.
- **Mycoplasmal Diseases**: Grassy shoot disease and Little leaf
- **Viral Diseases**: TMV, PMV and YVMV.
- **Nematode Disease**: Root knot

Credit – IV 15 lecture

Principles of Plant Disease Management

- Principles of plant disease management by cultural, physical, biological, chemical, organic amendments and botanicals methods of plant disease control, integrated control measures of plant diseases. Disease resistance and molecular approach for disease management.
- Foliage, seed and soil application of chemicals, role of stickers, spreaders and other adjuvants, health and environmental hazards, residual effects and safety measures.
- History of fungicides, bactericides, antibiotics, concepts of pathogen immobilization, chemical protection and chemotherapy, nature, properties and mode of action of antifungal, antibacterial and antiviral chemicals.
- Endemism in Pathology
- Integrated Pest Management (IPM), Integrated Disease Management (IDM)

References:

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M.Sc. Botany, Part - II (Semester - IV)

Mandatory Major Core Theory Course

Course Code – BOT 652 MJ

Title of the Course: BIOINFORMATICS AND BIO-STATISTICS

[No. of Credits: 4 Credit] **[Total 60 Lectures]**

Course Objectives:

1. Understand fundamental concepts of bioinformatics and biostatistics.
2. Learn to use bioinformatics tools for genomic and proteomic analysis.
3. Apply statistical methods to analyze biological data.
4. Develop skills in data visualization and interpretation.
5. Integrate bioinformatics and biostatistics in botanical research.

Course Outcomes:

1. Students will able to implement the knowledge of bioinformatics for the advanced studies in plant sciences.
2. Prediction and data validation of the hypothesis for futuristic studies.
3. Crucial interpretation of the data on the basis of statistical analyses.
4. Acquire employable skills for advanced data processing.
5. Improve the quality of the research.

BIOINFORMATICS - 2 Credit **30 L**

Credit I **15 L**

Unit I: Introduction to Bioinformatics **5 L**

Definition

Scope and applications of bioinformatics

1. Genomics and genome sequencing - Genome Assembly and Annotation, Comparative Genomics, Functional Genomics.
2. Proteomics - Protein Sequence Analysis, Protein Structure Prediction, Proteome Profiling.
3. Transcriptomic - RNA Sequencing (RNA-Seq), Splicing Variants, Gene Expression Analysis.
4. Metabolomics - Metabolic Pathway Analysis, Metabolite Profiling.
5. Phylogenetic and Evolutionary Biology - Phylogenetic Tree Construction, Molecular Evolution.
6. Structural Bioinformatics - Molecular Modelling, Drug Design and Discovery.

Unit II: Biological databases **5 L**

- NCBI (National Centre for Biotechnology Information) - Databases and Tools: GenBank, PubMed, BLAST (Basic Local Alignment Search Tool), Ref Seq (Reference Sequence Database); Applications - Genomic research, Comparative genomics, Phylogenetic, Biomedical research.
- EMBL (European Molecular Biology Laboratory - European Bioinformatics Institute) - Databases and Tools - ENA (European Nucleotide Archive), UniProt, Ensembl, Array

Express; Applications - Genome annotation, Functional genomics, Protein sequence analysis, Systems biology.

Unit III: Sequence Alignment and Analysis **5 L**

- DNA, RNA, and protein sequences.
- Pairwise and multiple sequence alignment -
    1. Pairwise sequence alignment – Global and local alignment;
    2. multiple sequence alignment – approaches: Progressive, Iterative, Consistency-Based Alignment
- Tools and software –
    1. BLAST (Basic Local Alignment Search Tool)
    2. ClustalW and Clustal Omega.

Credit II **15 L**

Unit I: Bioinformatics in Genomics **5 L**

- Genomics - Introduction and definition; Genome sequencing technologies - Sanger Sequencing, Next-Generation Sequencing (NGS), Third-Generation Sequencing, Single-Molecule Real-Time (SMRT) Sequencing, Nanopore Sequencing, Metagenomic Sequencing, Targeted Sequencing, Single-Cell Sequencing.
- Annotation and analysis of genomic data - Sequence Assembly, Gene Prediction, Functional Annotation, Pathway and Network Analysis, Comparative Genomics, Variant Analysis, Epigenetic Analysis.

Unit II: Proteomics **5 L**

- Proteomics – Introduction and definition; Protein Identification tools; Quantitative Proteomics; Post-translational Modification (PTM) Analysis; Protein-Protein Interaction (PPI) Analysis; Structural Proteomics; Data Integration and Visualization; Database Resources.
- Mass spectrometry data analysis - Data Pre-processing, Peak Picking, Alignment, Normalization, Statistical Analysis, Annotation, Visualization.

Unit III: Bioinformatics in Phylogenetic **5 L**

- Phylogenetic – Introduction and definition; Basics of phylogenetic analysis.
- Sequence Alignment; Construction of phylogenetic trees; Sequence Database Searches; Molecular Evolution Analysis; Bootstrap and Support Values, Phylogenetic Network Construction; Visualization and Interpretation; Comparative Genomics.
- Software tools - MEGA, PhyML.

BIOSTATISTICS – 2 Credit **30 L**

Credit III **15 L**

Unit I: Introduction to Biostatistics **6 L**

- Importance of biostatistics in biological research.
- Types of data and measurement scales, data representation.
- Sample and sampling methods
- Descriptive statistics (mean, median, mode, standard deviation, variance).

