LEARNING OUTCOMES BASED CURRICULUM FRAMEWORK (LOCF) FOR POSTGRADUATE PROGRAMMES

(Academic Year 2025-2026 onwards)

PG & RESEARCH DEPARTMENT OF BOTANY

(DST FIST Sponsored Department)

(Supported under DBT's STAR COLLEGE SCHEME)

M.Sc., BOTANY

Estd. 1919

NATIONAL COLLEGE

(AUTONOMOUS)

(Nationally Re-accredited at 'A' Grade by NAAC in 4th Cycle)

TIRUCHIRAPPALLI - 620 001

VISION AND MISSION OF
THE PG & RESEARCH DEPARTMENT OF BOTANY

VISION	Develop the students with solid knowledge in Botany for efficient use and management of biological resources towards sustainable development.
MISSION	Spread knowledge and transmit skills for employability, innovation in research and entrepreneurship in Plant Science.

PG & RESEARCH DEPARTMENT OF BOTANY

PROGRAMME OUTCOMES

PO1	**Disciplinary Knowledge:** Students will be capable of demonstrating comprehensive knowledge and understanding of various concepts of Plant and Allied Sciences through Undergraduate and Postgraduate Programmes of study. As a result of this student get transformed into skilled professionals adhering to the values of sustainable living.
PO2	**Communication Skills:** Students will acquire the ability to express thoughts and ideas effectively in writing and orally. They will be able to communicate with others using appropriate media and also confidently share one's views and express herself / himself. Students will demonstrate the ability to listen carefully, read and write analytically, and present complex information in a clear and concise manner to different groups.
PO3	**Critical thinking, Problem-Solving and Analytical Reasoning:** The capacity of the students to apply analytic thoughts through analyses, evaluation, arguments, claims, and beliefs on the basis of empirical evidence will be strengthened. The students will be able to identify relevant assumptions or implications and shall formulate coherent arguments. They will be able to critically evaluate practices, policies and theories by following scientific approach to knowledge development. Students will have the capacity to extrapolate from what one has learned and apply their competencies to solve different kinds of non-familiar problems, rather than replicate curriculum content knowledge; and apply one's learning to real life situations. Student will attain the ability to evaluate the reliability and relevance of evidence; identify logical flaws and holes in the arguments of others; analyse and synthesise data from a variety of sources; draw valid conclusions and support them with evidence and examples, and addressing opposing viewpoints in the field of Plant and Applied Sciences.
PO4	**Reflective thinking & Scientific Reasoning. Teamwork with Leadership qualities:** Students will develop critical sensibility to lived experiences, with self-awareness and reflexivity of both self and society. They will be able to analyze, interpret and draw conclusions from quantitative/ qualitative data; and critically evaluate ideas, evidence and experiences from an open-minded and reasoned perspective. Students will acquire the ability to work effectively and respectfully with diverse teams; facilitate cooperative or coordinated effort on the part of a group, and act together as a group or a team in the interests of a common cause and work efficiently as a member of a team. They will have the potential of mapping out the tasks of a team or an organization, setting direction, formulating an inspiring vision, building a team who can help achieve the vision, motivating and inspiring team members to engage with that vision, and using management skills to guide people to the right destination, in a smooth and efficient way.
PO5	**Moral and Ethical Awareness - Appreciating Environmental and Sustainability Issues** Students will understand and contextualize environmental and ethical issues and contribute towards the betterment of the environment and sustainable growth. They will have the ability to embrace moral / ethical values in conducting one's life, formulate a position/ argument about an ethical issue from multiple perspectives, and use ethical practices in all work. They will become capable of demonstrating the ability to identify ethical issues related to one's work, avoid unethical behaviour such as fabrication, falsification or misrepresentation of data or committing plagiarism, not adhering to intellectual property rights; appreciating environmental and sustainability issues; and adopting objective, unbiased and truthful actions in all aspects of work.
PO6	**Multicultural competency and Self-directed lifelong learning:** Students will develop multicultural competency and will engage in self-paced and self-directed lifelong learning through digital literacy for personal development and professional accomplishment. Students will possess knowledge of the values and beliefs of multiple cultures and a global perspective; and will develop capability to effectively engage in a multicultural society and interact respectfully with diverse groups. They will have the ability to work independently, identify appropriate resources required for a project, and manage a project through to completion. They will also be able to acquire knowledge and skills, including 'learning how to learn', that are necessary for participating in learning activities throughout life, through self-paced and self-directed learning aimed at personal development, meeting economic, social and cultural objectives, and adapting to changing trades and demands of work place through knowledge/skill development/reskilling and deskilling.

PG & RESEARCH DEPARTMENT OF BOTANY

(DST FIST Sponsored Department)

(Supported under DBT's STAR COLLEGE SCHEME)

PROGRAMME SPECIFIC OUTCOMES

PSO 1	Identify and classify the plants by using the key characters. Prepare and view specimens for examination using through microscopy and other tools. Use pure culture and selective techniques to isolate fungi, plant pathogens, algae and identify them growing on media.
PSO 2	Qualitatively and quantitatively estimate the number of floral components by using enumeration and suitable sampling, tools and techniques. Procure the knowledge of teaching plant science to wider audience.
PSO 3	Use appropriate plant molecular techniques and use of instrumentation related to it.
PSO 4	Documentation and report writing on experimental protocols, results and conclusions, study tours and filed visits etc. Become focused to take up Research and Teaching opportunities
PSO 5	Practice safe laboratory procedures, using appropriate protective, biosafety and emergency procedures.
PSO 6	Prepare themselves for competitive exams like TNPSC, UPSC, SET, CSIR, UGC, ICAR NET, TRB.

PG & RESEARCH DEPARTMENT OF BOTANY
(DST FIST Sponsored Department)
(Supported under DBT's STAR COLLEGE SCHEME)
NATIONAL COLLEGE (AUTONOMOUS)
(Nationally Re-accredited at 'A+' Grade by NAAC in 3rd Cycle)
(College with Potential for Excellence)
TIRUCHIRAPPALLI - 620 001.

M.Sc., BOTANY

Learning Outcomes based Curriculum Framework (LOCF)
Choice Based Credit System (CBCS)
(Applicable to the candidates admitted from the academic year 2025-2026 onwards)

COURSE PATTERN

S.No.	Sem	Course	Code	Course Title	Ins. hours /week	Credit	Exam Hr	Marks			Total
								CIA	W	O	
1.	I	Core Course – (CC1)	P25BO1	Plant Diversity - I (Algae, Fungi and Bryophytes)	6	5	3	25	75	-	100
2.		Core Course – (CC2)	P25BO2	Plant Diversity - II (Pteridophytes, Gymnosperms and Paleobotany)	6	5	3	25	75	-	100
3.		Core Course – (CC3)	P25BO3	Microbiology, Plant Pathology and Phyto-Immunology	6	5	3	25	75	-	100
4.		Core Course – (CC4)	P25BO4P	Practical-1 (P25BO1, P25BO2 & P25BO3)	6	5	3	25	70	5	100
5.		Elective Course – (EC1)	P25BO5E1	Ecology, Phytogeography and Conservation Biology	6	4	3	25	75	-	100
			P25BO5E2	Microalgal Technology	6	4	3	25	75	-	
			P25BO5E3	Bio-Resource Management	6	4	3	25	75	-	

		Total			**30**	**24**	**-**	**-**	**-**	**-**	**500**
6.	II	Core Course – (CC5)	P25BO6	Anatomy and Embryology	6	5	3	25	75	-	100
7.		Core Course – (CC6)	P25BO7	Angiosperm Taxonomy	6	5	3	25	75	-	100
8.		Core Course – (CC7)	P25BO8	Genetics and Plant Breeding	6	5	3	25	75	-	100
9.		Core Course – (CC8)	P25BO9P	Practical - 2 (P25BO6, P25BO7, P25BO8, P25BO10E)	6	5	3	25	70	5	100
10.		Elective Course – (EC2)	P25BO10E1	Organic Farming and Horticulture	6	4	3	25	75	-	100
			P25BO10E2	Ethnobotany	6	4	3	25	75		
			P25BO10E3	Industrial Botany	6	4	3	25	75		
		Total			**30**	**24**	**-**	**-**	**-**	**-**	**500**
11.	III	Core Course – (CC9)	P25BO11	Biochemistry	6	5	3	25	75		100
12.		Core Course – (CC10)	P25BO12	Plant Physiology	6	5	3	25	75		100
13.		Core Course – (CC11)	P25BO13P	Practical -3 (P25BO11, P25BO12, P25BO14E)	6	5	3	25	70	5	100
14.		Elective – (EC3)	P25BO14E1	Morphogenesis and Plant Tissue Culture	6	4	3	25	75		100
			P25BO14E2	Herbal Medicine	6	4	3	25	75		
			P25BO14E3	Floriculture and Landscaping	6	4	3	25	75		
15.		Elective - (EC4)	P25BO15E1	Genetic Engineering	6	4	3	25	75		100
			P25BO15E2	Bioprospecting, Drug Discovery and Product Development	6	4	3	25	75		
			P25BO15E3	Food Processing and Preservation	6	4	3	25	75		

		Total			**30**	**23**					**500**
16.	IV	Core Course – (CC12)	P25BO16	Research Methodology	6	5	3	25	75		100
17.		Core Course – (CC13)	P25BO17	Bioprocess Technology	6	5	3	25	75		100
18.		Elective – (EC5)	P25BO18E1	Bioinformatics	6	4	3	25	75		100
			P25BO18E2	Entrepreneurial Opportunities in Botany	6	4	3	25	75		
			P25BO18E3	Intellectual Property Rights and Patenting	6	4	3	25	75		
19.		Project	P25BOP19	Project Work	12	5		75	25		100
		Total			**30**	**19**					**400**
		Grand Total			**120**	**90**					**1900**

Sem.	Programme Code	Course Code	Course Type	Course Title	Category	Hrs. / Week	Credits
I	BOTPG1986	P25BO1	Core Course	**PLANT DIVERSITY - I (ALGAE, FUNGI AND BRYOPHYTES)**	Theory	6	5

Course Description:
This course provides a foundational understanding of plant diversity, covering major plant groups algae, Fungi and Bryophytes. It explores classification, reproduction and life cycle of algae, Fungi, and Bryophytes.

Course Objectives:

1. *To comprehensively understand algal classification criteria, Fritsch's system, and comparative accounts of major algal classes' structure, reproduction, and phylogeny.*
2. *To explore the diverse ecological roles of algae, including their habitats, cultivation, general biological trends, economic importance, and role as pollution indicators.*
3. *To master the general features of fungi, their structural organization, Alexopoulos and Mims' classification, and the life cycles of major fungal subdivisions.*
4. *To analyze fungal nutrition, reproductive variations like homothallism and parasexuality, economic importance, and symbiotic associations such as mycorrhizae and lichens.*
5. *To identify the salient features, origin, and classification of bryophytes (Reimer 1954), comparatively study their major classes, and understand the evolution and economic uses of their life forms*.

