Anekant Education Society's
Tuljaram Chaturchand College of Arts, Science & Commerce, Baramati
(Empowered Autonomous)

Two Year Degree Program in Botany
(Faculty of Science & Technology)

CBCS Syllabus
M.Sc. (Botany) Part-I Semester –I

For Department of Botany NEP 2.0
Choice Based Credit System Syllabus (2026 Pattern)
(As Per NEP 2020)

To be implemented from Academic Year 2026-2027
Department of Botany

Title of the Programme: M.Sc. (Botany)

Preamble

AES's Tuljaram Chaturchand College of Arts, Science and Commerce (Autonomous) has made the decision to change the syllabi of across various faculties from June, 2023 by incorporating the guidelines and provisions outlined in the National Education Policy (NEP), 2020. The NEP envisions making education more holistic and effective and to lay emphasis on the integration of general (academic) education, vocational education and experiential learning. The NEP introduces holistic and multidisciplinary education that would help to develop intellectual, scientific, social, physical, emotional, ethical and moral capacities of the students.

The NEP 2020 envisages flexible curricular structures and learning based outcome approach for the development of the students. By establishing a nationally accepted and internationally comparable credit structure and courses framework, the NEP 2020 aims to promote educational excellence, facilitate seamless academic mobility, and enhance the global competitiveness of Indian students. It fosters a system where educational achievements can be recognized and valued not only within the country but also in the international arena, expanding opportunities and opening doors for students to pursue their aspirations on a global scale.

In response to the rapid advancements in science and technology and the evolving approaches in various domains of Botany and related subjects, the Board of Studies in Botany at Tuljaram Chaturchand College of Arts, Science and Commerce (Autonomous), Baramati - Pune, has developed the curriculum for the first semester of F.Y. B.Sc. Botany which goes beyond traditional academic boundaries. The syllabus is aligned with the NEP 2020 guidelines to ensure that students receive an education that prepares them for the challenges and opportunities of the 21st century. This syllabus has been designed under the framework of the Choice Based Credit System (CBCS), taking into consideration the guidelines set forth by the National Education Policy (NEP) 2020, LOCF (UGC), NCrF, NHEQF, Prof. R.D. Kulkarni's Report, Government of Maharashtra's General Resolution dated 20th April and 16th May 2023, and the Circular issued by SPPU, Pune on 31st May 2023.

A Botany Post Graduates degree equips students with the knowledge and skills necessary for a diverse range of fulfilling career paths. Post Graduates in Botany find opportunities in various fields, including urban planning, teaching, environmental science, all plant sciences, Bioinformatics, Genetic Engineering, Biostatistics, Plant Biotechnology Database analysis, Organic farming, nursery management, entrepreneurship mushroom cultivation, Plant physiology, Bryology, Taxonomy, Ethnobotany, plant tissue culture method and many other domains. Throughout their Two-year degree program, students explore the significance of plant in life of each and every living organism on Earth. They learn tool, techniques, process which is required to set up agencies including pickles, jam, and jelly medicinal plant, fruit processing, vegetable processing, organic product, organic fertilizer and pesticides producing

industries also the can earn the knowledge to produce natural remedies for varies diseases. They became expert in discovery and development of many new therapeutic compounds which can be used in pharmaceutical herbal cosmetics and other cosmetic based industries.

Overall, revising the Botany syllabi in accordance with the NEP 2020 ensures that students receive an education that is relevant, comprehensive, and prepares them to navigate the dynamic and interconnected world of today. It equips them with the knowledge, skills, and competencies needed to contribute meaningfully to society and pursue their academic and professional goals in a rapidly changing global landscape.

Anekant Education Society's

Tuljaram Chaturchand College of Arts, Science and Commerce, Baramati

(Empowered Autonomous)

Faculty of Science and Technology

Post-Graduate Programme Outcomes: 2026 Pattern

As per National Education Policy (NEP) 2020
Applicable from Academic Year 2026–2027

PO No.	Programme Outcome Description
PO1	**Advanced Disciplinary Knowledge & Originality:** Demonstrate comprehensive and advanced knowledge in the chosen field of science, extending beyond the undergraduate level, providing a specialized foundation for developing and applying original ideas, particularly within a research context.
PO2	**Research, Analysis, and Complexity:** Formulate hypotheses and design experiments while demonstrating the capacity to integrate knowledge and handle complex information, even when it is incomplete or limited.
PO3	**Problem Solving in New Contexts**: Apply theoretical knowledge and problem-solving abilities to unfamiliar, real-world, or multidisciplinary environments, moving beyond standard classroom scenarios to innovative applications.
PO4	**Technical Mastery and Scientific Reasoning:** Utilize modern tools, specialized techniques, and instruments with high proficiency, underpinned by deep rationale and scientific reasoning for the choice of methodology.
PO5	**Integrated Communication:** Clearly and unambiguously communicate complex scientific conclusions and the supporting knowledge and rationale to both specialist peers and non-specialist stakeholders.
PO6	**Ethical, Social and Professional Judgment:** Adhere to strict ethical standards in research while reflecting on social and environmental responsibilities linked to the application of scientific knowledge and professional judgments.
PO7	**Autonomous and Lifelong Learning:** Exhibit learning skills necessary to pursue further study or professional development in a largely self-directed and autonomous manner.
PO8	**Employability, Innovation, and Entrepreneurship:** Translate advanced technical skills and independent thinking into professional excellence within industry, academia, or entrepreneurial ventures.

Anekant Education Society's
Tuljaram Chaturchand College of Arts, Science and Commerce, Baramati
(Empowered Autonomous)
Course Structure for M. Sc. I (Botany)
NEP 2020 (2026 Pattern)

Level	Sem.	Course type	Course Code	Title of Course	Theory/ Practical	No. of Credits
6.0	I	Major (Mandatory)	BOT-501-MRM	Plant Systematics-I	Theory	4
			BOT-502-MRM	Cell Biology and Cell signaling	Theory	4
			BOT-503-MRM	Advanced Botanical Techniques	Theory	2
			BOT-504-MRM	Practical's based on BOT- 501-MRM	Practical	2
			BOT-505-MRM	Practical's based on BOT-502-MRM	Practical	2
		Major (Elective)	BOT-506-MJE (A)	Plant Genetics	Theory (Any one)	2
			BOT-506-MJE (B)	Plant Breeding		
			BOT-507-MJE (A)	Practical's based on BOT-506-MJE (A)	Practical (Any one)	2
			BOT-507-MJE (B)	Practical's based on BOT-506-MJE (B)		
		Research Methodology	BOT-508-RM	Research Methodology	Theory	4
Total credits Sem. -I						**22**
6.0	II	Major (Mandatory)	BOT-551-MRM	Plant Systematics II	Theory	4
			BOT-552-MRM	Plant Physiology and Biochemistry	Theory	4
			BOT-553-MRM	Plant Genetic Engineering	Theory	2
			BOT-554-MRM	Practical's based on BOT- 551-MRM	Practical	2
			BOT-555-MRM	Practical's based on BOT-552-MRM	Practical	2
		Major (Elective)	BOT-556-MJE (A)	Plant Ecology	Theory (Any one)	2
			BOT-556-MJE (B)	Plant Biodiversity		
			BOT-557-MJE (A)	Practical's based on BOT-556-MJE (A)	Practical (Any one)	2
			BOT-557-MJE (B)	Practical's based on BOT-556-MJE (B)		
			BOT-558-OJT	On Job Training	Practical	4
Total credits Sem. -II						**22**
Cumulative credits for P. G Diploma I and II						**22+22=44**

Name of the Programme	**:**	**M.Sc. Botany**
Program Code	**:**	**PSBOT**
Class	**:**	**M.Sc.**
Semester	**:**	**I**
Course Type	**:**	**Mandatory Theory**
Course Name	**:**	**Plant Systematics-I**
Course Code	**:**	**BOT -501-MRM**
No. of Lectures	**:**	**60**
No. of Credits	**:**	**04**

A) Course objectives:

1. To create awareness and need of inculcating knowledge of Cryptogamic diversity.
2. To give an idea about classification of cryptogams up to species level.
3. To give an idea of applied importance of Cryptogams.
4. To give general account of thallus organization, reproduction and life history of algae, fungi bryophytes.
5. To impart knowledge of plants of lower groups and their uses in wellbeing of mankind
6. To create the awareness of plant conservation in society.
7. To impart the knowledge commercial applications of algae in industry.