Unit II: Probability and Distributions **4 L**

- Basic concepts of probability.
- Probability distributions (normal, binomial, Poisson).
- Statistical inference and hypothesis testing.

Unit III: Experimental Design **5 L**

- Principles of experimental design.
- Randomization and replication.
- Types of experimental designs (completely randomized, randomized block, factorial).

Credit – IV

Unit I: Statistical Tests **5 L**

- Z, t and F test, One-way and two-way ANOVA.
- Assumptions and interpretation
- Post-hoc tests of ANOVA results.

Unit II: Correlation and Regression Analysis **5 L**

- Correlation – Concept, Types, Parametric and Non-parametric
- Simple and multiple linear regression.
- Model fitting and interpretation.
- Non-linear regression models.

Unit III: Multivariate Statistics **5 L**

- Factor analysis, Principal component analysis (PCA), Multi-dimensional scaling (MDS) .
- Cluster analysis, Types
- Applications in botanical research.

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7. A Textbook of Bioinformatics by C. Subramanian. Publisher: Dominant Publishers and Distributors (2004).
8. Bioinformatics – Methods and Applications by Ashwani Patel. Publisher: RBSA Publishers, Jaipur (2014).
9. Statistical methods in Biology, Third Edition, by Norman T.J. Bailey. Publisher: Cambridge University Press.
10. Basic Bioinformatics, Second Edition by S. Ignacimuthu. Publisher: Narosa Publishing House (2013).
11. Introduction to Bioinformatics – A Theoretical and Practical Approach By Stephen A. Krawetz and David D. Womble. Publisher: Humana Press, Totowa, New Jersey (2003).
12. Introduction to Bioinformatics, Second International edition by Arthur M. Lesk. Publisher: Oxford University Press (2020).

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M.Sc. Botany, Part - II (Semester - III)

Mandatory Major Core Practical Course

Course Code – BOT 653 MJP

Title of the Course: PRACTICAL BASED ON BOT 651A MJ

[No. of Credits: 4 Credit] **[Total 30 Practicals]**

Advance Taxonomy of Angiosperm-II

1. Study of plant families as per APG System / Bentham and Hookers' system of classification Nymphaeaceae, Magnoliaceae, Asparagaceae, Cucurbitaceae, Rutaceae, Santalaceae, Rubiaceae, Asteraceae 8P
2. Preparation of herbarium specimens, documentation and digitization 2P
3. Ex-situ conservation methods of biodiversity – through seed, vegetative methods. 2P
4. Semi-permanent pollen preparations by acetolysis method and study of different pollen morphotypes. 2P
5. Taxonomic distribution of special units of pollen dispersal- bi celled pollen, tetrads, polyads and pollinia and pollen types. 2P
6. Molecular tools in solving taxonomic problems: RFLP/ RAPD/ AFLP 3P
7. To find out digital herbarium by using any recognized website 1P
8. Visit to biodiversity hot spots/ any botanical institute. 2P
9. Botanical excursion to any biodiversity hot spot, preferably outside the State. 2P

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M.Sc. Botany, Part - II (Semester - III)

Mandatory Major Core Practical Course

Course Code – BOT 653 MJP

Title of the Course: PRACTICAL BASED ON BOT 651B MJ

[No. of Credits: 4 Credit] **[Total 30 Practicals]**

Cyto-Genetics and Plant Breeding-II

1. Study of meiosis in suitable plant material. 1P
2. Study of mitosis in suitable plant material. 1P
3. Study of G banding pattern using appropriate material. 2P
4. Study of salivary gland chromosome in *Chironomus* larva. 1P
5. Isolation of DNA using standard method and its qualitative test. 2P
6. Study of different physical and chemical mutagens. 1P
7. Estimation of Proline in drought resistance plant. 2P
8. Study of plant tissue culture technique using Embryo, anther and Meristem culture. 3P
9. Isolation of protoplast using enzymatic and mechanical method. 2P
10. Separation of DNA using Agarose Gel electrophoresis. 1P
11. Separation of seed storage protein using SDS-PAGE. 2P
12. Perform genetic identification of selected plant material using RAPD technique. 2P
13. Perform RFLP of suitable plant material and analyse the amplified product. 2P
14. Demonstration of PCR technique. 1P
15. Visit to Plant Tissue Culture Laboratory and Plant Breeding Research Centre and submission of Report. 1P

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M.Sc. Botany, Part – II (Semester – III)