Unit-I: ALGAE (Teaching - 1 h / week)

Major criteria used for Algal classification (Cell wall, pigments, reserve food materials and flagella). Classification of algae – Fritsch (1935). Comparative account on structure, reproduction and phylogeny of Chlorophyceae (*Ulva*), Xanthophyceae (*Vaucheria*), Bacillariophyceae (*Navicula*), Phaeophyceae (*Padina*), Rhodophyceae (*Gracilaria*) and Myxophyceae (*Spirulina*).

Unit-II: ALGAE (Teaching - 1 hr/ week)

Ecology of Algae: Aquatic (Fresh water algae, marine algae), Terrestrial (aerophytic, cryptophytic and thermophytic algae). Soil algae and symbiotic associations. Cultivation of fresh water and marine algae. General trends in algae: Thallus organization, life cycle patterns and economic importance of algae. Algae as pollution indicators - Algal blooms.

Unit-III: FUNGI (Teaching-1 hr/ week)

General features of fungi. General structure and organization of fungal hypha. Classification of fungi (Alexopoulos and Mims, 1979). Structure, reproduction, life cycle and phylogeny of – Mastigomycotina (*Pilobolus*), Zygomycotina (*Taphrina*), Ascomycotina (*Xylaria*), Basidiomycotina (*Pleurotus*) and Deuteromycotina (*Lycoperdon*).

Unit-IV: FUNGI (Teaching-1 hr/ week)

Mode of nutrition and culture of fungi. Homothallism, heterothallism and parasexual cycle. Economic importance of fungi. Fungal association: Mycorrhiza - ecto, endo and ectoendomycorrhiza. Lichen - General features, thallus organization and economic importance.

Unit-V: BRYOPHYTES (Teaching-2 hrs / week)

Salient features of Bryophytes. Origin of bryophytes. Classification of Bryophytes (Reimer 1954). Comparative study on the structure, reproduction and life cycle of Hepaticopsida - *Targionia, Lunularia;* Anthocerotopsida - *Notothylas, Anthoceros;* and Bryopsida - *Spagnum, Funaria.* Evolution of gametophytes and sporophytes in Brypophytes. Economic uses of Bryophytes.

Course Outcomes:

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

CO1 *Understand the major groups of cryptogamic plants and their characteristics.*
CO2 *Study their interrelationships and trace their evolutionary trends of algae.*
CO3 *Know the classification, life cycle and economic importance of Algae*
CO4 *Acquire knowledge on general characteristics of Fungi and to study the Life cycle, mode of nutrition and fungal association.*
CO5 *Develop critical understanding on comparative structure, reproduction and life cycle of Bryophytes.*
CO6 *Understand the significance of mutual relationships between algae, fungi and higher plants on evolutionary perspective.*

Text Book:

- Chapman, C.J. and Chapman, D.J. (1981). The Algae. 2nd ed. Macmillan, London.
- Sharma, O. P. (2017). Algae. McGraw Hill, New Delhi.
- Sharma, O.P. (2017). Bryophyte. McGraw Hill, New Delhi, India.
- Vashishta, B. R. and Sinha, A. K. (2007). Botany for Degree Students - Fungi. S. Chand and Co. Ltd., New Delhi.

Reference:

- Alexopoulus, C. J. and Mims, C. W. (1979). Introductory Mycology. Wiley Eastern Ltd., New York.
- Fritsch, F. E. (1976). Structure and Reproduction of the Algae. Vol. I & II. Cambridge University Press, London.
- Sharma, P. D. (1987). The Fungi. Rastogi and Co., Meerut.
- Smith, G. M. (1971). Cryptogamic Botany. Vol. II. Bryophytes and Pteridophytes. Tata McGraw Hill, New Delhi.
- Vashishta, B. R. et al. (2008). Botany for Degree Students - Algae. S. Chand and Co. Ltd., New Delhi.

Web Resources:

- https://www.ruhr-uni-bochum.de/botanyonline/ (Navigate to "Contents" and then "Systematics of Plants")
- https://microbenotes.com/
- https://www.slideshare.net/ Alexopoulos Fungi classification PPT," "Targionia life cycle," "Sphagnum reproduction," "Economic importance of Bryophytes.

CO- PO Mapping (Course Articulation Matrix)

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	9	3	3	3	0
CO2	9	3	1	3	0	1
CO3	9	9	3	3	1	0
CO4	3	3	9	9	0	1
CO5	9	1	3	3	3	1
CO6	3	1	0	0	0	0
Weightage	**42**	**26**	**19**	**21**	**9**	**3**
Weighted percentage of Course contribution to POs	**35.00**	**21.67**	**15.83**	**17.50**	**7.50**	**2.50**

Level of Correlation between CO's and PO's } 1 – Low 3 – Medium 9 – High 0 – No Correlation (Suggested by UGC as per Six Sigma Tool – Cause and Effect Matrix)

Course Outcomes mapped with Knowledge level (Revised Bloom's Taxonomy) and POs

CO/ K-Level	Level of Correlation			
	High	Medium	Low	Zero
CO1/ K1	PO2,	PO1, PO3, PO4, PO5	-	PO6
CO2/ K2	PO1,	PO2, PO4	PO3,PO6	PO5
CO3/ K3	PO1, PO2	PO3, PO4	PO5	PO6
CO4/ K4	PO3,PO4	PO1,PO2	PO6	PO5,
CO5/ K5	PO1	PO3, PO4, PO5	PO2,PO6	-
CO6/ K6	-	PO1	PO2	PO3, PO4, PO5, PO6

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure:

K Levels	C1	C2	C3	C4	Total scholastic marks	Non Scholastic Marks C5	CIA Total	% of Assessment
	T1 5 Marks	T2 6 Marks	Assignment 4 Marks	Seminar 5 Marks	20 Marks	5 Marks	25 Marks	
K1	0	1			1	-	**1**	4
K2	1	1		1	3	-	**3**	12
K3	1	1	1	1	4	-	**4**	16
K4	1	1	1	1	4	-	**4**	16
K5	1	1	1	1	4	-	**4**	**16**
K6	1	1	1	1	4	-	**4**	**16**
Non Scholastic	--	--	--	--	--	5	**5**	20
Total	**5**	**6**	**4**	**5**	**20**	**5**	**25**	**100%**

***C = Component**

The COs and POs for the **PLANT DIVERSITY-I** course in the **M.Sc. Botany** Programme is effectively matched by the Course In-charge.

Signature of the Course In- charge

Signature of the Coordinator

Sem.	Programme Code	Course Code	Course Type	Course Title	Category	Hrs. / Week	Credits
I	BOTPG1986	P25BO2	Core Course	**PLANT DIVERSITY - II (PTERIDOPHYTES, GYMNOSPERMS AND PALEOBOTANY)**	Theory	6	5

Course Description:

This course provides an in-depth study of the diversity, morphology, anatomy, reproduction, evolution, and classification of Pteridophytes and Gymnosperms. It covers both living and fossil representatives and introduces key fossil plant groups and their relevance to paleobotanical research. The course emphasizes the evolutionary trends from simple to complex forms in vascular cryptogams and seed plants. Additionally, it explores the ecological, medicinal, and economic importance of these groups and the significance of paleobotanical evidence in understanding past climates, environments, and fossil fuel exploration.

Course Objectives:

1. *To describe the general characteristics, classification, and life cycles of various Pteridophyte orders including both fossil and extant forms.*
2. *To understand the morphology, anatomy, reproductive strategies, and evolutionary relationships of Gymnosperms.*
3. *To study fossil plant forms, geological time scales, and fossilization types, enhancing understanding of plant evolution and paleoenvironments.*
4. *To appreciate the ecological, economic, and medicinal importance of Pteridophytes and Gymnosperms.*
5. *To develop foundational knowledge in paleopalynology and the role of fossil plants in coal and oil exploration*.

Unit-I: PTERIDOPHYTES (Teaching - 1 h / week)

General features. Classification of Pteridophytes (Reimer, 1954). Range of morphology, structure, reproduction and evolution of gametophytes and sporophytes of the following orders: Psilotales (*Psilotum*), Lycopodiales (*Lycopodium*), Selaginellales (*Selaginella*), Isoetales (*Isoetes*) and Equisetales (*Equisetum*).

Unit-II: PTERIDOPHYTES (Teaching - 2 hrs / week)

Range of morphology, structure, reproduction and evolution of gametophytes and sporophytes of the following orders: Ophioglossales (*Ophioglossum*), Marattiales (*Angiopteris*), Osmundales (*Osmunda*), Filicales (*Pteris*) and Salviniales (*Marsilea*). Stelar evolution in pteridophytes, Ecological and Economic Importance of Pteridophytes.

Unit-III: GYMNOSPERMS (Teaching - 1 h / week)

History and Salient features of Gymnosperms. Classification of Gymnosperms (Sporne 1965). General structure and interrelationships of Pteridospermales, Bennettitales, Pentoxylales and Cordaitales.

Unit-IV: GYMNOSPERMS (Teaching - 1 h / week)

Distribution, morphology, anatomy, reproduction of Cycadales (*Cycas*), Coniferales (*Podocarpus*), Ginkgoales (*Ginkgo*), Gnetales (*Gnetum*) and Ephedrales (*Ephedra*). Economic Importance of Gymnosperms. Functional and morphological evolution in gymnosperms.

Unit-V: PALEOBOTANY (Teaching - 1 h / week)

Concepts of Paleobotany, A general account on Geological Time Scale. Fossil types: Compressions, incrustation, casts, molds, petrifactions, coalballs and compactions. Paleoclimate and fossil plants. Study of *Lepidodendron*, *Stigmaria*, *Lyginopteris* and *Cordaites*. Age of fossils – radiocarbon dating. Role of fossil in oil exploration and coal excavation. Palynology and their Applications.

Course Outcomes:

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

CO1 *Understand the diagnostic features and life history of Pteridophytes.*
CO2 *Develop critical understanding on comparative structure, reproduction and life cycle of Pteridophytes.*
CO3 *Analyze the general features and life cycle of Gymnosperms.*
CO4 *Understanding of morphology, anatomy and reproduction of Gymnosperms.*
CO5 *Acquire knowledge on the concepts of Palaeobotany and study the fossil plants and their role*
CO6 *Reconstruct ancient ecological system and climate through knowledge in Paleobotany which is the fundamental in the study of plant development and evolution.*

Text Book:

- Rashid, A. (1986). An Introduction to Pteridophyta. Vani Educational Books, New Delhi.
- Vasishta, P.C. et al. (2010). Botany for Degree Students: Gymnosperms. S. Chand and Co. Ltd., New Delhi.
- Shukla, A.C. and Mishra, S.P. (1982). Essentials of Paleobotany. 2nd ed. Vikas Publishing House Pvt. Ltd., New Delhi.