B) Course outcomes:

CO1. Student will get knowledge about cryptogams to conserve Cryptogamic diversity.
CO2. Student will be able to classify the cryptogams up to species level.
CO3. Students get aware about the importance of Cryptogams.
CO4. Students get knowledge about life history of algae, fungi bryophytes.
CO5. The students should be able to explain the role of Algae, Fungi and Bryophytes in human welfare.
CO6. Students will be aware of plant conservation in society.
CO7. Students get knowledge about industrial applications of algae.

Credit-I: Algae

Unit-1 **(22L)**

1.1 Systematics and Taxonomy: Principles, outline of classification of algae up-to family level according to Fritsch (1945) and recent developments in algal classification with special emphasis on emerging trends in molecular phylogeny and their relationships. 5L

1.2 Algal habitats, photosynthetic pigments in algae, reserve food material, origin and evolution of sex organs, contribution of phycologist from India and World. 4L

1.3 Cyanophyta: Habitat, distinguishing characters, thallus organization, ultra-structure of heterocyst, reproduction and life cycle patterns. 2L

1.4 Chlorophyta: Habitat, thallus organization, reproduction, life cycle patterns in unicellular, filamentous and multicellular green algae. 4L

1.5 Phaeophyta and Rhodophyta: Habitat, distinguishing characters, reproduction and life cycle patterns. 2L

1.5 Minor groups: Habitat, distinguishing characters, comparative structure and reproduction in Charophyta, Euglenophyta, Xanthophyta, Bacillariophyta and Chrysophyta. 4L

1.6 Applications of algae: Commercial applications of algae as biofertilizer and medicine 1L

Credit-II: Fungi

Unit-2 **(23L)**

2.1 Fungi: Habitat, thallus structure, cell structure, hyphal modifications, nutrition, reproduction, classification system of fungi proposed by Ainsworth (1973), Contribution of Mycologist in India and abroad. Economic importance of fungi. 5L

2.2 Myxomycota: Habitat, distinguishing characters, types of plasmodia, fruiting bodies, reproduction and life cycle pattern. 3L

2.3 Mastigomycotina: Habitat, distinguishing characters, structure of thallus in Chytridiomycetes, Oomycetes, reproduction and life cycle pattern. 3L

2.4 Zygomycotina: Habitat, distinguishing characters, thallus structure, reproduction and life cycle pattern. 3L

2.5 Ascomycotina: Habitat, distinguishing characters, thallus structure, fructifications, reproduction, comparative study of Hemiascomycetes and Euascomycetes 3L

2.6 Basidiomycotina: Habitat, distinguishing characters, thallus structure, types and structure of basidia, basidiocarps, reproduction life cycle pattern. 2L

2.7 Deuteromycotina: Habitat, distinguishing characters, thallus structure, fructifications and types of conidia and life cycle pattern. 2L

2.8 Applications of fungi: Biofertilizers, biocontrol, biopesticides, food and medicine. 2L

Credit-III: Bryophytes

Unit-3 **(15L)**

3.1 Bryophytes: Introduction, general characters, affinities with thallophytes and pteridophytes, contributions of Indian and Foreign bryologists (any three), classification of bryophytes according to G. M. Smith (1955), origin of bryophytes, evolution of sporophyte, apogamy and apospory. Economic importance of bryophytes. 4L

3.2 Distribution, distinguishing characters, morphology and anatomy of gametophyte and sporophytes of Marchantiales, Jungermanniales, Anthocerotales, Sphagnales, Polytrichales, Funariales, Takakiales, Calobryales and Sphaerocarpales. 10L

3.3 Applications of Bryophytes: Indicators of pollution, conservation and need of importance bryophytes. 1L

References:

1. Ainsworth, Sussman and Sparrow (1973): The fungi. Vol. IV A & IV B. Academic Press.
2. Alexopolous C. J., Mims C.W. and Blackwell M. (1999): Introductory Mycology. Willey, New York.
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10. Lee R. E. (2008): Phycology. Cambridge University Press.
11. Mehrotra R.S. and Aneja K.R. (1990): An introduction to mycology. New Age Publishers, ISBN 8122400892
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15. Smith G. M. (1950): The fresh water algae of the United States, Mc-graw Hill publication New York.
16. Udar R. (1970): Introduction to Bryophytes. Shashidhar Malaviya Prakashan. Lucknow.
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19. Vashista B.R, Sinha A.K and Singh V.P. (2005): Botany for degree students. Algae, S. Chand Publication New Delhi.

Choice Based Credit System Syllabus (2026 Pattern)
Mapping of Program Outcomes with Course Outcomes

Class: M. Sc. I (Sem. I) Subject : Botany
Course: Plant Systematics I Course Code : BOT -501-MRM
Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation

	Programme Outcomes (POs)							
Course Outcomes	PO1	PO2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8
CO 1	3							
CO 2		3						
CO 3			3					
CO 4	3							
CO 5						3		
CO 6			2					
CO 7	2	3						

Justification for the mapping

PO1: Disciplinary Knowledge
CO1. Get knowledge about cryptogams to conserve Cryptogamic diversity.
CO4. Get knowledge about life history of algae, fungi bryophytes.
CO7. Analyse industrial applications of algae.
PO2: Critical Thinking and Problem Solving
CO2. Classify the cryptogams up to species level.
CO7. Analyse industrial applications of algae.
PO3: Social competence

CO3. Get aware about the importance of Cryptogams.
CO6. Aware about plant conservation in society.

PO6: Personal and Professional Competence

CO5. Explain the role of Algae, Fungi and Bryophytes in human welfare.

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Name of the Programme	**:**	**M.Sc. Botany**
Program Code	**:**	**PSBOT**
Class	**:**	**M.Sc.**
Semester	**:**	**I**
Course Type	**:**	**Major Mandatory (Theory)**
Course Code	**:**	**BOT-502-MRM**
Course Title	**:**	**Cell Biology and Cell Signaling**
No. of Lectures	**:**	**60**
No. of Credits	**:**	**04**

A) Course objectives:

1. To introduce various aspect of Cell biology to the students.
2. To study structure of cell organelles and their functions.
3. To study structure and function of cell membrane.
4. To impart the knowledge of modern techniques in cell Biology.
5. To motivate the students in applied aspects of cell biology.
6. To inculcate the knowledge about cell cycle in plants.
7. To understand the general principles of cell communication.

B) Course objectives:

CO1. The students should be able to explain the concepts of the cell.
CO2. Students will be able explain basic cell structure.
CO3. Students able to describe the structure and function of cell membrane.
CO4. Students are able to expert with some cytological techniques.
CO5. The students should be able to understand current findings in cell biology.
CO6. The students are able to explain different phases of cell cycle.
CO7. The students get knowledge of different types of cell communication.