Mandatory Major Core Practical Course

Course Code – BOT 653 MJP

Title of the Course: PRACTICAL BASED ON BOT 651C MJ

[No. of Credits: 4 Credit] **[Total 30 Practicals]**

Plant Physiology-II

1.	Measurement a rate of photosynthesis by Winkler's method	1P
2.	Determination of Rubisco in C3 and C4 plants	1P
3.	To study the growth rate, days to flowering, in any one plant subjected to altered photoperiod / excess nitrogen fertilizer / water deficiency.	2P
4.	Mineral nutrient deficiency symptoms in plant (Demonstration)	1P
5.	Studies on effect of mineral deficiency on plant growth.	1P
6.	Study the structure of stomata and find out their frequency on the adaxial and abaxial surfaces of the leaves	1P
7.	Plant growth analysis- RGR, CGR, NAR and Leaf area	2P
8.	Techniques to develop the deficiency symptoms of nutrients – Hydroponics/Aeroponics- diagnosis of deficiency symptoms in agriculturally important crop plants (Demonstration)	1P
9.	Separate the leaf pigments by column chromatography	1P
10.	Collection of acid phosphatase from root exudates and enzyme assay for Phosphorus.	2P
11.	Estimation of carotene pigments concentration in leaves of nutrient deficient and nutrient sufficient plants.	2P
12.	Assay of SOD activity for Cu, Zn and Mn	2P
13.	Estimation of nitrogen concentration in plant tissue - Kjeldhal and Dumas method / Estimation of phosphorus concentration in plant tissue – colorimetric method	2P
14.	Estimation of any one macro/ micro nutrient in plant tissue using suitable method	2P
15.	Estimation of total sugar/ carbohydrate and vitamins of ripened and unripened fruit	2P
16.	Show the effect of CO2 concentration on the rate of photosynthesis by using test tube funnel experiment.	1P

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M.Sc. Botany, Part - II (Semester - III)

Mandatory Major Core Practical Course

Course Code – BOT 653 MJP

Title of the Course: PRACTICAL BASED ON BOT 651D MJ

[No. of Credits: 4 Credit] **[Total 30 Practicals]**

Herbal Drug Technology-II

1. Physical evaluation of biodrugs: determination of ash and extractive values. 1P
2. Determination of bitterness value and foaming index. 1P
3. Determination of moisture content, LOD and Swelling index. 1P
4. Estimation of fibre content, total solids, FOM and others. 1P
5. In vitro determination of antioxidant of plant extract 2P
6. Preparation and standardization of Asavas, Aristas and Churna. 3P
7. Preparation and standardization of sunscreen, UV protection cream, skin care formulations. 3P
8. Evaluation of herbal tablets and capsules. 2P
9. Formulation & standardization of herbal cough syrup. 2P
10. Formulation of herbal neutraceuticals (Any two) 2P
11. Analysis of Pharmacopoeial compounds of natural origin and their formulations by UV-Visible spectrophotometer. 2P
12. Collection of ethnobotanical drugs from tribal people/Area (Any Five). 1P
13. Collection and in-vitro culture of rare and endangered medicinal plants (Any two). 2P
14. Visit to Herbal drug Industry and Submission of report 1P

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M.Sc. Botany, Part - II (Semester - III)

Mandatory Major Core Practical Course

Course Code – BOT 653 MJP

Title of the Course: PRACTICAL BASED ON BOT 651E MJ

[No. of Credits: 4 Credit] **[Total 30 Practicals]**

Practical's on Credit-I: Seed Health Testing

1.	Study any one disease of cereal crop w.r.t. casual organism, symptoms and control measures	1P
2.	Study any one disease of fibre crop w.r.t. casual organism, symptoms and control measures	1P
3.	Study any one disease of oil seed crop w.r.t. casual organism, symptoms and control measures	1P
4.	Study any one disease of pulse crop w.r.t. casual organism, symptoms and control measures	1P
5.	Study any one disease of vegetable crop w.r.t. casual organism, symptoms and control measures	1P
6.	Analyse the seedlings for germinated, non-germinated, hard seed, dead seed, diseased seed and calculate percent seed germination in suitable seed sample	1P
7.	Identification of diseases with Blotter Paper/Agar Plate technique and microphotography of the pathogens	1P

Practical's on Credit-II: Basic of Plant Biotechnology

8.	Perform genetic identification of selected plant variety using RAPD technique	2P
9.	Perform RFLP of suitable plant variety and analyse amplified product	1P
10.	Demonstration of DNA fingerprinting for varietal identification	1P
11.	Perform western blotting techniques using protein sample (Isolated from suitable seed material)	2P
12.	Perform southern (DNA)/northern (RNA) blotting technique	1P

Practical's on Credit-III: Applied Plant Biotechnology

13.	Perform washing, sterilization of glassware's and suitable culture media preparation	1P
14.	Perform anther/embryo culture of suitable explant	1P
15.	Perform micro propagation technique in Banana	1P
16.	Somatic embryogenesis and synthetic seed preparation	1P
17.	Study effect of synthesized nanoparticle on seed germination	1P

Practical's on Credit-IV: Hybrid Seed Production

18.	Study field techniques for hybrid seed production	1P
19.	Perform emasculation and pollination technique in Cotton/Okra and detasseling and pollination technique in Maize	1P
20.	Perform laboratory method for confirmation of sterility in suitable crop by aceto-carmine test and calculate percent pollen viability	1P
21.	Perform the experiment for *In vitro* germination of suitable pollen grains, microphotography and calculate the percent pollen germination.	1P
22.	Visit to commercial hybrid seed production plot	1P

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M.Sc. Botany, Part - II (Semester - III)

Mandatory Major Core Practical Course

Course Code – BOT 653 MJP

Title of the Course: PRACTICAL BASED ON BOT 651F MJ

[No. of Credits: 4 Credit] **[Total 30 Practicals]**

Practical based on Applied Ecology and Environment-II (4 CREDITS)

1.	Study of terrestrial and aquatic ecosystem	2
2.	Study of indigenous exotic, invasive species of surrounding area	2
3.	Study of Environmental clearance and EIA report and visit to sugar factory/ distillery nearby area	2
4.	Preparation of media for microbial culture, Isolation and culturing of microbes from soil / water samples, Gram Staining.	2
5.	Baseline data collection for one season of any project	3
6.	Case study of EIA of any one project based on Oil/ Petrochemical/ iron and steel/ fertilizer/ sugar and distillery/ projects of road, dams and housing etc.	3
7.	Analysis of historical instrumental data from IMD	2
8.	Extraction of climatic data from repositories like Earth Null	2
9.	Bioremediation of textile dyes using fungi	2
10.	Study the map of phytogegraphical regions of India.	2
11.	Visit to EIA consultant organization for understanding EIA procedures	2