Reference:

- Seward, A.C. (1931). Plant Life through the Ages. Cambridge University Press, London.
- Sharma, O.P. (2017). Text Book of Pteridophyta. McGraw Hill Education India Ltd., India.
- Sporne, K.R. 1965. The Morphology of Pteridophytes. Hutchinson & Co., London.
- Sporne, K.R. (2015). The Morphology of Gymnosperm. 2nd edition, Scientific Publisher, Jodhpur, Inida.
- Vashishta, P.C. et al. (2008). Botany for Degree Students: Pteridophyta. S. Chand and Co. Ltd., New Delhi.

Web Resources:

- Digital Flora of India – Botanical Survey of India - http://bsi.gov.in
- Paleobotany at University of California Museum of Paleontology - https://ucmp.berkeley.edu

CO- PO Mapping (Course Articulation Matrix)

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	9	9	3	9	3	0
CO2	9	3	3	9	3	1
CO3	3	3	3	3	1	0
CO4	9	3	1	3	1	1
CO5	3	1	1	3	1	1
CO6	3	1	1	0	1	1
Weightage	**36**	**20**	**12**	**28**	**10**	**4**
Weighted percentage of Course contribution to POs	**32.73**	**18.18**	**10.91**	**25.45**	**9.09**	**3.64**

Level of Correlation between CO's and PO's } 1 – Low 3 – Medium 9 – High 0 – No Correlation (Suggested by UGC as per Six Sigma Tool – Cause and Effect Matrix)

Course Outcomes mapped with Knowledge level (Revised Bloom's Taxonomy) and POs

CO/ K-Level	Level of Correlation			
	High	Medium	Low	Zero
CO1/ K1	PO1	PO2	PO3	PO4, PO5, PO6
CO2/ K2	PO1	PO2, PO3		PO4, PO5, PO6
CO3/ K3	PO1, PO2	PO3, PO4		PO5, PO6
CO4/ K4	PO2, PO3	PO1, PO4		PO5, PO6
CO5/ K5	PO4	PO2, PO3	PO1	PO5, PO6
CO6/ K6	PO4, PO5, PO6	PO2, PO3	PO1	-

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure:

K Levels	C1	C2	C3	C4	Total scholastic marks	Non Scholastic Marks C5	CIA Total	% of Assessment
	T1 5 Marks	T2 6 Marks	Assignment 4 Marks	Seminar 5 Marks	20 Marks	5 Marks	25 Marks	
K1	0	1			1	-	**1**	4
K2	1	1		1	3	-	**3**	12
K3	1	1	1	1	4	-	**4**	16
K4	1	1	1	1	4	-	**4**	16
K5	1	1	1	1	4	-	**4**	**16**
K6	1	1	1	1	4	-	**4**	**16**
Non Scholastic	--	--	--	--	--	5	**5**	20
Total	**5**	**6**	**4**	**5**	**20**	**5**	**25**	**100%**

***C = Component**

The COs and POs for **the PLANT DIVERSITY-II** course in the **M.Sc. Botany** Programme is effectively matched by the Course In-charge.

Signature of the Course In- charge

Signature of the Coordinator

Sem.	Programme Code	Course Code	Course Type	Course Title	Category	Hrs. / Week	Credits
I	BOTPG1986	P25BO3	Core Course	**MICROBIOLOGY, PLANT PATHOLOGY AND PHYTO-IMMUNOLOGY**	Theory	6	5

Course Description:

This core course offers a comprehensive understanding of microorganisms, plant diseases, and plant immune responses. It covers the diversity, structure, classification, and growth of bacteria and viruses, with emphasis on plant pathogens and their control. Students explore the principles of plant pathology, including disease diagnosis, disease triangle, host–pathogen interactions, and integrated management practices. A detailed study of economically important plant diseases is included. The course also introduces the fundamentals of phytoimmunology, including plant immune signalling pathways, PAMP-triggered responses, and systemic acquired resistance. This course prepares students for advanced research in plant-microbe interactions, pathology, and plant defence mechanisms.

Course Objectives

1. *To study the structure, classification, nutrition, and reproduction of bacteria and viruses relevant to plant health.*
2. *To understand the principles, terminology, and methods used in plant pathology.*
3. *To examine the etiology and control strategies of economically important plant diseases.*
4. *To analyse the host–pathogen relationship and concepts such as the disease triangle and pathogen dissemination.*
5. *To introduce principles and molecular mechanisms of plant immunity, including HR and systemic responses.*
6. *To familiarise students with integrated approaches to plant disease management, including IPM practices.*

Unit-I: BACTERIA (Teaching - 1 h / week)

Overview of types of microorganisms. General characteristic of bacteria – Outline classification of Bergey's manual of 9th edition. Classification of bacteria based on Morphological, cultural, physiological and molecular characteristics. Bacterial growth Curve. Factors affecting growth. Determination of bacterial growth – Direct method: Haemocytometer, Viable plate count; Indirect method: Turbidity. Nutritional types. Reproduction - Fission and sporulation. Overview of Mycoplasma.

Unit-II: VIRUSES (Teaching - 1 h / week)

General characters, Classification, Structure, Multiplication. Overview of Phycoviruses and Mycoviruses and Plant viruses. Cultivation of viruses – in embryonated egg and in plants. Control of viral infections. Bacteriophages - Lytic and Lysogenic cycle. Viroids and prions.

Unit-III: PLANT PATHOLOGY (Teaching - 1 h / week)

Objectives and common terminologies used in plant pathology. Animate and Inanimate causes and classification of plant diseases. Diseases triangle. Dissemination and dispersion of pathogens. Methods of studying plant diseases – examination. Host parasite interactions. Control of plant diseases - principles and methods. Overview of Integrated Pest Management (IPM).

Unit-IV: PLANT DISEASES (Teaching - 1 h / week)

Etiology, pathogenesis, epidemiology, control and prevention measure of the following plant diseases:

Early and Late Blight of potato - Smut of Sorghum - Wilt of Banana - Downy mildew of grapes – Leaf curl of Papaya - Wilt of cotton – Black rust of wheat.

Unit-V: PHYTO IMMUNOLOGY (Teaching - 2 hrs / week)

Principles of Plant Immunity – difference between plants and animals. Classes of plant immune response. Basal response – PAMP recognition. Hypersensitive response (HR). Systemic acquired immunity. Jasmonic acid/ ethylene pathways. Non-host immunity.

Course Outcomes:

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

CO1 *Develop critical understanding of the diversity of microorganisms*
CO2 *Know about the general features, classification, isolation and vector relationship of viruses*
CO3 *Acquire knowledge on the fundamental aspects of plant pathology*
CO4 *Learn the etiology, pathogenesis, epidemiology and control of few plant diseases.*
CO5 *Basic understanding of fundamentals of immunology and antigen & antibody interaction and detection.*
CO6 *To invent holistic ways those create safer living environments to plants and to boost the agriculture economy.*

Text Book:

- Annadurai, B. (2008). A Textbook of Immunology and Immunotechnology. S. Chand and Co. Ltd., New Delhi.
- Kanungo, R. (2017). Ananthanarayan and Paniker's Textbook of Microbiology (10th ed.). Universities Press, Hyderabad, India.
- Rangaswamy, G. (1972). Diseases of Crop Plants in India. Prentice Hall of India Pvt. Ltd.
- Sharma, P.D. (2011). Plant Pathology, Rastogi Publication, Meerut, India.

Reference:

- Agrios, G.N. (1997). Plant Pathology, 4th edition, Academic Press, U.K.
- Kuby, J. (2000). Immunology, 4th edition, W H Freeman & Co (Sd).
- Nandini Shetty. (2008). Immunology Introductory Textbook. New Age International Publishers, New Delhi.
- Pelczar, M.J. (2001). Microbiology, 5th edition, Tata McGraw-Hill Co, New Delhi.
- Prescott, L.M., Harley, J.P. and Klien, D.A. (1996). Microbiology (3rded.), Brown W.C. Publishers, Boston, USA.
- Mehrotra, R.S. and Ashok Aggarwal, (2017). Plant Pathology. Mc Graw Hill India

CO- PO Mapping (Course Articulation Matrix)

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	9	3	3	3	0
CO2	9	3	3	3	1	1
CO3	9	9	3	3	1	0
CO4	3	3	3	9	1	1
CO5	9	1	3	3	3	1
CO6	3	1	1	0	1	0
Weightage	**42**	**26**	**16**	**21**	**10**	**3**
Weighted percentage of Course contribution to POs	35.59	22.03	13.56	17.80	8.47	2.54

Level of Correlation between CO's and PO's: 1 – Low 3 – Medium 9 – High 0 – No Correlation (Suggested by UGC as per Six Sigma Tool – Cause and Effect Matrix)

Course Outcomes mapped with Knowledge level (Revised Bloom's Taxonomy) and POs

CO/ K-Level	Level of Correlation			
	High	**Medium**	**Low**	**Zero**
CO1/ K1	PO1, PO2	PO3, PO4, PO5	PO6	_
CO2/ K2	PO1, PO2	PO3, PO4	PO5, PO6	_
CO3/ K3	PO1	PO2, PO3, PO4,	PO5	PO6
CO4/ K4	PO1	PO2, PO3, PO4	PO5	PO6
CO5/ K5	PO1	PO2	PO3, PO4	PO5, PO6
CO6/ K6	PO1	PO2	PO3, PO4,	PO5, PO6

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure:

K Levels	C1	C2	C3	C4	Total scholastic marks	Non Scholastic Marks C5	CIA Total	% of Assessment
	T1 5 Marks	T2 6 Marks	Assignment 4 Marks	Seminar 5 Marks	20 Marks	5 Marks	25 Marks	
K1	0	1			1	-	**1**	4
K2	1	1		1	3	-	**3**	12
K3	1	1	1	1	4	-	**4**	16
K4	1	1	1	1	4	-	**4**	16
K5	1	1	1	1	4	-	**4**	**16**
K6	1	1	1	1	4	-	**4**	**16**
Non Scholastic	--	--	--	--	--	5	**5**	20
Total	**5**	**6**	**4**	**5**	**20**	**5**	**25**	**100%**

***C = Component**

The COs and POs for the **MICROBIOLOGY, PLANT PATHOLOGY AND PHYTO IMMUNOLOGY** course in the M.Sc. Botany Programme is effectively matched by the Course In-charge.

Signature of the Course In-charge

Signature of the Coordinator

Sem.	Programme Code	Course Code	Course Type	Course Title	Category	Hrs. / Week	Credits
I	BOTPG1986	P25BO4P	Core Course	**PRACTICAL – 1** (P25BO1, P25BO2 & P25BO3)	Practical	6	5

Course Description:
This course provides a foundational understanding of plant diversity, covering major plant groups algae, Fungi, Bryophytes, Pteridophytes and Gymnosperms. It explores classification, reproduction and life cycle of algae, Fungi, Bryophyte, Pteridophytes and Gymnosperms.