Credit-I

Unit-1: **(15L)**

1.1 Introduction to cell biology: Definition, Cell theory and cell structure. Cell Wall- Biogenesis, Ultra Structure and function of cell wall, Growth- primary and secondary cell wall. 3L

1.2 Cell membranes: Structure and function, Fluid mosaic model, Membrane protein diffusion, Electrical properties of membranes, Transport across membranes- Facilitated diffusion, Carrier and channel proteins, Transporters, Active transport, Transport of ions and solutes. 5L

1.3 Ultrastructure and biogenesis of chloroplast and mitochondrial membrane. 2L

1.4 Vacuoles: Biogenesis, transporters, Role as storage organelles, Transport across vacuolar membrane. 2L

1.5 Endoplasmic reticulum: Ultra structure of ER, Role in synthesis and transport of secretary proteins. 2L

1.6 Golgi complex: Ultra structure of Golgi complex, Role in sorting, storage and secretion. 1L

Credit-II

Unit -2: **(15L)**

2.1 **Study of cell organelles**

a) Nucleus: Structure, Organization and regulation of nuclear pore complex, Transport across nuclear membrane 2L

b) Ribosomes: Structure, Assembly and dissociation of subunits, functions. 2L

c) Lysosomes: structure of lysosomes, Membrane integrity and functions. 2L

d) Glyoxysomes: Structure and functions. 1L

e) Peroxisomes: Structure and functions. 1L

2.2 Cytoskeleton: Composition and organization of microtubules, Intermediate filaments, microfilaments, flagella- Structure and organization, Role in motility. 4L

2.3 Techniques in cell biology: In Situ-hybridization to locate transcripts in cell types, FISH, GISH and Confocal Microscopy. 3L

Credit-III

Unit- 3: (15L)

3.1 Signal transduction: Types of receptors: Ion channel linked receptor, Enzyme linked receptor, G Protein linked receptor. 3L

3.2 Phospholipid signaling, secondary messengers, Ca2+, Calmodulin cascade, regulation of signaling pathways. Diversity in protein kinases and phosphatases. 3L

3.3 Specific signaling mechanisms with suitable examples- Biotic and abiotic stress, ABA induced stomatal closure, Stomatal guard cell signaling. 3L

3.4 Nuclear- organelle signaling during plastid development. Ethylene mediated two component system. 2L

3.5 Cellular communication: general principles of cell communication, cell adhesion and roles of different adhesion molecules, gap junctions, extracellular matrix, integrins and its regulation. 4L

Credit-IV

Unit- 4: (15L)

4.1 Cell cycle: Phases of cell cycle, functional importance of each phase, Molecular events during cell cycle, Regulation of cell cycle, check points, Cyclins and protein kinase, MPF (Maturation promoting factor). 6L

4.2 Methods to study cell cycle -labeled mitotic curve and flow cytometry. 3L

4.3 Cell ageing and cell senescence, programmed cell death- molecular aspects, regulation of cell death, PCD in response to stress. 3L

4.4 Apoptosis: Role of different genes, cell organelles during apoptosis, genetic control of apoptosis. 3L

References:

1. Buchanan, B., Gruissem, W., & Jones, R. (2000). Biochemistry and molecular biology of plants. American Society of Plant Physiologists.
2. De Robertis, E. D. P., & De Robertis, E. M. F. (2005). Cell and molecular biology (8th Indian Ed.). Lippincott Williams & Wilkins.
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4. Lewin, B. (2000). Genes VII. Oxford University Press.
5. Pawar, C. B. (2015). Cell biology. Himalaya Publishing House.
6. Verma, P. S., & Agarwal, V. K. (2022). Cell biology: Cytology, biomolecules and molecular biology. S. Chand & Company Limited.

Choice Based Credit System Syllabus (2026 Pattern)
Mapping of Program Outcomes with Course Outcomes

Class: M. Sc. I (Sem. I) Subject: Botany
Course: Cell Biology and Cell Signaling Course Code: BOT– 502 -MRM
Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation

	Programme Outcomes (POs)							
Course Outcomes	PO1	PO2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8
CO 1	3							
CO 2	3							
CO 3	3							
CO 4		3	3					
CO 5	3	3			3		3	
CO 6	3							
CO 7	3							

Justification for the mapping

PO 1: Advanced Disciplinary Knowledge & Originality
CO1. The students should be able to explain the concepts of the cell.
CO2. Students will be able explain basic cell structure.
CO5. The students should be able to understand current findings in cell biology.
CO6. The students are able to explain different phases of cell cycle.
CO7. The students get knowledge of different types of cell communication.
PO 2: Research, Analysis, and Complexity
CO1. The students should be able to explain the concepts of the cell.
PO3: Problem Solving in New Contexts
CO1. The students should be able to explain the concepts of the cell.
PO 4: Technical Mastery and Scientific Reasoning
CO2. Students will be able explain basic cell structure.
CO3. Students able to describe the structure and function of cell membrane.
PO 5: Integrated Communication
CO1. The students should be able to explain the concepts of the cell.
CO2. Students will be able explain basic cell structure
PO6: Ethical, Social, and Professional Judgment
CO1. The students should be able to explain the concepts of the cell.
PO 7: Autonomous and Lifelong Learning
CO1. The students should be able to explain the concepts of the cell.

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Name of the Programme	**:**	**M.Sc.**
Subject	**:**	**Botany**
Program Code	**:**	**PSBOT**
Class	**:**	**M.Sc. I**
Semester	**:**	**I**
Course Type	**:**	**Major Mandatory (Theory)**
Course Code	**:**	**BOT-503-MRM**
Course Title	**:**	**Advanced Botanical Techniques**
No. of Teaching Hours	**:**	**30**
No. of Credits	**:**	**02**

A) Course objectives:

1. To understand different concepts in botanical techniques.
2. To understand microscopy, different types and working of microscopes.
3. To understand practical applications of microscopic techniques.
4. To impart the basic skills about centrifugation techniques.
5. To impart the knowledge about electrochemical techniques.
6. To describe the principles and applications of various chromatographic techniques.
7. To analyse the principles and applications of major spectroscopic techniques.

B) Course outcomes:

By the end of the course, students will be able to:

CO1. Enrich student knowledge with advance botanical techniques.
CO2. Students get knowledge about different types and working of microscopes.
CO3. Students' expertise in microscopic techniques.
CO4. Students will expertise in different centrifugation techniques.
CO5. Students get expertise in different electrochemical techniques.
CO6. Students get knowledge about chromatographic techniques.
CO7. Students get knowledge about antigen–antibody interaction.