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M.Sc. Botany, Part - II (Semester - III)

Mandatory Major Core Practical Course

Course Code – BOT 653 MJP

Title of the Course: PRACTICAL BASED ON BOT 651G MJ

[No. of Credits: 4 Credit] **[Total 30 Practicals]**

Course Objectives:

1 **Mastery of Fungal Isolation Techniques**: Develop proficiency in the Warcup method for isolating soil fungi and the isolation of nematophagous fungi from garden or agricultural soil. Gain hands-on experience in the isolation of fungal pathogens from infected plant material, enhancing skills in microbiological techniques and fungal identification.

2 **Understanding the Mechanisms of Pathogen Inhibition**: Gain insight into the in-vitro inhibition of plant pathogens by different plant extracts and the effect of fungicides on the germination and growth of plant pathogenic fungi. Understand the principles underlying the antifungal properties of plant extracts and chemicals, contributing to the development of novel disease management strategies.

3 **Quantification of Fungal Growth**: Learn techniques for measuring fungal growth using linear determination methods and studying the effect of incubation temperatures on fungal growth. Develop skills in experimental design, data collection, and interpretation, facilitating research on fungal physiology and ecology.

4 **Study of Specific Plant Diseases**: Acquire knowledge of specific plant diseases such as wart of potato, downy mildew of grapes, bunt of rice, and citrus canker. Understand the symptoms, causal agents, disease cycles, and management strategies associated with each disease, enhancing expertise in plant pathology and disease diagnosis.

Course Outcomes:

By studying the course students will able to……..

CO-1 Implement mycological methods to isolate fungi, soil nematodes and infected plant leaves.

CO-2 Estimate minimum inhibitory concentration and salt on fungal growth.

CO-3 Examine fungal growth and effect of temperature on fungal growth.

CO-4 Understand plant diseases according to their symptoms, causal organisms.

Practical based on Advanced Mycology and Plant Pathology - II

1	Isolation of soil fungi by Warcup method	3P
3	Measurement of fungal growth by linear determination	2P
4	Study of effect of incubation temperatures on fungal growth (15^0C, 30^0C & 60^0C)	3P
5	Isolation of nematophagus fungi from garden soil/agriculture soil	2P
6	Isolation of fungal pathogens from infected leaves	3P

7	Study of the following diseases: i) Wart of potato ii) Downy mildew of grapes iii) Bunt of rice iv) Tobacco, Cauliflower Mosaic Virus v) Little leaf of Brinjal vi) Grassy shoot of Sugarcane vii) Citrus canker viii) bacterial blight of Pomegranate	4P
8	Minimum inhibition concentration of salt (Which salt? NaCl?) on fungal growth	2P
9	Study of the effect of fungicides and plant extracts on the germination and growth of plant pathogenic fungi	2P
10	Study of Lichen diversity in your area.	1P
11	Field study about symptomology and management of plant diseases in your area.	2P

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M.Sc. Botany, Part - II (Semester - IV)

Mandatory Major Core Theory Course

Course Code – BOT 681 RP

Title of the Course: MAJOR RESEARCH PROJECT

[No. of Credits: 6 Credit]

GUIDELINES FOR MAJOR RESEARCH PROJECTS

Semester	Verticals	Course Type	Course Code	Course Title	Credits	Internal Marks	External Marks
IV	Research Project	Core	BOT 681 RP	Major Research Project	6C	30	70

Research Committee: A research committee is to be constituted in the department with HoD as the Chairman, Research Guide and one faculty related to the subject from the same department/other institute as the members.

Guide: Normally a candidate shall be required to complete his/her minor/major research work under the supervision of the guide allotted to him/her by the department. However, the Research Committee concerned may allow change of guide on the production of a 'No Objection Certificate' from the first guide and an acceptance letter from the new guide.

Outline Preparation: Students are supposed to identify relevant topic for research in concern with the mentors and prepare an outline stating

I. Introduction

- Background and context
- Research question(s) or hypothesis
- Purpose and scope of the study
- Significance and relevance of the research

II. Literature Review

- Overview of relevant theories and concepts
- Summary of previous research on the topic

III. Methodology

- Research design and approach
- Data collection methods (e.g., surveys, interviews, experiments)
- Data analysis methods (e.g., statistical tests, thematic analysis)

IV. Expected Outcomes

- Potential findings and implications
- Contribution to the field of study
- Practical applications and significance

V. Timeline and Milestones

- Research schedule and deadlines
- Expected completion dates

VII. Conclusion

- Summary of the research project and its goals
- Expected impact and significance
- Future directions for research

(Note: This is just a general outline, and the specific sections and details may vary depending on the research project and field of study.)

The outline is to be presented in front of the research committee for topic finalization. Corrections (if any) suggested by the committee to be incorporated, finalized and submitted to the department.

Progress: All the students shall be required to submit the elaborated progress report to the Head, Place of Research, through their research guides every month (Appendix -A). The committee shall scrutinize the progress reports and prepare a brief statement on the progress of the student which will be considered for evaluation.