Course Objectives:

1. *To study the general structure and anatomy of Algae, Fungi and Lichen.*
2. *To demonstrate proficiency in the experimental techniques and methods of appropriate analysis relevant to Bryophytes, Pteridophytes and Gymnosperm..*
3. *To develop critical understanding of the diversity of microorganisms.*
4. *To understand the etiology, pathogenesis, epidemiology and control of few plant diseases.*
5. *To study the structure and functions of ecosystem.*

Algae: Micropreparation of *Anabaena, Spirulina, Nitella, Padina, Sargassum* and *Gracilaria*.

Fungi: *Pilobolus, Taphrina, Xylaria, Pleurotus* and *Lycoperdon*

Lichens: *Parmelia* and *Usnea*

Bryophytes: Morphological and anatomical study of representative members of the following genera: *Lunularia, Targionia, Notothylus* and *Funaria.*

Pteridophytes: Study of the morphology and anatomy of the vegetative and reproductive parts of the following genera: *Isoetes, Angiopteris, Osmunda, Pteris, and Nephrolepis*.

Gymnosperms: Study of the morphology and anatomy of vegetative and reproductive parts of the following genera: *Podocarpus, Cupressus* and *Ephedra*

Paleobotany: *Lepidodendron, Stigmaria, Lyginopteris* and *Cordaites*

Microbiology: Media preparation - Sterilization. Culture transfer techniques - Isolation of pure cultures – Streak Plate Techniques. Isolation of microbes from soil and food. Gram's staining of Bacteria.

Plant Pathology: Study of the Anthracnose of mango - Wilt of cotton - White rust of Mustard - Smut in sorghum - Bunchy top of banana.

Ecology, Phytogeography and Conservation Biology

Field visit and report submission of the following:

- Pond ecosystem
- Sacred Groves
- Agro-forestry
- Botanical Garden

Course Outcomes:

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

CO1 *Acquire skills in laboratory to general structure and anatomy of Algae, Fungi and Lichen.*

CO2 *Demonstrate proficiency in the experimental techniques and methods of appropriate analysis relevant to Bryophytes, Pteridophytes and Gymnosperm.*

CO3 *Develop critical understanding of the diversity of microorganisms.*

CO4 *Learn the etiology, pathogenesis, epidemiology and control of few plant diseases.*

CO5 *Understand the conservatory aspect of bio-resources*

CO6 *Develop goals to maintain important aspects of plant life on earth – Plant diversity, health and integrity with ecosystem.*

CO- PO Mapping (Course Articulation Matrix)

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	9	9	3	9	3	1
CO2	9	9	3	3	1	1
CO3	9	3	3	3	1	1
CO4	3	3	3	3	1	1
CO5	3	1	3	0	0	0
CO6	3	1	3	0	0	0
Weightage	**36**	**26**	**18**	**18**	**10**	**4**
Weighted percentage of Course contribution to POs	**32.14**	**23.21**	**16.07**	**16.07**	**8.93**	**3.57**

Level of Correlation between CO's and PO's } 1 – Low 3 – Medium 9 – High 0 – No Correlation (Suggested by UGC as per Six Sigma Tool – Cause and Effect Matrix)

Course Outcomes mapped with Knowledge level (Revised Bloom's Taxonomy) and POs

CO/ K-Level	Level of Correlation			
	High	**Medium**	**Low**	**Zero**
CO1/ K1	PO1, PO2	PO3, PO4, PO5	PO6	_
CO2/ K2	PO1, PO2	PO3, PO4	PO5, PO6	_
CO3/ K3	PO1	PO2, PO3,	PO4, PO5	PO6
CO4/ K4	PO1	PO2, PO3	PO4, PO5	PO6
CO5/ K5		PO1, PO2	PO3, PO4	PO5, PO6
CO6/ K6		PO1, PO2	PO3, PO4,	PO5, PO6

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure:

K Levels	C1	C2	C3	C4	Total scholastic marks	Non Scholastic Marks C5	CIA Total	% of Assessment
	T1 4 Marks	T2 10 Marks	Assignment 6 Marks	Seminar 5 Marks	20 Marks	5 Marks	25 Marks	
K1	1	2	1	--	4	--	**4**	**16**
K2	1	2	1	--	4	--	**4**	**16**
K3	1	2	1	--	4	--	**4**	**16**
K4	1	2	1	--	4	--	**4**	**16**
K5		1	1	--	2	--	**2**	**8**
K6		1	1	--	2	--	**2**	**8**
Non Scholastic	--	--	--	--	--	**5**	**5**	**20**
Total	**4**	**10**	**6**	--	**20**	**5**	**25**	**100%**

***C = Component**

The COs and POs for the **PRACTICAL 1** course in the M.Sc. Botany Programme is effectively matched by the Course In-charge.

Signature of the Course In-charge

Signature of the Coordinator

Sem.	Programme Code	Course Code	Course Type	Course Title	Category	Hrs. / Week	Credits
I	BOTPG1986	P25BO5E1	Elective Course	**ECOLOGY, PHYTOGEOGRAPHY AND CONSERVATION BIOLOGY**	Theory	6	4

Course Description:

This course explores the fundamental principles of ecology, ecosystem dynamics, and species adaptations to environmental factors. It introduces population and community ecology, biotic interactions, and the basics of phytogeography. Students will gain insight into biodiversity conservation strategies, both in situ and ex situ, and the role of national and international organizations. The course also emphasizes environmental ethics, education, and sustainable development approaches.

Course Objectives:

1. *Understand the structure, function, and dynamics of ecosystems, including energy flow and biogeochemical cycles.*
2. *Examine ecological adaptations, population growth patterns, and species interactions within ecological communities.*
3. *Gain knowledge of phytogeography, plant distribution theories, and India's major phytogeographical regions.*
4. *Learn about biodiversity conservation approaches and the role of global and national conservation organizations.*
5. *Explore in situ and ex situ conservation methods, environmental ethics, and the importance of environmental education.*

UNIT-1: ECOLOGY (Teaching-1 h/week)

Concept and dynamics of ecosystem: Types of ecosystem, components, Food chain, Food web and energy flow. Trophic level and ecological pyramids. Productivity and biogeochemical cycles (N,P,C,S) Ecological amplitude of a species and adaptation – Ecads, ecotypes, ecospecies, Raunkaier's life forms.

UNIT-II: ECOLOGICAL ADAPTATIONS AND POPULATION ECOLOGY (Teaching-1 h/week)

Variations in adaptation of plants in relation to light, temperature, water, wind and fire. Biotic interactions: Competition: Inter- and intraspecific competition; Ammensalism, heterotrophy; mutualism, commensalism, parasitism; herbivory, carnivory, protocooperation, Population ecology: Characteristics and population growth, population regulation, life history strategies; *r* and *k* selection. Community Ecology: nature of Communities-Community structures and attributes, Edges and ecotones.

UNIT-III: PHYTOGEOGRAPHY (Teaching-1 h/week)

Phytogeography: definitions, divisions and principles. Endemics, Continuous, discontinuous and Endemism. Range – Dispersal and migration barriers hypothesis. Continental drift hypothesis. Land – Brides hypothesis, Age and Area hypothesis. Theory of tolerance. Brief description of major terrestrial biomes (one each from tropical, temperate & tundra). Remote Sensing and GIS. Phyto-geographical region of India.

UNIT-IV: CONSERVATION BIOLOGY (Teaching-1 h/week)

Conservation Biology – Introduction - Ecosystem and Species based approaches - Social approaches for Forest conservation - Chipko movement – Forest management. Biodiversity awareness programme. Biodiversity Education Resources and Sustainable Development - Role of IUCN, UNESCO, WWF, ICSU, NBPGR in Conservation Programme.

UNIT – V: CONSERVATION BIOLOGY (Teaching-2hrs / week)

In situ conservation (Afforestation, Social Forestry, Agro Forestry, Botanical Gardens. Biosphere Reserves, National Parks, Sanctuaries, Sacred Groves and Sthalavrikshas) and *ex situ* conservation (Cryopreservation, Gene Bank, Seed Bank, Pollen Bank, Sperm Bank, DNA Bank, Tissue Culture and Biotechnological strategies) – Environmental Education, Environmental ethics.

Course Outcomes:

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

CO1 *Impart knowledge and types of ecosystem and biogeochemical cycles.*
CO2 *Learn about the ecological adaptations and population ecology.*
CO3 *Acquire the knowledge on phytogeography / phytogeographical division of India*
CO4 *Understand the conservatory aspect of bio-resources*
CO5 *Gain an understanding of in-situ and ex-situ conservation of Bio-resources.*
CO6 *Develop strategies to be adopted for conservation of plant diversity under clanging environment in relation to their bio geographic distribution.*

Text Book:

- Ananthakrishnan, T. N. (1982). Bioresources Ecology. Oxford & IBH Publications, New Delhi.
- Krishnamurthy, K. V. (2004). An Advanced Textbook on Biodiversity: Principles and Practice. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
- Odum, E. P. (1975). Ecology. 2nd ed. Oxford & IBH Publications, New Delhi.
- Suresh K. Dhameja (2004). Environmental Engineering and Management. S. K. Kataria and Sons, Delhi
- Sharma, P.D. (2019). Ecology and Environment. Rastogi Publications. Meerut.

Reference:

- Frankel, O. H., Brown, A. H. D. and Burdon, J. J. (1995). The Conservation of Plant Diversity. Cambridge University Press, London.
- Heywood, V. H. (1995). Global Biodiversity Assessment. UNEP, Cambridge University Press, London.
- Jogdand, S. N. (2003). Environmental Biotechnology (Industrial Pollution Management). Himalaya Publishing House, Delhi.
- Mani, M. S. (1974). Ecology and Biogeography of India. Dr. W. Junk Publishers, The Haque.