Credit –I

Unit- 1: (15L)

1.1 Microscopy: Image formation (properties of light), Lens- refraction, magnification concept, resolution concept. Confocal microscopy, Fluorescence microscopy, Electron microscopy. 8L

1.2 Centrifugation techniques: Rotors and their types, Types of centrifuges, Types of centrifugation: Preparative and Analytical. 5L

1.3 Electrochemical techniques: Electrical conductivity, pH meter, Oxygen electrode.2L

Credit –II

Unit-2: (15L)

2.1 Chromatography techniques: - Introduction, concept of partition coefficient, Column, Gel filtration, Affinity, Ion exchange and HPLC. 4L

2.2 Electrophoretic techniques: - Principles, working and application of Agarose Gel Electrophoresis (AGE), Pulsed Field Gel Electrophoresis (PFGE) and Polyacrylamide Gel Electrophoresis (PAGE). 4L

2.3 Spectroscopic techniques: Principles, working and application of UV-Visible spectroscopy, Nuclear Magnetic Resonance (NMR) spectroscopy, X-ray crystallography, Spectroflurometry, AAS, MS and IR Spectroscopy. 7L

References:

1. Skoog, D. A., Holler, F. J., & Crouch, S. R. (2018). Principles of instrumental analysis (7th Ed.). Cengage Learning.
2. Wilson, K., & Walker, J. (2018). *Principles and techniques of biochemistry and molecular biology* (8th Ed.). Cambridge University Press.
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9. Marimuthu R. (2008): Microscopy and Micro technique. MJP Publishers, Chennai.
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11. Srivastava S. and Singhal V. (1995): Laboratory Methods in Microbiology. Anmol Publication Pvt. Ltd. Delhi.

Choice Based Credit System Syllabus (2026 Pattern)
Mapping of Program Outcomes with Course Outcomes

Class: M.Sc. I (Sem. I) Subject: Botany

Course: Advanced Botanical Techniques Course Code: BOT-503-MRM

Weightage:1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation

	Programme Outcomes (POs)							
Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3		2	3		1	2	2
CO2	3			3			2	
CO3	3	3		3	2			
CO4		3						
CO5		3	2					2
CO6	3		2	3			2	2
CO7			2			2	2	2

Justification for the mapping

PO1: Advanced Disciplinary Knowledge & Originality:

CO1. Enrich student knowledge with advance botanical techniques.

CO2. Students get knowledge about different types and working of microscopes.

CO3. Students' expertise in microscopic techniques.

CO6. Students get knowledge about chromatographic techniques.

PO2: Research, Analysis, and Complexity:

CO3. Students' expertise in microscopic techniques.

CO4. Students will expertise in different centrifugation techniques. CO5. Students get expertise in different electrochemical techniques.

PO3: Problem Solving in New Contexts:
CO1. Enrich student knowledge with advance botanical techniques.
CO5. Students get expertise in different electrochemical techniques.
CO6. Students get knowledge about chromatographic techniques.
CO7. Students get knowledge about antigen–antibody interaction.
PO4: Technical Mastery and Scientific Reasoning:
CO1. Enrich student knowledge with advance botanical techniques.
CO2. Students get knowledge about different types and working of microscopes.
CO3. Students' expertise in microscopic techniques.
CO6. Students get knowledge about chromatographic techniques.
PO5: Integrated Communication:
CO3. Students' expertise in microscopic techniques.
PO6: Ethical, Social, and Professional Judgment:
CO1. Enrich student knowledge with advance botanical techniques.
CO7. Students get knowledge about antigen–antibody interaction.
PO7: Autonomous and Lifelong Learning:
CO1. Enrich student knowledge with advance botanical techniques.
CO2. Students get knowledge about different types and working of microscopes.
CO6. Students get knowledge about chromatographic techniques.
CO7. Students get knowledge about antigen–antibody interaction.
PO8: Employability, Innovation, and Entrepreneurship:
CO1. Enrich student knowledge with advance botanical techniques.
CO5. Students get expertise in different electrochemical techniques.
CO6. Students get knowledge about chromatographic techniques.
CO7. Students get knowledge about antigen–antibody interaction.

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Department of Botany M.Sc. Semester-I

Name of the Programme	**:**	**M.Sc. Botany**
Program Code	**:**	**PSBOT**
Class	**:**	**M.Sc. I**
Semester	**:**	**I**
Course Type	**:**	**Mandatory Practical**
Course Name	**:**	**Practical based on BOT-501-MRM**
Course Code	**:**	**BOT -504-MRM**
No. of Lectures	**:**	**60**
No. of Credits	**:**	**02**

A) Course objectives:

1. To study Cryptogamic habit and habitat diversity.
2. Hand on training for the identification and study of methods of reproduction of cryptogams and ultrastructure of cell organelles.
3. To introduce basic knowledge of structure, forms of lower cryptogams.
4. To study morphology and reproduction in cryptogams.
5. To provide the basic knowledge of thallus, reproduction and evolution of cryptogams.
6. To understand knowledge of spore dispersal mechanism of bryophyte.
7. To understand Cryptogamic diversity.

B) Course outcomes:

CO1. Developed skilled Cryptogamist.
CO2. Student will train in cell biology techniques.
CO3. Students get basic knowledge about life cycle of cryptogams.
CO4. Students get better understand structure of cryptogams.
CO5. Students get basic knowledge about evolution of lower cryptogams.
CO6. Students will understand spore dispersal mechanism.
CO7. Students well understand variations in cryptogamic diversity.

Practicals based on BOT-501- MRM
Morphological observations, description and illustrations of following forms

1. Cyanophyta: Any two form from each.	1P
2. Chlorophyta: Any two form from each.	1P
3. Charophyta: Any two form from each.	1P
4. Phaeophyta: Any two form from each.	1P
5. Rhodophyta: Any two form from each.	1P
6. Myxomycota: Any two form from each.	1P
7. Mastigomycotina: Any three form for each.	1P
8. Zygomycotina: Any three form from each.	1P
9. Ascomycotina: Any three form from each.	1P
10. Basidiomycotina: Any three form from each.	1P
11. Deuteromycotina: Any three form from each	1P
12. Hepaticopsida: Any two form from each	1P
13. Anthoceratopsida: Any two form from each	1P
14. Bryopsida: Any two form from each	1P

15. Excursion tour for study of Cryptogamic Diversity. Note: Mandatory submission of tour report. 1P

Choice Based Credit System Syllabus (2026 Pattern)
Mapping of Program Outcomes with Course Outcomes

Class: M. Sc. I (Sem. I) Subject : Botany
Course: Botany Laboratory - I Course Code : BOT-504- MRM
Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation

	Programme Outcomes (POs)							
Course Outcomes	PO1	PO2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8
CO 1				3				
CO 2		2						
CO 3	3							
CO 4	3							
CO 5	3							
CO 6	3		3					
CO 7					3			

Justification for the mapping

PO1: Disciplinary Knowledge
CO3. Understand basic knowledge about life cycle of cryptogams.
CO4. Internal and external structure of cryptogams.
CO5. Explain basic knowledge about evolution of lower cryptogams.
CO6. Discuss spore dispersal mechanism.
PO2: Critical Thinking and Problem Solving
CO2. Train in cell biology techniques.
PO 3: Social competence
CO6. Discuss spore dispersal mechanism.
PO 4: Research-related skills and Scientific temper
CO1. Develop identification skill in cryptogams.
PO5: Trans-disciplinary Knowledge
CO7. Understand variations in cryptogamic diversity.

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Department of Botany M.Sc. Semester-I

Name of the Programme	**:**	**M.Sc. Botany**
Program Code	**:**	**PSBOT**
Class	**:**	**M.Sc. I**
Semester	**:**	**I**
Course Type	**:**	**Major Mandatory (Practical)**
Course Code	**:**	**BOT-505-MRM**
Course Title	**:**	**Practical Based On BOT-502-MRM**
No. of Teaching Hours	**:**	**60**
No. of Credits	**:**	**02**

A) Course objectives:

1. To study structure of cell organelles and their functions.
2. To know basic biology and theoretical concepts.
3. To pertain knowledge of different cytological techniques.
4. To study structure of basic components of cell organelles.
5. To study the working of cells in plants.
6. To understand cytoplasmic streaming in eukaryotic cell.
7. To give practical knowledge about cell and cell organelles.