Submission and Evaluation of Synopsis and Thesis: The submission of synopsis and pre-submission seminar is to be considered for internal evaluation (15 Marks). The synopsis should contain introduction, chapter-wise brief account of the work done and overall conclusions. Student has to publish one research paper in a standard refereed journal before the submission of the thesis or present oral/poster paper in a Conference/Seminar, and produce evidence for the same in the form of acceptance letter/reprint/certificate. At the time of synopsis submission the student shall give a pre-submission seminar in front of the Research Committee.

The submission of the thesis shall be considered for external evaluation (35 Marks). The thesis shall be submitted in compact bound form at the time of final practical exam. Two copies of the abstract shall be submitted at the time of final project evaluation. The final thesis shall be presented in accordance with the following specifications: The paper used for printing shall be of A4 size; Printing shall be in a standardized form on both sides of the paper and in 1.5 line spacing; A margin of 1.5 inches shall be on the left hand side; The card for cover shall not be more than 330 GSM; The title of the thesis, name of the candidate, degree, name of the guide, place of research, the month and year of submission shall be printed on the title page and the front cover; The hard-bound thesis cover shall be of black colour.

The thesis shall include a Declaration by the student, [Appendix-B], Certificate of the guide [Appendix-C], that the work reported in the thesis has been carried out by the student himself/herself and that the material from other sources, if any, is duly acknowledged. The thesis shall be written in English. It should include Acknowledgement, Index, List of Tables/Graphs/Photographs (if any), Introduction, Review of Literature, Materials and Methods, Results and Discussion, Summary and Conclusions, References etc.

Note: Minor and major research projects for semester-III and IV may be correlated so that the candidate will get more time for quality research work and paper publication/presentation.

Format for Progress Report, Declaration of Candidate and Certificate of Research Guide is same as mentioned in guideline of Minor research project.

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M.Sc. Botany, Part - II (Semester - IV)

Major Elective Theory Course

Course Code – BOT 660 MJ

Title of the Course: ORGANIC FARMING AND SOIL HEALTH TECHNOLOGY

[No. of Credits: 2 Credit] **[Total 30 Lectures]**

Course Objectives:

1) To create awareness about organic farming and soil health.
2) To familiarize with organic crop management practices, organic standards and certification
3) To equip learners with the knowledge and skills necessary to maintain the soil health and to practice sustainable agriculture and the production of healthy, organic food.
4) To introduce the concept of organic ecosystem
5) To inoculate the importance of soil health and doing organic farming as the responsibility

Course Outcomes:

Learning Attributes (GAs) are measurable outcomes that signify the capabilities and potentials of the students to attain accomplishment and perform in adequate manner at appropriate situations. Following are the attributes of learning this course.

CO1. Fundamentals and acquaintance with subject- Gain in-depth knowledge and understandings of each

CO2. Problem analysis: Ability to analyze and address multifaceted scientific issues to organic farming.

CO3. Application of modern tool and techniques: Select, learn and apply appropriate techniques, resources, sophisticated instruments all knowledge for explaining different activities.

CO4. Problem Solving: Address and solve scientific vis-a-vis environmental problems via rational and original thinking.

CO5. Multidisciplinary competence: Develop sound knowledge and perception initiatives and leadership in collaborative-multidisciplinary and trans-disciplinary scientific research.

CO6.Communication: Ability to communicate scientific/technological knowledge and new learning to the scientific community and the society

CO7.Ethical values and moral values: Attain strong academic integrity, professional code of conduct, ethics of experimental research.

CO8. Futuristic approach: Ability to recognize and address current issues of land degradation and sustainable agriculture in changing world with a futuristic view and practicing intuitiveness and interest towards scientific prediction via application of basic knowledge of science especially with regard to India's SDGs and national action plan for sustainable development.

Credit- I - ORGANIC FARMING

Unit-1 Organic Farming: **2L**

- Stages in Agricultural Development – History of Alternative Agricultural Development

Organic farming-

-Need, Definition and Components, Concepts-

-Organic Concept

-Holistic Concept

-Living Soil Concept

-Healthy Plant Concept

-Essential characteristics-

-Natural farming,

-Biodynamic farming,

-Zero Budget Farming.

Unit 2. Principles, Approaches and Initiatives of Organic Farming **3L**

Principles-

Health, Ecology, Fairness, Care

Approaches of Organic Farming

-Traditional, Sustainable, Biodynamic, Natural Farming, Permaculture, -LEISA Farming

Initiatives of Organic Farming in India

-Major Organic Products from India, Constraints for Organic Farming, Potential Customers for Organic Products in the Domestic Market

Unit 3. Organic Farm Designing, Structures and Cultural Practices **3L**

Designing

- Components of an Organic Farm, Characteristics, Planning and Layout of the Farm, Farm Components in Different Agro Eco-Systems, Field Crops in Organic Farms, Buffer Zone

Farm Structures-

-Cattle Shed, Compost Yard, Benefits of Trees in organic Farm, Farm Biodiversity

Cultural Practices-

-Land Preparation for Organic farming, Pre Sowing Irrigation, Crop Rotation Intercropping, Mixed Cropping, Destruction of Volunteer Plants

Unit 4. Inspection of Organic Produce **4L**

Basics of Inspection, Requirements for Inspection, Key Steps in the Inspection Procedure, Check Lists for Inspection.