Web Resources:

- https://www.usgs.gov/media/images/biogeochemical-cycles
- https://www.iucnredlist.org/
- https://www.nature.com/scitable
- https://openstax.org/details/books/biology-2e (Navigate to the "Ecology" section)
- https://archive.org/details/conservationbiology0000unse_k0m9

CO- PO Mapping (Course Articulation Matrix)

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	9	9	3	9	3	1
CO2	9	9	3	9	3	1
CO3	9	3	3	3	3	1
CO4	9	3	3	3	1	1
CO5	1	3	3	0	0	0
CO6	1	3	1	0	0	0
Weightage	**38**	**30**	**16**	**24**	**10**	**4**
Weighted percentage of Course contribution to POs	**31.15**	**24.59**	**13.11**	**19.67**	**8.20**	**3.28**

Level of Correlation between CO's and PO's } 1 – Low 3 – Medium 9 – High 0 – No Correlation (Suggested by UGC as per Six Sigma Tool – Cause and Effect Matrix)

Course Outcomes mapped with Knowledge level (Revised Bloom's Taxonomy) and POs

CO/ K-Level	Level of Correlation			
	High	Medium	Low	Zero
CO1/ K1	PO1		PO2, PO3	PO4, PO5, PO6
CO2/ K2	PO1	PO2, PO3	PO4	PO5, PO6
CO3/ K3	PO1, PO3	PO2, PO4	PO5	PO6
CO4/ K4	PO3, PO4	PO1, PO2	PO5	PO6
CO5/ K5	PO3, PO4	PO1, PO2. PO5	PO6	-
CO6/ K6	PO3, PO4, PO5, PO6	PO2	PO1	-

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure:

K Levels	C1	C2	C3	C4	Total scholastic marks	Non Scholastic Marks C5	CIA Total	% of Assessment
	T1 5 Marks	T2 6 Marks	Assignment 4 Marks	Seminar 5 Marks	20 Marks	5 Marks	25 Marks	
K1	0	1			1	-	**1**	4
K2	1	1		1	3	-	**3**	12
K3	1	1	1	1	4	-	**4**	16
K4	1	1	1	1	4	-	**4**	16
K5	1	1	1	1	4	-	**4**	**16**
K6	1	1	1	1	4	-	**4**	**16**
Non Scholastic	--	--	--	--	--	5	**5**	20
Total	**5**	**6**	**4**	**5**	**20**	**5**	**25**	**100%**

***C = Component**

The COs and POs for the **ECOLOGY, PHYTOGEOGRAPHY & CONSERVATION BIOLOGY** course in the M.Sc. Botany Programme is effectively matched by the Course In-charge.

Signature of the Course In- charge Signature of the Coordinator

Sem.	Programme Code	Course Code	Course Type	Course Title	Category	Hrs. / Week	Credits
I	BOTPG1986	P25BO5E2	Elective Course	**MICROALGAL TECHNOLOGY**	Theory	6	4

Course Description:

This course provides an in-depth understanding of the morphology, reproduction, and ecological diversity of microalgae including cyanobacteria and diatoms. It covers techniques for mass cultivation, including upstream and downstream processes, and explores their roles in biofertilizers, biofuels, nutraceuticals, and environmental applications. The syllabus also focuses on microalgal bioactive compounds and their potential in food, feed, and pharmaceuticals. Advancements in genetic engineering of microalgae including CRISPR and synthetic biology are introduced for industrial and research applications.

Course Objectives:

1. *Understand the diversity, morphology, and reproductive strategies of microalgae across various habitats.*
2. *Learn methods of microalgae isolation, cultivation, and large-scale biomass production systems.*
3. *Explore the role of microalgae in agriculture, food, feed, and bioactive compound production.*
4. *Analyze the applications of microalgae in energy, environment, and space-related technologies.*
5. *Examine genetic modification techniques and molecular tools used in algal biotechnology.*

Unit-I: Morphology, Reproduction and General Characteristics of Microalgae: (Teaching-1 h/week)

Habitat – distribution of microalgae – cyanobacteria – diatom – Freshwater – Marine and extremophilic forms. Morphology – Reproduction – sexual – asexual – life cycle. General characteristics of microalgae – Photosynthesis of microalgae and cyanobacteria.

Unit-II: Mass Cultivation of Microalgae: (Teaching-1 h/week)

Upstream processing - Isolation, purification and preservation of starter cultures. Culturing techniques and photo bioreactor based production; downstream processing. Heterotrophic production; Mass cultivation - Circular – Tubular column – Raceway pond – Pit method. Mass cultivation of Chlorella – Spirulina – Dunaliella. Algal bloom. Factor influence algal growth – nutrients – temperature – light.

Unit-III: Algae as Biofertilizer and Green Manure: (Teaching-1 h/week)

Symbiotic and non-symbiotic algae in soil fertility and crop production. Microalgal protein – peptides – SCP as food and feed - pigments – carotenoids – phycocyanin – phycoerythrin. Lipids – FAME – Growth promoting substance from microalgae – extracellular polymeric Substance – Harmful Algal blooms and Toxins.

Unit-IV: Microalgae in Human Welfare: (Teaching-1 h/week)

Nutraceuticals; Pharmaceuticals; Biofertilizers; and phycoremediation. Biofuels – biodiesel – biobutanol – biohydrogen – Bioethanol and nanoparticles from microalgae - Algal in Transgenics –

antimicrobials from microalgae and cyanobacteria. Algal in transgenics - food colorant – CO2 sequestration – Algae in Space.

Unit-V: Targeted Genetic Modifications in Microalgae: (Teaching-1 h/week)

Genome shuffling and evolutionary engineering- Chlamydomonas reinhardtii as model organism; Application of synthetic biology in algae. Evolution at morphological and ultra-structural level, horizontal gene transfer and evolution of algal chloroplast. Quorum sensing in microalgae - Introns. CRISPR - CAS discovery, mode of action and application.

Course Outcomes:

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

- Understand the classification, characteristics and reproduction of microalgae.
- Formulate the media and techniques for mass cultivation of algae.
- Evaluate the role of algae as biofertilizer and green manure.
- Elaborate the applications of microalgae in human welfare.
- Analyze the targeted genetic modifications in microalgae.

Text Books

- Amrik SA. (2003). Phycology: Principles, processes and applications. Daya Publishing House, Delhi.
- Biris ES, Maria T, Tania M, Radu M and Antonia O. (2016). Applications of Microalgae in Wastewater Treatments: a Review. ProEnvironment
- Sonal D and Singh DP. (2015). Phycoremediation: Future Perspective of Green Technology.
- Ismail R, Sanjay K. Gupta, Amritanshu S, Poonam S, Sheena K and Faizal B. (2016). Microalgae Applications in Wastewater Treatment.

Reference:

- Whitton BA, Potts M. (2002). Ecology of Cyanobacteria-Their diversity in time and space. Springer Netherlands.
- Rajarao VN. (1990). Perspectives in Phycology, Today and Tomorrow Printers and publishers.
- Craggs R, Park J, Heubeck S and Sutherland D. (2014). High rate algal pond systems for low-energy wastewater treatment, nutrient recovery and energy production. Vol. 52(1): Algal and cyanobacterial bioenergy and Diversity.
- Steve P. (2009). Protozoans, Algae and Other Protists - Capstone Press.

Web Resources

- https://en.wikipedia.org/wiki/Phycotechnology?utm_source=chatgpt.com "Phycotechnology"
- https://biotechnologyforbiofuels.biomedcentral.com/articles/10.1186/s13068-024-02461-0?utm_source=chatgpt.com "Microalgae biofuels: illuminating the path to a sustainable future ..."
- https://algatex.org/ebook/Handbook%20of%20microalgal.pdf?utm_source=chatgpt.com "[PDF] Handbook of Microalgal Culture - Algatex Biotechnology"
- https://www.mdpi.com/bookfiles/book/6947/Biotechnology_Applications_of_Microalgae.pdf?utm_source=chatgpt

CO- PO Mapping (Course Articulation Matrix)

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	9	9	9	9	3	0
CO2	9	9	3	9	3	1
CO3	9	9	3	3	3	1
CO4	9	3	3	3	3	1
CO5	9	1	1	1	1	1
CO6	3	1	1	0	1	1
Weightage	**48**	**32**	**20**	**25**	**14**	**5**
Weighted percentage of Course contribution to POs	33.33	22.22	13.89	17.36	9.72	3.47

Level of Correlation between CO's and PO's } 1 – Low 3 – Medium 9 – High 0 – No Correlation (Suggested by UGC as per Six Sigma Tool – Cause and Effect Matrix)

Course Outcomes mapped with Knowledge level (Revised Bloom's Taxonomy) and POs

CO/ K-Level	Level of Correlation			
	High	Medium	Low	Zero
CO1/ K1	PO1	PO2	PO3	PO4, PO5, PO6
CO2/ K2	PO1	PO2, PO3	PO4, PO5	PO6
CO3/ K3	PO1, PO2	PO3, PO4		PO5, PO6
CO4/ K4	PO2, PO3	PO1, PO4	PO5	PO6
CO5/ K5	PO4	PO2, PO3	PO1	PO5, PO6
CO6/ K6	PO4, PO5, PO6	PO2, PO3	PO1	-

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure:

K Levels	C1	C2	C3	C4	Total scholastic marks	Non Scholastic Marks C5	CIA Total	% of Assessment
	T1 5 Marks	T2 6 Marks	Assignment 4 Marks	Seminar 5 Marks	20 Marks	5 Marks	25 Marks	
K1	0	1			1	-	**1**	4
K2	1	1		1	3	-	**3**	12
K3	1	1	1	1	4	-	**4**	16
K4	1	1	1	1	4	-	**4**	16
K5	1	1	1	1	4	-	**4**	**16**
K6	1	1	1	1	4	-	**4**	**16**
Non Scholastic	--	--	--	--	--	5	**5**	20
Total	**5**	**6**	**4**	**5**	**20**	**5**	**25**	**100%**

***C = Component**

The COs and POs for the **MICROALGAL TECHNOLOGY** course in the M.Sc. Botany Programme is effectively matched by the Course In-charge.

Signature of the Course In- charge Signature of the Coordinator

Sem.	Programme Code	Course Code	Course Type	Course Title	Category	Hrs. / Week	Credits
I	BOTPG1986	P25BO5E3	Elective Course	**BIO-RESOURCE MANAGEMENT**	Theory	6	4

Course Description:

This course provides an interdisciplinary understanding of natural resources and their management, covering ecological, social, and economic perspectives. It introduces the concept and classification of resources, their global distribution, and their critical role in sustainable development. The course explores key resource categories including forests, energy, food, land, and water, emphasizing current challenges such as over-exploitation, deforestation, desertification, and resource conflicts. It also examines various approaches to resource management, with a focus on integrated strategies, equity, poverty, and governance, especially in the context of developing countries.

Course Objectives:

1. *To introduce the fundamental concepts of natural resources, their classification, and interrelationships across ecological, social, and economic dimensions.*
2. *To examine the status, use, and management issues related to forest, energy, food, land, and water resources at both national and global levels.*
3. *To critically analyze the environmental and socio-economic impacts of resource overexploitation, including deforestation, salinity, drought, and tribal displacement.*
4. *To explore the challenges of sustainable resource management in the context of poverty, inequality, and conflicts in developing countries.*
5. *To understand and apply integrated and ecological approaches to resource management, emphasizing sustainability and community participation*

Unit I INTRODUCTION (Teaching-15 Hours)

Introduction to Natural Resource Bases: Concept of resource, classification of natural resources. Factors influencing resource availability, distribution and uses. Inter-relationships among different types of natural resources. Ecological, social and economic dimension of resource management. Natural resources and development.

Unit II FOREST RESOURCES (Teaching-15 Hours)

Forest vegetation, status and distribution, contribution as resource. Use and over-exploitation, deforestation. Timber extraction, mining, dams and their effects on forest and tribal people, Forest products.