B) Course outcomes:

By the end of the course, students will be able to:

CO1. Students will explain basic cell structure.
CO2. Students able to understand basic biological concepts.
CO3. Students will be acquainting with some cytological techniques.
CO4. Students will get basic knowledge about structure of cell organelles.
CO5. Students able to explain mechanism of cells in plant.
CO6. Students will knowledge about eukaryotic cell.
CO7. Students get practical knowledge about cell organelles.

Practical's based on BOT-502-MRM: Cell Biology

1. Differential centrifugation for isolation of cell fractions. 1P
2. Differential centrifugation for isolation of nuclear fraction. 1P
3. Isolation of Chloroplasts to study Hill reaction to measure intactness 1P
4. Isolation of mitochondria for: Estimation of succinic dehydrogenase activity. 1P
5. Isolation of Lysosomal fraction. 1P
6. Estimation of acid phosphatase activity. 1P
7. Study of Electron Micrographs of cell organelles. 1P
8. Cytochemical / Histochemical studies of special cell types: guard cells, senescent cells. 1P
9. Cytochemical / Histochemical studies of special cell types: bundle sheath cells, meristematic cells. 1P
10. Cytochemical / Histochemical studies of special cell types: lactiferous cells, glandular cells. 1P
11. Cytochemical / Histochemical studies of special cell types: Pollen grains, stigma. 1P
12. Study of mitotic index of onion root tips. 1P
13. Estimation of Chrorophylls in normal and senescent leaves. 1P

14. Effect of abiotic factors on stomatal response. 1P
15. Interpretation of cell cycle. 1P

Choice Based Credit System Syllabus (2026 Pattern)
Practical's based on BOT-502-MRM: Cell Biology

Class: M. Sc. I (Sem. I) Subject: Botany
Course: Botany Laboratory –II Course Code: BOT -505-MRM
Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation

	Programme Outcomes (POs)							
Course Outcomes	PO1	PO2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8
CO 1	3							
CO 2	3							
CO 3		3	3					
CO 4	3							
CO 5	3							
CO 6	3							
CO 7		3	3					

Justification for the mapping

PO 1: Advanced Disciplinary Knowledge & Originality
CO1. Students will explain basic cell structure.
CO2. Students able to understand basic biological concepts.
CO4. Students will get basic knowledge about structure of cell organelles.
CO5. Students able to explain mechanism of cells in plant.
CO6. Students will knowledge about eukaryotic cell.
PO 2: Research, Analysis, and Complexity
CO3. Students will be acquainting with some cytological techniques.
CO7. Students get practical knowledge about cell organelles.
PO 3: Technical Mastery and Scientific Reasoning
CO3. Students will be acquainting with some cytological techniques.
CO7. Students get practical knowledge about cell organelles.

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Department of Botany M.Sc. Semester-I

Name of the Programme	**:**	**M.Sc. Botany**
Program Code	**:**	**PSBOT**
Class	**:**	**M.Sc. I**
Semester	**:**	**I**
Course Type	**:**	**Major Elective (Theory)**
Course Code	**:**	**BOT-506-MJE (A)**
Course Title	**:**	**Plant Genetics**
No. of Teaching Hours	**:**	**30**
No. of Credits	**:**	**02**

A) Course objectives:

1. To study genetic inheritance and gene interactions in plants.
2. To make aware about linkage and recombination.
3. To evaluate conclusions based on linkage and recombination.
4. To understand the knowledge of genetic code, gene expression and regulation.
5. To understand knowledge of linkage and recombination.
6. To understand about gene interaction.
7. Design and analyze population genetic experiments.

B) Course outcomes:

By the end of the course, students will be able to:

CO1.Students will come to know nature of gene inheritance.
CO2. Students will be able to know inheritance of gene in day to day life.
CO3. Students get expert in evaluation of conclusions based on genetic data.
CO4.Students will get knowledge about gene expression and regulation of gene.
CO5. Students will be able study fixing and preservation of cells.
CO6.Students get knowledge of gene interactions.
CO7. Student will get knowledge of population genetics

Credit –I **(15L)**

Unit -1

1.1 Principles of Mendelian inheritance and Interaction of genes: 6L

Mendel's laws: Dominance, Segregation, Independent assortment, Modified ratios and Interaction of genes- Complementary, epitasis, inhibitory, polymeric and additive.

1.2 Cytoplasmic inheritance: 3L

Mitochondrial chloroplast genomes, Inheritance of chloroplast genes (*Mirabilis jalapa*), Inheritance of mitochondria genes (Petit yeasts), Cytoplasmic male sterility in Maize), Interaction between nuclear and cytoplasmic genes.

1.3 Inheritance: Quantitative and Sex linked inheritance 6L

Quantitative traits, Inheritance of quantitative traits, Polygenic traits: corolla length in Nicotiana, Cob length in *Zea mays*, Heritability and its measurement Chromosomal theory of inheritance: Inheritance of X and Y linked genes, Sex limited and sex influenced genes.

Credit-II

Unit- 2: **(15L)**

2.1 Concept of gene, allele, multipleallele, pseudoallele, Complementation test. 4L

2.2 Hardy Weinberg's Law, Factors affecting gene and gene frequencies,

Pedigree analysis in Human genetics, Genomic Imprinting. 4L

2.3 Linkage and Recombination in Chromosomes: homologous, non-homologous, site specific recombination, Linkage maps, LOD score for linkage testing, Tetrad analysis in Yeast(unordered), Neurospora (ordered). 7L.

References:

1. Ahluwalia, K.B. (2005). Genetics (1st Ed.) New Age International Private Ltd.
2. Griffiths, A.J.F., Wessler, S.R., Carroll, S.B., & Doebley, J. (2020). Introduction to Genetic Analysis (12th Edition). W.H. Freeman & Company.
3. Pierce, B.A. (2020). Genetics*:* A Conceptual Approach (7th Ed). W.H. Freeman & Company.
4. Strickberger, M.W. (2000). Genetics (3rd Ed).
5. Gardner and Simmons Snustad (2005): (8th Edition). Principles of Genetics, John Wiley and Sons, Singapore.
6. Verma, P.S., & Agarwal, V.K. (2010). Genetics (9th Ed). S. Chand & Company Ltd.
7. Singh, B.D. (2009). Fundamentals of Genetics (3rd Ed) Kalyani Publishers.

Choice Based Credit System Syllabus (2026 Pattern)
Mapping of Program Outcomes with Course Outcomes

Class: M. Sc. I (Sem. I) Subject: Botany
Course: Plant Genetics Course Code: BOT-506-MJE (A)
Weightage:1=weak or low relation, 2=moderate or partial relation,3=strong or direct relation

	Programme Outcomes (POs)							
Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	2	3	3	2	2	3	-
CO2	2	3	3	3	2	2	3	3
CO3	2	3	3	2	3	3	3	3
CO4	1	3	2	2	3	3	3	
CO5	1	2	3	2	1	2	2	-
CO6	1	2	2	1	3	3	2	
CO7	1	3	2	2	2	3	3	3

Justification for Mapping

PO1: Advanced Disciplinary Knowledge
Strongly mapped with CO1, CO3, CO4, CO7 as they emphasize gene interactions, genetic data evaluation, gene expression, and quantitative genetics—core advanced genetics concepts.

PO2: Research, Analysis & Complexity
Strong mapping with CO2, CO3, CO7 because breeding techniques, data interpretation, and quantitative experiment design require hypothesis formulation and handling complex datasets.