Critical Control Points (CCP)

General Introduction to HACCP and CCP, Organic Critical Control Points (OCCP) at different Stages, Risk Assessment, Organic Crop Protection Strategies

Certification Trademark

IFOAM Guidelines, NPOP Guidelines, Grant of License, Use of logo, Signification of Certification Trademark, Description of Organic Certification Trademark.

Unit 5. Marketing of Organic Produce **3L**

Classification of Markets Channel of Distribution, Role of Middlemen, Understanding the Marketing Process, Current Status of World Organic Market, Organic Market in India, Limitation of Organic Market in India

Economics of Organic Production

Benefit-Cost Ratio, Comparison between Organic and Conventional Production System, Economics of Organic Farming, Role of Organic inputs in the Economics of Organic Farming

Benefits of Organic Farming

-Economic, Ecological, Social.

Credit- II –SOIL HEALTH TECHNOLOGY

Unit 1. Introduction and Scope **2L**

- Definition and concept
- Ill effects of Green Revolution
- Detrimental effects of currently chemical dependant farming.
  - Reduction of crop production due to depletion of soil Health.
  - Pesticide contamination and human health hazard.
  - Contamination of food products by pesticides & chemicals.
  - Environmental (soil, water, air) pollution.
  - Reduction of natural enemies of crop pests.
  - Threat to Bio diversity

Unit 2. Commodity Technology for soil health **3L**

-Nutrients

- Sources of nutrients for Organic Agriculture, -Management in Organic farming and soil testing, Functions of Nutrients in growth and Development of crops

-Biofertilizers development and maintenance

-Green manures, Vermicomposts, Vermiwash, Mycorrhiza, BGA, and Azolla

-Biopesticides –

-Introduction, Types and importance, Organic insecticides and fungicides, Shelf life and sell of Biopesticides

Unit 3. Soil Physics **4L**

Soil as a three-phase system, volume and mass relationships of soil constituents. Soil texture, soil strength,

Soil water- content and potential, soil water retention, soil-water constants,

measurement
of soil water content, energy state of soil water, soil water potential, soil-moisture characteristic curve; hysteresis, measurement of soil-moisture potential.
Poiseuille's
law, Darcy's law, hydrologic cycle, field water balance, soil-plant-atmosphere continuum.
Soil Air-
Composition of soil air, measurement of soil aeration, aeration requirement for plant growth, thermal properties of soil, measurement of soil temperature, soil temperature in relation to plant growth;

Unit 4. Soil Chemistry **4L**

-Modern concept of soil; Chemical (elemental) composition of the soils, Concept and importance of soil solution, chemistry of soil water, soil and plant nutrition, Soil colloids, origin of charge, concept of point of zero-charge (PZC), zeta potential, stability soil organic matter, fractionation of soil organic matter and different fractions,
Ion exchange processes in soil, Chemistry of acid soils, active and potential acidity, soil
acidity reclamation, soil pH, ECe, ESP, SAR and important relations.

Unit 5. Soil Biology **3L**

-Soil biota, soil microbial ecology, types of organisms in different soils, soil microbial biomass, microbial interactions, un-cultivable soil biota, Microbiology and biochemistry of root-soil interface, rhizosphere, soil enzymes - origin, activities and importance, soil characteristics influencing growth and activity of microflora, Biochemical composition humus formation, Organic wastes and their use for production of biogas and manures, biotic factors in soil development; microbial toxins in the soil.

References:

1. Dhaliwal, G.S. and D.S. Kler. (2000). Agricultural Ecology, Himalaya Publishing Company, Mumbai.

2. IIRR (1996), Recording and using Indigenous Knowledge: A Manual International Institute of Rural Reconstruction, Silang, Cavite, Philippines.

3. Palaniappan.S.P. and K. Annadurai.(1999). Organic Farming Theory and Practice. Scientific Publishers (India), Jodhpur.

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5. Sundaramari, M. (2003). Indigenous Agricultural Practices for Sustainable Farming, Agrobios (India), Jodhpur.

6. Alvares, C.,1996. The Organic Farming Source Book. The other India Press, Mapusa, Goa.

7.Principles of Organic farming, with theory and practicals, E. Somasundaram,D.

Udayanandini,M. Meyyappan.

8. Organic Urban farming,The Indian Way, Prabal Mallik

9. Organic Horticulture, Principles, Practicals and Technologies, H. P. Sing

10. Integrated Organic farming Handbook, Dr. H. Panda

11. The World of Organic Agriculture: Statistics and Emerging Trends 2008, Edited by HegaWiller

12. Organic farming for Sustainable Agriculture, DilipNandwani, Springer

18. Farm to table Organic Food, English Paper back, Scholastics

19. Sustainable Family Farming and Organic Gardening, BreendonZontle

20. Organic Farming Book/PDF Agrigyan.in.2020

21. National Organic –Farming Handbook Directives System – USDA

22. Farmer's Basic Agriculture –Manage, http://www.manage.gov.in

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M.Sc. Botany, Part - II (Semester - IV)

Major Elective Theory Course

Course Code – BOT 661 MJ

Title of the Course: GREEN NANO-TECHNOLOGY

[No. of Credits: 2 Credit] **[Total 30 Lectures]**

OBJECTIVES:

1. To introduce the concept of green nano-technology and its significance in sustainable development.
2. To familiarize students with the synthesis and characterization techniques of green nanomaterials.
3. To explore the applications of green nanotechnology in life sciences.