Unit III ENERGY & FOOD RESOURCES (Teaching-15 Hours)

Renewable and non-renewable energy sources, use of alternate energy sources. World food problems, changes caused by agriculture and over-grazing, effects of modern agriculture, fertilizer-pesticide problems, salinity and case studies.

Unit IV LAND & WATER RESOURCES (Teaching-15 Hours)

Land use classification, Dry land, land use planning and desertification. Land resource management and major issues. Use and over-utilization of surface and ground water, drought, conflicts over water, dams-benefits and problems. Water ecology and management.

Unit V APPROACHES IN RESOURCE MANAGEMENT (Teaching-15 Hours)

Approaches in Resource Management: Ecological and economical approaches. Integrated resource management strategies. Poverty and implications in resource management in developing countries – poverty in developing countries, causes and link with resources scarcity and poverty. Resource conflicts: Resource extraction, access and control system.

Expected Course Outcomes:
On the completion of the course the student will be able to

CO1 Understand the knowledge on natural resource bases.
CO2 Acquire knowledge on forest biodiversity.
CO3 Food preservation and their dietary needs.
CO4 Formulate a strategy towards the social, ecological, economic, cultural and environmental purpose of forest.
CO5 Evaluate the strategies and appreciate uses of land and water resources.
CO6 Solve problems related to resource management.

Recommended References:

1. Francois Ramade 1984. Ecology of Natural Resources. John Wiley & Sons Ltd.
2. Harikesh N Mishra 2014 Managing Natural Resources- Focus on Land and Water.PHI Lerning Publication.
3. Global Change and Natural Resource Management, Vitousek, P.M. 1994. Beyond global warming: Ecology and global change. Ecology 75, 1861-1876.
4. Townsend C., Harper J, and Michael Begon. Essentials of Ecology, Blackwell Science.

Related Online Contents:

- https://www.nature.com/articles/s41538-024-00260-3
- https://www.nature.com/articles/nclimate1462
- https://www.sciencedirect.com/science/article/pii/S1389934124000790
- United Nations Environment Programme (UNEP) – Natural Resources https://www.unep.org
- FAO – Food and Agriculture Organization of the United Nations https://www.fao.org

CO- PO Mapping (Course Articulation Matrix)

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	9	9	3	9	3	0
CO2	9	9	3	9	3	1
CO3	3	1	3	3	1	0
CO4	9	3	1	3	3	1
CO5	3	1	3	1	1	1
CO6	3	1	1	0	1	0
Weightage	**36**	**24**	**14**	**26**	**12**	**3**
Weighted percentage of Course contribution to POs	**31.30**	**20.87**	**12.17**	**22.61**	**10.43**	**2.61**

Level of Correlation between CO's and PO's } 1 – Low 3 – Medium 9 – High 0 – No Correlation (Suggested by UGC as per Six Sigma Tool – Cause and Effect Matrix)

Course Outcomes mapped with Knowledge level (Revised Bloom's Taxonomy) and POs

CO/ K-Level	Level of Correlation			
	High	**Medium**	**Low**	**Zero**
CO1/ K1	-	PO1, PO2, PO3,PO4	PO5, PO6	-
CO2/ K2	PO1,	PO2, PO4 PO5	PO3,PO6	_
CO3/ K3	PO1, PO2	PO3,PO4 PO5	PO6	_
CO4/ K4	PO2, PO3	PO1	PO6,PO4	PO5,
CO5/ K5	PO1,PO3, PO4	PO2, PO5	PO6	_
CO6/ K6		PO1,PO2	PO3, PO5, PO6	PO4,

K Levels	C1	C2	C3	C4	Total scholastic marks	Non Scholastic Marks C5	CIA Total	% of Assessment
	T1 5 Marks	T2 6 Marks	Assignment 4 Marks	Seminar 5 Marks	20 Marks	5 Marks	25 Marks	
K1	0	1			1	-	**1**	4
K2	1	1		1	3	-	**3**	12
K3	1	1	1	1	4	-	**4**	16
K4	1	1	1	1	4	-	**4**	16
K5	1	1	1	1	4	-	**4**	**16**
K6	1	1	1	1	4	-	**4**	**16**
Non Scholastic	--	--	--	--	--	5	**5**	20
Total	**5**	**6**	**4**	**5**	**20**	**5**	**25**	**100%**

The COs and POs for the **Bio-Resource Management** course in the **M.Sc. Botany** Programme is effectively matched by the Course In-charge.

Signature of the Course In-charge

Signature of the Coordinator

Sem.	Programme Code	Course Code	Course Type	Course Title	Category	Hrs. / Week	Credits
II	BOTPG1986	P25BO6	Core Course	**ANATOMY AND EMBRYOLOGY**	Theory	6	5

Course Outcomes:

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

CO1 *Understand the fundamental concepts of plant anatomy*

CO2 *Explain the importance of secondary growth and to state the location of tissues involved in secondary growth in dicot and monocot plants.*

CO3 *Understand the secondary structure of xylem and phloem components and study about the wood.*

CO4 *Evaluate the structural organization of flower and the process of pollination and fertilization.*

CO5 *Acquire the knowledge about the pollination mechanisms, development of dicot and monocot embryo and also study the endosperm.*

CO6 *To construct connections between plant anatomy and embryology with advanced scientific concepts in Plant biology.*

Unit-I: ANATOMY (Teaching - 2 hrs / week)

Meristems – Characteristics of meristematic cells, classification and theories on Shoot and Root apical meristems. Concepts: phytomer units of shoots and root apex. Foloral meristems (Arabidopsis model). Structure and diversification of simple tissues (Parenchyma, Collenchyma and Sclerenchyma) Brief account on epidermal tissue, stomatal types in moncotyledons and dicytoledons.

Unit-II: ANATOMY (Teaching - 1 h / week)

Cambium in dicotyledons: Origin, pattern of cell division and development of cambial tissues. Seasonal effects and activity. Factors affecting cambial activity, cambrial varients (anomalous secondary growth), Cambium in monocotyledons. Periderm (Cork Cambium):- Structure, components & functions. Phellogen, Phellem and Phelloderm. Secretory (External and Internal) Structures: External secretory structure – Glandular trichomes, Nectaries, Hydathodes and Salt glands. Internal Secretory structures & Laticifers.

Unit-III: ANATOMY (Teaching - 1 h / week)

Secondary Xylem: Structure of Xylem components (tracheids, vessel elements, xylem fibres and xylem parenchyma). Ecological and Ecophysiological role of woody parenchyma cells. Secondary Phloem: Structure of Phloem components (Sieve tube elements, companion cell, phloem fibres and phloem parenchyma). Annual rings: Growth and seasonal activity. Basic concepts of dendrochronology. Wood: Types of wood - ring and diffuse; sap and heart; soft and hard; tension and compression woods. Economic uses of wood.

Unit-IV: EMBRYOLOGY (Teaching - 1 h / week)

Flower – ABC models of flower development - Microsporangium: Structure and development of anther - wall layers, epidermis, endothecium, middle layer and tapetum - types. Sporogenous tissue: Microspore mother cell – structure and development of pollen grain, Microgametogenesis, pollen wall layers, Sporopollenin. Development of male gametophyte . Inheritance of cytoplasmic traits.

Mechanism of male sterility. Megasporangium: Structure and types of ovules – megasporogenesis. Embryosac: Structure and types.

Unit-V: EMBRYOLOGY (Teaching - 1 h / week)

Double fertilization – outline on nature of stigma and style – pollen germination, pollen tube growth and discharge of gametes. Pollen incompatibility – interspecific and intraspecific, methods to overcome pollen incompatibility. Pollen allelopathy. Development of embryo in – dicot (Crucifer type) and monocot (*Triticum*). Endosperm: types – nuclear, cellular, helobial and ruminate. Endosperm - Reserve food substance. Functions of Endosperm. Parthenocarpy. Polyembryony and Apomixis.

Text Book:

- Bhojwani, S.S. & Bhatnagar, S.P. (2011). Embryology of Angiosperms. Vikas Publication House Pvt. Ltd. New Delhi. 5th edition.
- Pandey, B. P. (1989). Plant Anatomy. S. Chand and Co. Ltd., New Delhi.
- Dwivedi, J. N. (1998). Embryology of Angiosperms. Rastogi and Co., Meerut.

Reference:

- Mauseth, J.D. (1988). Plant Anatomy. The Benjamin/Cummings Publisher, USA.
- Singh, V., Pande, P. C. (1987). Anatomy of Seed Plants. Rastogi Publications, Meerut.
- Maheswari, P. (1963). An Introduction to Embryology of Angiosperms. International Society of Plant Morphologies, University of Delhi.
- Ray F. Evert (2006). Esau's Plant Anatomy, Third edition, John Wiley & Son, New Jersey.
- Fahn, A (1990). Plant Anatomy, Pergamon Press. Oxford, UK.

Web resources:

- https://www.ipni.org/
- http://www.theplantlist.org/
- https://faculty.etsu.edu/liuc/plant_anatomy_sites.htm
- http://aryacollegeludhiana.in/E_BOOK/Botany/plant_anatomy.pdf
- https://www.uou.ac.in/sites/default/files/slm/BSCBO-202.pdf
- http://greenlab.cirad.fr/GLUVED/html/P1_Prelim/Bota/Bota_typo_014.html
- https://www.askiitians.com/

CO- PO Mapping (Course Articulation Matrix)

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	9	9	3	9	3	1
CO2	9	9	3	3	1	1
CO3	9	3	3	3	1	1
CO4	3	1	3	3	1	0
CO5	1	1	1	0	0	0
CO6	1	1	1	0	0	0
Weightage	**32**	**24**	**14**	**18**	**6**	**3**

Level of Correlation between CO's and PO's } 1 – Low 3 – Medium 9 – High 0 – No Correlation (Suggested by UGC as per Six Sigma Tool – Cause and Effect Matrix)

Course Outcomes mapped with Knowledge level (Revised Bloom's Taxonomy) and POs

CO/ K-Level	Level of Correlation			
	High	**Medium**	**Low**	**Zero**
CO1/ K1	PO1, PO2	PO3, PO4, PO5	PO6	_
CO2/ K2	PO1, PO2	PO3, PO4	PO5, PO6	_
CO3/ K3	PO1, PO2	PO3, PO4,	PO5	PO6
CO4/ K4	PO1, PO2	PO3, PO4	PO5	PO6
CO5/ K5	_	PO1, PO2,	PO3, PO4	PO5, PO6
CO6/ K6	_	PO1, PO2	PO3, PO4,	PO5, PO6

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure:

K Levels	C1	C2	C3	C4	Total scholastic marks	Non Scholastic Marks C5	CIA Total	% of Assessment
	T1 5 Marks	T2 6 Marks	Assignment 4 Marks	Seminar 5 Marks	20 Marks	5 Marks	25 Marks	
K1	0	1			1	-	**1**	4
K2	1	1		1	3	-	**3**	12
K3	1	1	1	1	4	-	**4**	16
K4	1	1	1	1	4	-	**4**	16
K5	1	1	1	1	4	-	**4**	**16**
K6	1	1	1	1	4	-	**4**	**16**
Non Scholastic	--	--	--	--	--	5	**5**	20
Total	**5**	**6**	**4**	**5**	**20**	**5**	**25**	**100%**

***C = Component**

The COs and POs for the **ANATOMY AND EMBRYOLOGY** course in the M.Sc. Botany Programme is effectively matched by the Course In-charge.