PO3: Problem Solving in New Contexts
Strong mapping with CO2, CO3, CO5, CO6, CO7 since field breeding, emasculation, pollination, and experimental design involve applying theory to

real agricultural and research settings.

PO4: Technical Mastery & Scientific Reasoning

Strongly linked to CO2, CO5, CO6, CO7 due to hands-on breeding techniques, floral biology practices, and quantitative experiment planning.

PO5: Integrated Communication

Strong mapping with CO3 as students evaluate and interpret genetic data, requiring clear presentation of scientific conclusions.

PO6: Ethical, Social & Professional Judgment

Strong mapping with CO5 & CO6 since gene interactions and their applications in agriculture and research.

PO7: Autonomous & Lifelong Learning

Strong mapping with CO7 as designing quantitative experiments encourages independent research thinking and continued learning**.**

PO8: Employability, Innovation & Entrepreneurship

Strong mapping with CO2, CO5, CO6, CO7 because breeding skills, floral biology expertise, and quantitative experiment design are directly relevant to agriculture, seed industry, and research careers.

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Department of Botany M.Sc. Semester-I

Name of the Programme	**:**	**M.Sc. Botany**
Program Code	**:**	**PSBOT**
Class	**:**	**M.Sc. I**
Semester	**:**	**I**
Course Type	**:**	**Major Elective (Theory)**
Course Code	**:**	**BOT-506-MJE (B)**
Course Title	**:**	**Plant Breeding**
No. of Teaching Hours	**:**	**30**
No. of Credits	**:**	**02**

A) Course objectives:

1. To make aware about plant breeding.
2. To evaluate conclusions based on breeding data.
3. To understand the knowledge of techniques of production of new superior crop varieties.
4. To understand practical emasculation and pollination methods of important crops.
5. To understand about floral biology and selection of proper breeding method.
6. Design and analyze quantitative plant breeding experiments.
7. To understand the knowledge of plant breeding techniques in agricultural fields for crop improvements.

B) Course outcomes:

By the end of the course, students will be able to:

CO1. Students will use breeding techniques in field.
CO2. Students get expert in evaluation of conclusions based on plant breeding
CO3. To study the techniques of production of new superior crop varieties.
CO4. Students Will be able to do emasculation and pollination methods.
CO5. Students get practical knowledge about floral biology and proper breeding method.
CO6. Student will get expertise in design the quantitative genetic experiments.
CO7. Student understand the concept of plant breeding involving the principles, the selection Process and achievements in plant breeding.
CO8. Implement their knowledge of plant breeding techniques in agricultural fields for crop Improvements.

Credit-I

Unit-1: **(15L)**

1.1 Plant Breeding: Concept, Objectives and applications of plant breeding, modern concepts in plant breeding and challenges ahead with future breeding strategy. 2L

1.2 Plant Genetic Resources: History, Concept, Importance, need and conservation of plant genetic resources (PGR), Gene pool: primary, secondary and tertiary; Centers of origin and global pattern of diversity, Principles, strategies and practices of exploration, collection, characterization, evaluation and Cataloging of PGR; Germplasm conservation- *In-situ*, *Ex-situ*, NBPGR. 4L

1.3 **Methods in plant breeding:** Introduction, Selection- Mass Selection and Pure line selection. Recombination breeding – Pedigree method, Bulk method, Backcross and single seed descent method. 3L

1.4 Mutation Breeding:

Introduction, Nature and classification of mutations: spontaneous and induced mutations, Physical mutagens, Chemical mutagens. Mutagen effects in M1

generation: plant injury, Lethality, sterility, chimeras *etc*., - Observing mutagen effects in M2 generation – Estimation of mutagenic efficiency and effectiveness. Application of mutation breeding 4L

1.5 Breeding for nutritional traits

Breeding for special traits viz. oil, protein, vitamins, amino acids, elimination of toxic Substances. 2L

Credit-II

Unit-2

2.1 Genetic Basis of Breeding Crops: Selection in Self-fertilizing Crops- Definition and genetic basis of pure lines Genetic variations in pure lines 3L

2.2 Hybridization: Objectives, Types of hybridization, Consequences of hybridization, selection of parents for Hybridization. 3L

2.3 Basics Quantities Genetics Concepts. Quantitative variability, the concept of multiple factors, Role of environment in quantitative variability, Partitioning of quantitative variability. 3L

2.4 Pollination control concepts

Self-incompatibility and male sterility in crop plants, Heterosis, Inbreeding depression 3L

2.5 Standard criteria for the protection: Cultivar development testing, release and notification, maintenance breeding, Participatory Plant Breeding; Plant breeder' rights and regulations for plant variety protection and Farmer rights. 3L

References: -

1. Allard R.W (1995): Principles of Plant Breeding. John Wiley and Sons, Ice.,Singapore.
2. Chahal G. S and Gosal S. S (2002): Principles and procedures of Plant Breeding, Narosa.
3. Sharma J. R. (1994): Principles and practices of Plant Breeding. Tata McGraw-Hill Publishers Company Ltd., New Delhi.
4. Singh B. D. (1996): Plant Breeding – Principles and methods. Kalyani Publications, Ludhiana.
5. Strickberger (2005): (Third Edition). Genetics. Prentice Hall of India Pvt. Ltd., New Delhi.
6. Sultan Singh and Pawar I.S. (2006) Genetic Basis and Methods of Plant Breeding, CBS publishers and distributors pvt. Ltd., New Delhi.

Mapping of Program Outcomes with Course Outcomes

Class: M. Sc. I (Sem. I) **Subject**: Botany

Course: Genetics and Plant Breeding **Course Code:** BOT -506-MJE (B)

Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation

	Programme Outcomes (POs)							
Course Outcomes	PO1	PO2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8
CO 1	3	2	3	3	1	1	1	2
CO 2	3	3	2	2	2	1	1	2
CO 3	3	3	3	3	1	2	1	3
CO 4	2	2	2	3	1	1	1	2

CO 5	3	2	2	2	1	1	1	2
CO 6	3	3	2	3	2	1	2	2
CO 7	3	2	1	1	2	2	2	2
CO 8	3	2	3	3	2	2	1	3

Justification for the mapping

PO1 (Advanced Knowledge)
Strongly mapped (3) with most COs since plant breeding theory, genetics, and techniques demand advanced disciplinary understanding.

PO2 (Research & Analysis)
High with CO2, CO3, CO6 — involving experimental design, evaluation, and hypothesis-based crop improvement.

PO3 (Problem Solving in New Contexts)
Strong in CO1, CO3, CO8-students apply breeding in real agricultural environments.

PO4 (Technical Mastery)
High with CO1, CO4, CO6, CO8-includes hands-on emasculation, genetics experiments, and modern breeding tools.

PO5 (Communication)
Moderate with CO2, CO6, CO8-students interpret and present experimental outcomes.

PO6 (Ethics & Responsibility)
Linked to sustainable breeding, responsible experimentation, and crop improvement impact.

PO7 (Lifelong Learning)
Moderate in CO6, CO7-learning evolving breeding strategies and self-directed research.

PO8 (Employability & Innovation)
Strong with CO3, CO8- practical breeding skills directly support agriculture careers and entrepreneurship.