OUTCOMES:

After completion of this course students are able to,

1. Define the nanomaterial and know the importance of nanomaterials
2. Understand the utilization process of nanomaterials in medical science
3. Explain the structure of nanomaterials

Credit I **15 L**

Unit I: Introduction to Green Nano-Technology **2 L**

1. Definition and significance of green nano-technology.
2. Concept of Nanoparticle.
3. Principles of green chemistry and its application in nano-technology.

Unit II: Physicochemical Properties of Nanoparticles **6 L**

1. Physical – Size, shape, and Density.
2. Chemical – Reactivity, Surface chemistry.
3. Biological – Biocompatibility, cellular uptake.
4. Thermal – Melting point, conductivity, Expansion and Heat capacity.
5. Optical – Plasmonic properties, Quantum confinement.
6. Magnetic – Superparamagnetism.
7. Mechanical – Strength, hardness, Elasticity, Flexibility.

Unit III: Types of Nanomaterials **7 L**

1. Carbon Based Nanomaterials - Carbon Nanotubes (CNTs) and Fullerenes
2. Metallic Nanomaterials - Metal and Metal Oxide Nanoparticles
3. Ceramic Nanomaterials - Ceramic Nanotubes, Silica Nanoparticles, Ceramic Nanocomposites, Ceramic Thin Films

4. Semiconductor Nanomaterials - Quantum Dots, Nanowires, Nanorods, Nanocrystals, nanotubes, 2D Semiconductor Materials, Colloidal Semiconductor Nanocrystals.
5. Polymeric Nanomaterials – Polymeric Nanoparticles, Nanocomposites, Dendrimers, Nanofibers, Nano-capsules, Micelles, Nanogels.
6. Lipid Based Nanomaterials – Liposomes, Solid Lipid Nanoparticles (SLNs), Nanostructured Lipid Carriers (NLCs), Lipid-Based Micelles, Lipid-Coated Nanoparticles and nanotubes.

Credit II **15 L**

Unit I: Methods of Nanomaterial synthesis **6 L**

1. Top Down Synthesis Method - Mechanical Milling, Laser Ablation, Electron Beam Lithography, Ball Milling
2. Bottom up Synthesis Method - Chemical Precipitation; Sol-Gel, Hydrothermal and Microemulsion Synthesis
3. Biological Synthesis Methods - Plant-Mediated, Microbial, Enzyme-Mediated, Cellular Extract-Mediated, Bioinspired, and Protein-Mediated Synthesis.

Unit II: Characterization of Nanoparticles **6 L**

1. Morphological characterizations - Transmission Electron Microscopy (TEM) and Scanning Electron Microscopy (SEM).
2. Structural Characterization – X-ray Diffraction (XRD), Fourier Transform Infrared Spectroscopy (FTIR), Zeta Potential Measurement
3. Optical Characterization: UV-Visible Spectroscopy, Fluorescence Spectroscopy
4. Size and Size Distribution - Dynamic Light Scattering (DLS), Atomic Force Microscopy (AFM).
5. Thermal Properties - Thermogravimetric Analysis (TGA), Differential Scanning Calorimetry (DSC).

Unit III: Applications of Green Nano-Technology **3 L**

Applications of nano-particles in - water Treatment; Renewable Energy; Environmental Remediation; Sustainable Agriculture; Packaging Materials; Energy Storage and Biomedical Applications

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1. Sengupta, A., & Sarkar, C. Kumar. (Eds.). (2015). *Introduction to nano : basics to nanoscience and nanotechnology*. Springer
2. Hays, S. A. (2013). *Nanotechnology, the brain, and the future*. Springer.

3. Kulkarni, S. K. (2014). *Nanotechnology : principles and practices* (Third edition.). Springer. https://doi.org/10.1007/978-3-319-09171-6
4. Malsch, I., & Emond, C. (Eds.). (2013). *Nanotechnology and human health*. Taylor & Francis.
5. Zhong Lin Wang, Handbook of Nanophase and Nanomaterials (Vol 1 and II) Springer
6. J.C.Vickerman, Surface Analysis: The Principal Techniques, John Wiley and Sons.

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M.Sc. Botany, Part - II (Semester - IV)

Major Elective Theory Course

Course Code – BOT 662 MJ

Title of the Course: MUSHROOM CULTIVATION TECHNOLOGY

[No. of Credits: 2 Credit] **[Total 30 Lectures]**

Credit I **(15 L)**

1. **Introduction to mushrooms:** 3L

History and Scope of Mushroom Cultivation; Morphology and life cycle of mushroom, Differentiation of edible and poisonous mushroom, Global and National Scenario of Mushroom Industry

2. **Mushroom ecology:** 3L

Habitat, nutrition, life cycle of button and oyster mushrooms, conservation and diversity; nutritional and medicinal importance of mushrooms, ethno -medicinal Importance of mushrooms.

3. **Mushroom Classification:** 3L

Based on occurrence- Epigenous & Hypogenous, Natural Habitats, Humicolous, Lignicolous, Terricolous & Coprophilous. Macro-and micro morphology of fruit bodies- gilled fungi and pore fungi

4. Nutritional and medicinal value of mushroom, Health benefits of Mushroom, economic importance of mushroom cultivation 3L

5. **Cultivation System and Farm design:** 3L

Fundamentals of cultivation system- small unit & larger commercial unit. Principles of mushroom farm layout- location of building plot, design of farm, composting platform, equipment and facilities, pasteurization room and growing rooms.