Signature of the Course In-charge

Signature of the Coordinator

Sem.	Programme Code	Course Code	Course Type	Course Title	Category	Hrs. / Week	Credits
II	BOTPG1986	P25BO7	Core Course	**ANGIOSPERM TAXONOMY**	Theory	6	5

Course Description:

This course offers a comprehensive understanding of the history and modern approaches to plant classification, including chemotaxonomy and molecular techniques. It provides detailed insight into the principles of botanical nomenclature, taxonomic keys, herbarium practices, and institutional contributions. The taxonomy of selected plant families is covered extensively, with emphasis on their characteristics, classification, distribution, and economic value. The course also highlights the role of herbaria and botanical gardens in plant identification and conservation.

Course Objectives:

1. Understand the historical and modern trends in plant classification systems, including molecular taxonomy techniques.
2. Learn the principles of botanical nomenclature and the use of taxonomic keys, herbaria, and nomenclatural codes.
3. Study the classification, morphology, and economic significance of selected dicotyledonous plant families.
4. Explore the diversity, systematics, and applications of selected monocotyledonous and dicot families.
5. Recognize the institutional roles of BSI and Indian botanical gardens in plant systematics and conservation.

UNIT-I: PLANT SYSTEMATICS: (Teaching – 15 Hours)

Introduction: History of classification - Linnaeus, Engler and Prantl, Cronquist and Takhtajan and APG-IV. Modern Trends - Chemotaxonomy, Numerical Taxonomy and Molecular Taxonomy techniques (RAPD RFLP, AFLPs, DNA-DNA hybridization, DNA-RNA hybridization).

UNIT-II: BOTANICAL NOMENCLATURE: (Teaching – 15 Hours)

International Code of Nomenclature – principles, levels of nomenclature, typification, priority and their limitations. Effective and valid publications - author citation, retention, choice and rejection of names. A general account on Taxonomic keys. Herbarium preparation and management. A brief account of BSI and its role. Botanical Gardens in India.

UNIT-III: PLANT TAXONOMY - (Teaching – 15 Hours)

Study of Systematic position, salient features, description, distribution and economic importance of, Menispermaceae, Papaveraceae, Polygaleceae, Caryophyllaceae, Tiliaceae, Meliaceae and Rhamnaceae.

UNIT-IV: PLANT TAXONOMY - (Teaching – 15 Hours)

Study of Systematic position, salient features, description, distribution and economic importance of Sapindaceae, Rosaceae, Combretaceae, Passifloraceae, Plumbaginaceae, Sapotaceae and Oleaceae.

UNIT-V: PLANT TAXONOMY - (Teaching – 30 Hours)

Study of Systematic position, salient features, description, distribution and economic importance of Convolvulaceae, Bignoniaceae, Lamiaceae, Amaranthaceae, Aristalochiaceae, Piperaceae, Santalaceae, Casuarinaceae, Orchidaceae, Amaryllidaceae, Commelinaceae, Aracaceae, Typhaceae and Poaceae.

Course Outcomes:

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

CO1 *Comprehend the basic concepts of taxonomy and botanical nomenclature*
CO2 *Understand the relevance of molecular techniques in plant systematics.*
CO3 *Evaluate the significance of herbarium*
CO4 *Study the Binomial nomenclature and how it is governed by the ICBN.*
CO5 *Analyze the morphological characters delineate flowering plants and their classification up-to generic and species level*
CO6 *To develop taxonomic inventorization of angiosperms to be utilized in various aspects.*

Text Book:

- Bhattacharyya, B. (2005). Systematic Botany. Narosa Publishing House, New Delhi.
- Pandey, B. P. (2007). Taxonomy of Angiosperms. S. Chand and Co. Ltd., New Delhi.
- Sharma, O.P. (2017). Plant Taxonomy. McGraw Hill Education, New Delhi.
- Vashista, P. C. (2021). Taxonomy of Angiosperms. S. Chand and Co. Ltd., New Delhi.
- Sundara Rajan, S (2003). Practical manual of Angiosperm, Anmol Publications Pvt Ltd, Bengaluru.
- Simpson, S (2019). Plant Systematics. Academic Press, Cambridge.

Reference:

- https://www.ijls.in/upload/394213364PAPER_31.pdf
- www.iapt-taxon.org
- John Britto S. (2019). Flora of the Central and north Tamil Nadu., The Rapinat Herbarium, Tiruchirappalli-, South India.
- Dahlgren, R. (1984). The Families of Monocotyledons: Structure, Evolution and Taxonomy. Springer Verlag.
- Davis, P. H. and Heywood, V. H. (1967). Principles of Angiosperm Taxonomy. Oliver and Boyd, London.
- Gamble, J. S. (1933). Flora of the Presidency of Madras. Botanical Survey of India, Calcutta.
- Pandey, B. P. (2020). Economic Botany. S. Chand & Co. Ltd., New Delhi.
- Lawrence, G.H.M. (1953). Taxonomy of Vascular Plants, Oxford & IBH Publishers, New Delhi

CO- PO Mapping (Course Articulation Matrix)

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	9	9	3	9	1	1
CO2	9	9	3	3	1	1
CO3	9	9	3	3	1	1
CO4	9	1	3	3	1	1
CO5	1	1	1	0	0	0
CO6	1	1	1	0	0	0
Weightage	**38**	**30**	**14**	**18**	**4**	**4**
Weighted percentage of Course contribution to POs	**35.19**	**27.78**	**12.96**	**16.67**	**3.70**	**3.70**

Level of Correlation between CO's and PO's } 1 – Low 3 – Medium 9 – High 0 – No Correlation (Suggested by UGC as per Six Sigma Tool – Cause and Effect Matrix)

Course Outcomes mapped with Knowledge level (Revised Bloom's Taxonomy) and POs

CO/ K-Level	Level of Correlation			
	High	**Medium**	**Low**	**Zero**
CO1/ K1	PO1, PO2, PO4	PO3	PO5,PO6	_
CO2/ K2	PO1, PO2	PO3, PO4	PO5, PO6	_
CO3/ K3	PO1, PO2	PO3, PO4	PO5, PO6	_
CO4/ K4	PO1	PO3, PO4	PO2, PO5, PO6	_
CO5/ K5	_	_	PO1, PO2, PO3	PO4, PO5, PO6
CO6/ K6	_		PO1, PO2, PO3	PO4, PO5, PO6

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure:

K Levels	C1	C2	C3	C4	Total scholastic marks	Non Scholastic Marks C5	CIA Total	% of Assessment
	T1 5 Marks	T2 6 Marks	Assignment 4 Marks	Seminar 5 Marks	20 Marks	5 Marks	25 Marks	
K1	0	1			1	-	**1**	4
K2	1	1		1	3	-	**3**	12
K3	1	1	1	1	4	-	**4**	16
K4	1	1	1	1	4	-	**4**	16
K5	1	1	1	1	4	-	**4**	**16**
K6	1	1	1	1	4	-	**4**	**16**
Non Scholastic	--	--	--	--	--	5	**5**	20
Total	**5**	**6**	**4**	**5**	**20**	**5**	**25**	**100%**

***C = Component**

The COs and POs for the **Angiosperm Taxonomy** course in the **M.Sc. Botany** Programme is effectively matched by the Course In-charge.

Signature of the Course In- charge

Signature of the Coordinator

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Sem.	Programme Code	Course Code	Course Type	Course Title	Category	Hrs. / Week	Credits
II	BOTPG1986	P25BO8	Core Course	**GENETICS AND PLANT BREEDING**	Theory	6	5

Course Description:

This course introduces the core concepts of classical and modern genetics including Mendelian principles, mutation, chromosomal aberrations, and polyploidy. It explains mechanisms like linkage, crossing over, and recombination in relation to heredity and variation. The course also highlights plant breeding principles and techniques applied to various crop types. Emphasis is laid on genetic improvement strategies such as hybridization, heterosis, and somaclonal variation for sustainable agriculture.

Course Objectives:

1. Understand fundamental genetic concepts including cell division, Mendelian and non-Mendelian inheritance.
2. Explore types of mutations, chromosomal aberrations, mutagenic agents, and DNA repair mechanisms.
3. Examine the role of polyploidy and chromosomal variations in crop evolution and improvement.
4. Learn genetic principles relevant to plant breeding and their application to trait inheritance.
5. Acquire knowledge of breeding methods for different types of crops and the role of hybrid vigor and somaclonal variation.

UNIT 1: GENETICS (Teaching - 1 h / week)

Fundamental concepts of genetics. Mitotic and meiotic cell division. Fundamental of Genetics – Mendelian & Non-Mendelian principles, gene interaction. Mechanism and theories of linkage, crossing over, Recombination models, Synaptonemal complex.

UNIT II: MUTATION AND CHROMOSOMAL ABERRATIONS

(Teaching - 1 h / week)

Mutation – definition, types, structural variation in chromosomes – Deletion, Deficiency, Duplication, Translocation and Inversion. Causes of Chromosomal Aberration. DNA repair mechanisms, Physical & chemical mutagens, Mutation and its evolutionary significance.

UNIT III: POLYPLOIDY AND CHROMOSOMAL VARIATIONS

(Teaching - 1 h / week)

Polyploidy – Origin, Importance of polyploidy in Cultivated plants. Euploidy, Aneuploidy, Autoploids, Alloploids, Secondary Polyploids. Induction and Evolutionary significance. Artificially induced polyploidy. Role of polyploidy in crop improvement.

UNIT IV: PRINCIPLES OF PLANT BREEDING

(Teaching - 1 h / week)

Genetic principles applied in Plant Breeding – Inheritance, Segregation, Independent Assortment. Characters targeted in Plant Breeding – Qualitative, Quantitative, Quasi-quantitative.

UNIT V: PLANT BREEDING METHODS

(Teaching - 2 hrs / week)

Methods for self-pollinated crops, cross pollinated crops, vegetatively propagated and apomictic plants. Inbreeding depression - Role of heterosis and hybrid vigour in plant breeding. Somaclonal variation in crop improvement.