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Department of Botany M.Sc. Semester-I

Name of the Programme	**:**	**M.Sc. Botany**
Program Code	**:**	**PSBOT**
Class	**:**	**M.Sc. I**
Semester	**:**	**I**
Course Type	**:**	**Major Elective (Practical)**
Course Code	**:**	**BOT-507-MJE (A)**
Course Title	**:**	**Practical Based on BOT-506-MJE (A)**
No. of Teaching Hours	**:**	**60**
No. of Credits	**:**	**02**

A) Course objectives:

1. To study genetic inheritance and gene interactions in plants.
2. To make aware about linkage and recombination.
3. To evaluate conclusions based on linkage and recombination.
4. To understand the knowledge of genetic code, gene expression and regulation.
5. To understand knowledge of linkage and recombination.
6. To understand about gene interaction.
7. Design and analyse population genetic experiments.

B) Course outcomes:

By the end of the course, students will be able to:

CO1. Students will come to know nature of gene inheritance.
CO2. Students will be able to know inheritance of gene in day to day life.
CO3. Students get expert in evaluation of conclusions based on genetic data.
CO4. Students will get knowledge about gene expression and regulation of gene.
CO5. Students will be able to do fixing and preservation of cells.
CO6. Students get practical knowledge of gene interactions.
CO7. Student will get knowledge of population genetics.

Practicals Based on BOT-506-MJE (A)

1.	Preparation of stains, Fixatives.	1P
2.	Preparation of Preservatives, pretreatments to plant material.	1P
3.	Study of cell cycle.	1P
4.	Preparation of somatic C metaphase chromosomes of *Allium cepa*.	2P
5.	Karyotype analysis in *Allium* root tip.	1P
6.	Study of meiotic configuration in *Rhoeo* bud.	1P
7.	Examples based on polygenic inheritance.	1P
8.	Problems based population genetics.	1P
9.	Study of examples based on *Neurospora* tetrad analysis.	1P
10.	Gene Mapping using two and three-Point Test Cross.	1P
11.	Study of polygenic inheritance by fingerprint analysis.	1P

Department of Botany M.Sc. Semester-I

Choice Based Credit System Syllabus (2026 Pattern)
Mapping of Program Outcomes with Course Outcomes

Class: M. Sc. I (Sem. I) Subject: Botany
Course: Plant Genetics Course Code: BOT-507-MJE (A)
Weightage:1=Weak or low relation, 2= Moderate or partial relation, 3=Strong or direct relation

	Programme Outcomes (POs)							
Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	2	3	3	2	2	3	-
CO2	2	3	3	3	2	2	3	3
CO3	2	3	3	2	3	3	3	3
CO4	1	3	2	2	3	3	3	
CO5	1	2	3	2	1	2	2	-
CO6	1	2	2	1	3	3	2	
CO7	1	3	2	2	2	3	3	3

Justification for the Mapping

PO1: Advanced Disciplinary Knowledge
Strongly mapped with CO1, CO3, CO4, CO7 as they emphasize gene interactions, genetic data evaluation, gene expression, and quantitative genetics—core advanced genetics concepts.

PO2: Research, Analysis & Complexity
Strong mapping with CO2, CO3, CO7 because breeding techniques, data interpretation, and quantitative experiment design require hypothesis formulation and handling complex datasets.

PO3: Problem Solving in New Contexts
Strong mapping with CO2, CO3, CO5, CO6, CO7 since field breeding, emasculation, pollination, and experimental design involve applying theory to real agricultural and research settings.

PO4: Technical Mastery & Scientific Reasoning
Strongly linked to CO2, CO5, CO6, CO7 due to hands-on breeding techniques, floral biology practices, and quantitative experiment planning.

PO5: Integrated Communication
Strong mapping with CO3 as students evaluate and interpret genetic data, requiring clear presentation of scientific conclusions.

PO6: Ethical, Social & Professional Judgment
Strong mapping with CO5 & CO6 since gene interactions and their applications in agriculture and research.

PO7: Autonomous & Lifelong Learning
Strong mapping with CO7 as designing quantitative experiments encourages independent research thinking and continued learning.

PO8: Employability, Innovation & Entrepreneurship
Strong mapping with CO2, CO5, CO6, CO7 because breeding skills, floral biology expertise, and quantitative experiment design are directly relevant to agriculture, seed industry, and research careers.

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Department of Botany M.Sc. Semester-I

Name of the Programme	**:**	**M.Sc. Botany**
Program Code	**:**	**PSBOT**
Class	**:**	**M.Sc. I**
Semester	**:**	**I**
Course Type	**:**	**Major Elective (Practical)**
Course Code	**:**	**BOT-507-MJE (B)**
Course Title	**:**	**Practical Based on BOT-506-MJE (B)**
No. of Teaching Hours	**:**	**60**
No. of Credits	**:**	**02**

A) Course objectives:

1. To study mutagenic effect in plants.
2. To make aware about selection.
3. To evaluate conclusions based on Polyploidy.
4. To understand the knowledge of hybridization method.
5. To understand knowledge of Intellectual property rights
6. To understand about gene interaction.
7. Design and analyse probability of plant breeding.

B) Course outcomes:

By the end of the course, students will be able to:

CO1.Students will come to know nature of pollen viability.
CO2. Students will be able to know mutagenic effect of gene in plant.
CO3. Students get expert in evaluation of conclusions based on genetic data.
CO4.Students will get knowledge about Probability and Chi-square.
CO5. Students will be able to do self-pollination.
CO6.Students get practical knowledge of Emasculation.
CO7. Student will get knowledge of Plant Breeding.

Practical's based on BOT-506-MJE (B)

1. Study of Floral Biology and Assessment of Pollen Viability in Major Crops. 1P
2. Evaluation of the Effect of Chemical Mutagens on Seed Germination and Seedling Growth. 1P
3. Laboratory Exercises on Probability Principles and Chi-Square Test in Genetics. 1P
4. Induction of Mutation Using Chemical Mutagens and Study of M_1 Generation 1P
5. Assessment of Seed Viability in Crop Plants. 1P
6. Comparative Study of Floral Structure in Self-Pollinated and Cross-Pollinated Crops. 1P
7. Study of Genetic and Cytoplasmic Male Sterility Systems in Crop Plants. 1P
8. Demonstration of Hybridization Techniques (Emasculation, Hand Pollination, Bagging and Tagging) in Cotton / Tomato. 1P
9. Induction and Detection of Mutations through Genetic Tests, DNA Extraction and PCR Amplification. 2P
10. Extraction and Analysis of Proteins and Isozymes; Agrobacterium-Mediated and Biolistic Transformation Methods. 2P

11. Practical Demonstration of Transgene Detection, Biolistic Gene Transfer and Electrophoresis Techniques. 1P
12. Educational Visit to Plant Breeding Unit / Seed Bank / Transgenic Glasshouse and Study of Practical Considerations. 1P
13. Collection and Submission of Wild Seeds / Native Landraces of Crop Plants.1P

Choice Based Credit System Syllabus (2026 Pattern)
Mapping of Program Outcomes with Course Outcomes

Class: M.Sc. I (Sem. I) Subject: Botany
Course: Plant Breeding Course Code: BOT-507-MJE (B)
Weightage:1=Weak or low relation, 2= Moderate or partial relation, 3=Strong or direct relation

Course Outcomes (CO's)	Programme outcomes (PO's)							
	PO1	PO2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8
CO 1	2	2	2	2			2	
CO 2	3	3	3			2		2
CO 3	3	3	3		3		3	
CO 4		2		3	2			3
CO 5	2			3		2		
CO 6				3		2		
CO 7	3	3	3	3		3	3	3
CO 8	2		2		3			3

Justification for the mapping

PO1 – Advanced Disciplinary Knowledge & Originality
Mapped with CO1, CO2, CO3, CO7Students develop in-depth knowledge of pollen viability, gene mutation effects, genetic data interpretation and plant breeding principles.