Credit II (15 L)

1. Mushroom Spawn (seed) production 2L

Definition, facilities required for spawn preparation, Sterilization of glassware, equipment, and culture media used in mushroom cultivation Preparation of pure culture, media used in raising pure culture; culture maintenance, preparation of spawn substrate, Preparation of mother spawn and commercial spawn, storage of spawn, Criteria for selection of good quality spawn

2. Mushroom bed preparation- 2L

Paddy straw, sugarcane trash, maize straw, banana leaves. Factors affecting the mushroom bed preparation. Composting: Principles of composting, machinery required for

compost making, materials for compost preparation. Methods of Composting- Long method of composting and Short method of composting

Casing: Definition, Importance of casing mixture, Quality parameters of casing soil, different types of casing mixtures.

3. Cultivation of economically important and medicinal mushrooms- 4 L

Agaricus bisporus (Button mushroom), *Pleurotus sajor-caju*, *Volvariella volvacea*, Ganoderma lucidum (Reishi), Lentinula edodes (Shiitake)

4. Cropping, Harvesting and storage 2L

Cropping and Harvesting, Post-harvest technology-Preservation of mushrooms - freezing, dry freezing, drying, canning, quality assurance and entrepreneurship. Storage of fresh and dry mushroom, Short-term storage, Long-term storage, Processing of mushrooms (canning, dehydration, and packing)

5. Disease and pest management: 1L

Pest and pathogens of mushroom; control measures; Integrated Pest Management (IPM).

6. Value addition of Mushroom 1L

Value added products / recipes, Quality assurance, packaging 2L

7. Marketing of mushroom: market demand, market channels, direct marketing and wholesale marketing. Business plan, Banking – Deposit, loan facilities, government sponsored schemes and subsidies, legal process in company or industry registration and agriculture finance and patenting.

References:

1. Pandey, R.K. and Ghosh, S.K. (1996). A handbook of Mushroom Cultivation. Emkey Publication.
2. Pathak, V.N. and Yadav, N. (1998). Mushroom Production and Processing Technology. Agrobios, Jodhpur.
3. Nita, B. (2000). Handbook of Mushrooms. Vol 1 & 2. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
4. Tewari, P. and Kapoor S.C. (1998). Mushroom Cultivation, Mittal Publication, New Delhi.

National Education Policy 2020

M.Sc. Botany, Part - II (Semester - IV)

Major Elective Practical Course

Course Code – BOT 663 MJP

Title of the Course: PRACTICAL BASED ON BOT 660 MJ

[No. of Credits: 2 Credit] **[Total 15 Practicals]**

Practicals:

1.	Preparation of Bio pesticides formulations and Botanical pesticides	1P
2.	Zero Budget Farming components and preparation of organic nutrients.	1P
3.	Vermicomposting, Verm wash and Jeevamrut making	1P
4.	Preparation of Panchagavya, Beejamrut	1P
5.	Measurement of soil-water content by different methods	1P
6.	Soil temperature measurements by different methods	1P
7.	Extraction and determination of available plant nutrients in soil	1P
8.	Potentiometric and conductometric titration of soil humic and fulvic acids	1P
9.	Determination of soil microbial population; Soil microbial biomass	1P
10.	Analysis of soil and plant samples for N, P, K, Ca, Mg, S, Zn, Cu, Fe, Mn; B and Mo	2P
11.	Soil fertility evaluation by chemical and biological methods	1P

National Education Policy 2020

M.Sc. Botany, Part - II (Semester - IV)

Major Elective Practical Course

Course Code – BOT 664 MJP

Title of the Course: PRACTICAL BASED ON BOT 661 MJ

[No. of Credits: 2 Credit] **[Total 15 Practicals]**

Green Nanotechnology

1	To study the synthesis of micelles and inverse micelles.	1P
2	To study the synthesis of Silver nanoparticles chemical and biogenic methods	2P
3	To study the synthesis of Copper Oxide and Zinc Oxide nanoparticles chemical and biogenic methods	2P
5	To study the synthesis of Iron Oxide Nanoparticle	2P
6	To determine the Absorption Maxima of synthesized nanoparticles	1P
7	To study the characterization methods for the nanomaterials (Demonstration) 1. FTIR 2. XRD 3. SEM 4. TEM 5. Zeta Sizer	1P
8	To study the thin film preparation by spin coating technique	2P
9	Study of Resistivity measurement of a thin film	1P

National Education Policy 2020

M.Sc. Botany, Part - II (Semester - IV)

Major Elective Practical Course

Course Code – BOT 665 MJP

Title of the Course: PRACTICAL BASED ON BOT 662 MJ

[No. of Credits: 2 Credit] **[Total 15 Practicals]**

PRACTICALS

1. Study of morphology of any 6 edible mushrooms & variations in mushroom morphology. 1P
2. Preparation of culture media, Sterilization of glassware, equipment, and culture media used in mushroom cultivation 2 P
4. Preparation of Mushroom spawn 1 P
5. Cultivation of any three mushroom- White button mushroom, Paddy straw mushroom, Oyster mushroom, Ganoderma. (White button mushroom, and Ganoderma Cultivation is not possible at collage level!), Milky white mushroom 3 P
6. Study of disease in White button and Paddy straw mushroom 2P
7. Preparation of value added products / recipes of Mushroom 2P
8. Visit to Mushroom Cultivation Unit / industry 1P