PO2 – Research, Analysis, and Complexity
Mapped with CO1, CO2, CO3, CO4, CO7Experimental analysis of pollen fertility, mutagenic studies and genetic data evaluation and statistical hypothesis testing using Chi-square.

PO3 – Problem Solving in New Contexts
Mapped with CO2, CO3, CO4, CO7Students apply genetic theories to unfamiliar mutation patterns, statistical inheritance problems, real breeding challenges.

PO4 – Technical Mastery and Scientific Reasoning
Mapped with CO1, CO4, CO5, CO6, CO7 Microscopy, statistical tools, self-pollination, emasculation techniques, and plant breeding methodologies

PO5 – Integrated Communication
Mapped with CO3, CO4 Interpretation and presentation of genetic data, probability results and research conclusions.

PO6 – Ethical, Social, and Professional Judgment
Mapped with CO2, CO5, CO6, CO7 Responsible use of mutagens, ethical handling of plant materials and awareness of crop improvement's societal impact promote professional integrity and environmental responsibility.

PO7 – Autonomous and Lifelong Learning
Mapped with CO1, CO3, CO7 Independent experimental analysis, continuous

learning in genetics and evolving plant breeding techniques foster self-directed scientific growth.

PO8 – Employability, Innovation, and Entrepreneurship

Mapped with CO2, CO3, CO5, CO6, CO7Hands-on breeding skills, data interpretation, genetic improvement strategies, and research competence prepare students for careers in agriculture, biotechnology, seed industries.

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Department of Botany M.Sc. Semester-I

Name of the Programme	**:**	**M.Sc. Botany**
Program Code	**:**	**PSBOT**
Class	**:**	**M.Sc. I**
Semester	**:**	**I**
Course Type	**:**	**Research Methodology (Theory)**
Course Code	**:**	**BOT-508-RM**
Course Title	**:**	**Research Methodology**
No. of Teaching Hours	**:**	**60**
No. of Credits	**:**	**04**

A) Course objectives:

1. To impart the knowledge and skills of research methodology.
2. To equip the students with the tools and methods of research.
3. To give idea about analysis of research data.
4. To train them in documenting research.
5. To aware the students about the need of conservation of biodiversity.
6. To know the scope of different branches of botany.
7. To train advanced techniques in botany.

1.

B) Course outcomes:

By the end of the course, students will be able to:

CO1. Students will be able to develop skills of research methodology.
CO2. Students are expertise in handling tools and methods of research.
CO3. Student will able to analyze research data.
CO4. Students get expert in compiling research documents.
CO5. Students will recognize conservation of biodiversity
CO6. Students will analyze use of different branches of botany.
CO7. Students will able to use different techniques in their botanical research.

Credit-I

Unit- 1: Research Methodology (15L)

1.1 Introduction of Research: Meaning of research, Objectives of research, Types of research 4L

1.2 Importance of Research: Research approaches, Significance of research, Research methods, Research and scientific methods, Research ethics. 4L

1.3 Research processes: steps involved in research process, Criteria for good research. 4L

1.4 Research problem: Selecting the problem, Necessity of defining the problem, Techniques involved in defining a problem 3L

Credit-II

Unit-2: Research Design and Sample Surveys (15L)

2.1 Research Design: Meaning and need for research design, features of a good design. 3L

2.2 Important concepts relating to research design: Dependent and independent variables, Control, Research hypothesis, Experimental and non-experimental hypothesis – Testing research, Experimental and control group. 4L

2.3 Types of research designs: Research design in case of exploratory research studies, Research design in case of hypothesis- testing research studies, basic principles of experimental designs, Important Experimental Designs. 4L

2.4 Sampling Design: steps in sample design, criteria of selecting a sampling procedure, characteristics of a good sample design, different types of sample design. 4L

Credit-III

Unit- 3: **Data Collection and Data Processing. (15L)**

3.1 Measurements in Research: Measurement Scales, Sources of errors in Measurement. 3L

3.2 Collection of primary data: Observation Method, Interview Method, through questionnaires, through schedules, difference between questionnaire and schedule. 4L

3.3 Collection of secondary data: Selection of appropriate methods for data collection, Case study method. 4L

3.4 Data processing operations: editing, coding, classification, tabulation, graphical representation, types of analysis, Statistics in research, Dispersion and Asymmetry, Measures of Relationship. 4L

Credit- IV

Unit - 4 Data Analysis (15L)

4.1 Basic Concepts Concerning Testing of Hypotheses: Procedure and Flow diagram for Hypothesis Testing, Measuring the Power of a Hypothesis Test, Tests of Hypotheses, Hypothesis Testing of Correlation Coefficients and Limitations of the Tests of Hypotheses. 10L

4.2 Chi-Square Test: Chi-Square Test for Comparing Variance, Chi-square as a Non-parametric Test, Conditions for the Application of Chi-Square Test, Steps Involved in Applying Chi-square Test, Important Characteristics of Chi-Square Test and caution in using Chi-Square test. Characteristics of test, Distribution-free or Non-parametric Tests. 2L

4.3 ANOVA-introduction, objectives, principal types of ANOVA and its applications. 3L

References:

1. Singh G. (2010): Plant systematic: An Integrated approach. Science Publisher. USA.
2. C. R. Kothari (2004): Research Methodology- Methods and Techniques, New Age Publ. Wiley Eastern
3. Dawson, C. (2002): Practical Research Methods. New Delhi. UBS Publ.
4. Kumar Ranjit (2005): Research Methodology. A step by step Guide for Beginners. Singapore, Pearson Education.
5. Bhome S. (2013): Research Methodology, Himalaya Publishing House, New Delhi.

Choice Based Credit System Syllabus (2026 Pattern)
Mapping of Program Outcomes with Course Outcomes

Class: M. Sc. I (Sem. I) Subject: Botany
Course: Research Methodology Course Code: BOT - 508- RM
Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation

Course Outcomes (CO's)	Programme outcomes (PO's)							
	PO1	PO2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8
CO 1	3	2	1	2	–	–	1	2

CO 2	2	3	3	2	–	1	1	2
CO 3	3	3	3	3	1	1	1	2
CO 4	2	2	3	3	2	–	1	2
CO 5	2	2	2	3	2	2	2	2
CO 6	3	3	3	3	3	1	2	2
CO 7	3	3	3	3	3	1	2	2

Justification for the mapping

PO1: Disciplinary Knowledge
This PO is strongly supported by CO1, CO3, CO6, and CO7, as students gain fundamental and advanced knowledge of research concepts, research design, statistical analysis, and hypothesis testing.

PO2: Critical Thinking
This PO is highly attained through CO2, CO3, CO6, and CO7, which require analytical reasoning, evaluation of research designs, interpretation of data, and hypothesis testing.

PO3: Problem Analysis
This PO is strongly achieved through CO2 and CO3, as students identify research problems and analyze appropriate research designs. It is also highly supported by CO6 and CO7, where students analyze data and solve research problems statistically.

PO4: Research Skills
This PO is highly supported by CO3, CO4, CO5, CO6, and CO7, since these outcomes directly involve designing research, collecting data, analyzing results, and testing hypotheses.

PO5: Modern Tool Usage
This PO is strongly achieved through CO6 and CO7, where students apply statistical tools and techniques for data analysis and hypothesis testing.

PO6: Ethics
This PO is moderately supported by CO5, where ethical considerations in data collection are emphasized.

PO7: Communication Skills
This PO is moderately achieved through CO5.

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