Course Outcomes:

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

CO1 *Learn the various theories pertaining to genetics*

CO2 *Acquire knowledge on chromosomal aberrations and variations*

CO3 *Understand the mutation and polyploidy*

CO4 *Comprehend the basic principles, techniques and applications of plant breeding.*

CO5 *Acquire knowledge on heterosis and somaclonal variation in plant breeding*

CO6 *Design new technologies for purposeful manipulation of plants qualities.*

Text Book:

- Gardner et al. (2004). Principles of Genetics. John Wiley and Sons Inc., Singapore.
- Klug, W.S, Cummings, M.R., Spencer, C.A., Palladino, M.A. (2016). Concepts of Genetics, 10th edition, Pearson Education, India.
- Singh, B.D. (2018) Plant Breeding Principles and Methods. Kalyani Publisher, New Delhi.
- Sundararaj, D. D. and Thulasidas, G. and Durairaj, M. S. (1997). Introduction to Cytogenetics and Plant Breeding. Popular Book Depot, Chennai.

Reference:

- Primrose, S. B. and Twyman, R. M. (2006). Principles of Gene Manipulation and Genomics. 7th ed. Blackwell Science, London.
- Rothwell, N. V. (1983). Genetics. Oxford University Press, London.
- Sharma, A. K. and Sharma, A. (1985). Advances in Chromosome and Cell Genetics. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
- Vasishta, P. C. and Gill, P. S. (1998). Genetics: Speciation and Plant Breeding. Pradeep Publications, Jalandhar.
- Vijendra Das, L. D. (1998). Plant Breeding. New Age International Publishers, New Delhi.

Web Resources:

- https://www.khanacademy.org/science/biology/cellular-molecular-biology
- https://le.ac.uk/vgec/topics/cell-cycle/the-cell-cycle-higher-education
- https://www.britannica.com/science/plant-breeding
- https://davuniversity.org/images/files/study-material/Fundamentals%20of%20Plant%20Breeding%20AGS127.pdf
- https://archive.org/details/in.ernet.dli.2015.271669

CO- PO Mapping (Course Articulation Matrix)

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	9	9	9	9	1	1
CO2	9	9	9	3	1	1
CO3	9	9	3	3	1	1
CO4	3	3	3	3	1	1
CO5	3	3	1	0	0	0
CO6	3	1	1	0	1	1
Weightage	**36**	**34**	**26**	**18**	**5**	**5**
Weighted percentage of Course contribution to POs	**29.03**	**27.42**	**20.97**	**14.52**	**4.03**	**4.03**

Level of Correlation between CO's and PO's } 1 – Low 3 – Medium 9 – High 0 – No Correlation
(Suggested by UGC as per Six Sigma Tool – Cause and Effect Matrix)

Course Outcomes mapped with Knowledge level (Revised Bloom's Taxonomy) and POs

CO/ K-Level	Level of Correlation			
	High	Medium	Low	Zero
CO1/ K1	PO1	PO2	PO3	PO4, PO5, PO6
CO2/ K2	PO1	PO2, PO3		PO4, PO5, PO6
CO3/ K3	PO1, PO2	PO3, PO4		PO5, PO6
CO4/ K4	PO2, PO3	PO1, PO4		PO5, PO6
CO5/ K5	PO4	PO2, PO3	PO1	PO5, PO6
CO6/ K6	PO4, PO5, PO6	PO2, PO3	PO1	-

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure:

K Levels	C1	C2	C3	C4	Total scholastic marks	Non Scholastic Marks C5	CIA Total	% of Assessment
	T1 5 Marks	T2 6 Marks	Assignment 4 Marks	Seminar 5 Marks	20 Marks	5 Marks	25 Marks	
K1	0	1			1	-	**1**	4
K2	1	1		1	3	-	**3**	12
K3	1	1	1	1	4	-	**4**	16
K4	1	1	1	1	4	-	**4**	16
K5	1	1	1	1	4	-	**4**	**16**
K6	1	1	1	1	4	-	**4**	**16**
Non Scholastic	--	--	--	--	--	5	**5**	20
Total	**5**	**6**	**4**	**5**	**20**	**5**	**25**	**100%**

***C = Component**

The COs and POs for the **GENETICS AND PLANT BREEDING** course in the **M.Sc. Botany** Programme is effectively matched by the Course In-charge.

Signature of the Course In- charge Signature of the Coordinator

Sem.	Programme Code	Course Code	Course Type	Course Title	Category	Hrs. / Week	Credits
II	BOTPG1986	P25BO9P	Core Course	**PRACTICAL – 2** (P25BO6, P25BO7, P25BO8, P25BO10E)	Practical	6	5

Course Description:

This course offers hands-on experience in plant anatomy and wood science through dissection, tissue analysis, and microscopic slide studies. It includes embryological techniques, taxonomic identification using Gamble Flora, and field-based herbarium preparation. Practical genetics and plant breeding techniques are taught alongside organic farming and horticultural propagation methods. Emphasis is placed on laboratory skills, field observation, and sustainable agricultural practices.

Course Objectives:

1. *Examine shoot apex, stomata, and secondary growth patterns through anatomical and wood analysis.*
2. *Study embryological stages including anther, embryo sac, and embryo dissection in flowering plants.*
3. *Identify plant species using morphological characters and floras; prepare herbarium with proper documentation.*
4. *Apply cytogenetic and breeding techniques including mitosis, meiosis, emasculation, and hybridization.*
5. *Practice sustainable techniques in organic farming, lawn preparation, and plant propagation methods.*

Anatomy and Wood Science

- Dissection of shoot apex in *Hydrilla* and whole mount.
- Wood structure - TS, TLS, RLS and maceration - showing variations in vessel elements, fibres axial parenchyma and ray parenchyma.
- Identification of different types of stomata (Spotters)
- Anomalous secondary growth in *Nyctanthus* and *Aristolochia*.

Embryology

- Slides showing developmental stages of anther, embryosac and embryo.
- Study of different types of pollen grains.
- Study of endosperm types (Spotters)
- Dissection of Embryo - *Abelmoschus, Tridax*

Taxonomy

- Study of the plants belonging to the families mentioned in the Core Course -6:
- Identification of binomial of the plants with the help of Gamble Flora.
- ICN based problems to be worked out.
- Submission of **15 herbarium specimens** with field note book and tour report.

The students should undertake as part of their course a tour and field study of vegetation under the guidance of the staff for three to five days within the state and neighbouring states. Students who have not undertaken the above activities shall forfeit the appropriate marks allotted for this purpose (10 marks) for practical examination.

Genetics and Plant Breeding

- Squash and Smear techniques - Onion root tip - Mitosis. Meiosis in *Tradescantia* flower bud.
- Emasculation, Crossing, Bagging
- Working problems in population genetics – Mono, dihybrid, complementary, epistasis

Organic farming and Horticulture

- Organic farming – Preparation of Organic manure
- Lawn preparation practice.
- Propagation – Grafting - cleft, bud; Layering – Air, ground

CO- PO Mapping (Course Articulation Matrix)

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	9	9	9	9	3	3
CO2	9	9	9	3	1	1
CO3	9	3	3	3	1	1
CO4	1	3	3	3	1	1
CO5	1	3	1	0	0	0
CO6	1	1	1	0	1	0
Weightage	**30**	**28**	**26**	**18**	**7**	**6**
Weighted percentage of Course contribution to POs	26.09	24.35	22.61	15.65	6.09	5.22

Level of Correlation between CO's and PO's } 1 – Low 3 – Medium 9 – High 0 – No Correlation (Suggested by UGC as per Six Sigma Tool – Cause and Effect Matrix)

Course Outcomes mapped with Knowledge level (Revised Bloom's Taxonomy) and POs

CO/ K-Level	Level of Correlation			
	High	Medium	Low	Zero
CO1/ K1	PO1,	PO2, PO3,PO4	PO5	PO6
CO2/ K2	PO1, PO2	PO4, PO5	PO3,PO6	_
CO3/ K3	PO1, PO2	PO3, PO4 PO5	_	PO6
CO4/ K4	PO1, PO2, PO3,PO4	_	PO6	PO5,
CO5/ K5	PO1,PO3, PO4	PO2, PO5	PO6	_
CO6/ K6	PO2	PO1	PO3	PO4, PO5, PO6

The COs and POs for the **PRACTICAL – 2 (Pertaining to CC – 5, 6, 7 & EC2)** course in the **M.Sc. Botany** Programme is effectively matched by the Course In-charge.

Signature of the Course In- charge Signature of the Coordinator

Sem.	Programme Code	Course Code	Course Type	Course Title	Category	Hrs. / Week	Credits
II	BOTPG1986	P25BO10E1	Elective Course	**ORGANIC FARMING AND HORTICULTURE**	Theory	6	4

Course Description:

This course provides a comprehensive understanding of organic farming principles, systems, and sustainable agricultural practices. It explores organic and conventional farming differences, soil and nutrient management, and green manuring. The course also covers the fundamentals of horticulture, plant propagation, and gardening systems. Emphasis is placed on commercial cultivation of flowers, vegetables, and fruits, along with value addition and employment potential in horticulture.

Course Objectives:

1. *Understand the principles and practices of organic farming, including global and Indian perspectives.*
2. *Learn about organic farming systems, integrated nutrient management, and the role of green manuring.*
3. *Gain knowledge of horticultural crop classification and propagation methods.*
4. *Identify types of gardens, their components, and greenhouse and bonsai maintenance techniques.*
5. *Explore commercial cultivation practices in floriculture, olericulture, and pomology for rural development.*

UNIT - I Introduction to Organic Farming (Teaching- 1h/week)
Organic Farming - Definition and Principles of Organic Farming. Differences Between Organic and Conventional Farming. Overview of Global and Indian Organic Farming Practices. Challenges in Organic Farming. Land and water management – land use, minimum tillage; shelter zones, hedges, pasture management, agro-forestry.

UNIT - II Organic farming systems and Organic manure (Teaching- 1h/week)
Farming systems, Integrated nutrient management –Problems and prospects, Concept of management of Soil productivity, crop rotations, multiple and relay cropping systems. General account on organic fertilizers. Green Manuring - definition, objectives, advantages, classification and characteristics. Agromic practices of some green manure crops.

UNIT- III Horticulture -1 (Teaching-1hr/week)
Definition, Importance, and Scope of Horticulture. Classification of Horticultural Crops: Fruits, Vegetables, Flowers, Medicinal, and Aromatic Plants. Plant propagation methods - Cutting, layering, grafting, budding. Stock - scion relationship, Role of growth regulators in horticulture. Research and development in horticulture. Future challenges and prospects.

Unit-IV: Horticulture -2 (Teaching-2hr/week)
Gardens - Tools and implements. Major gardening types and its components: Outdoor garden (Hedges, Edges, Fences, Trees, Topiary, Trophy, Climbers, Arches, *Cycads*, Ferns, and Palms)

Indoor garden, Water garden, Rock garden, Roof garden, Terrace garden, Temple garden. Lawn establishment and maintenance. Establishment and maintenance of green house. Bonsai – types and methods.

UNIT- V: Horticulture -3 (Teaching- 1h/week)

Floriculture - Commercial cultivation and uses of - Rose, *Jasmine*, *Chrysanthemum*. Olericulture - Classification of vegetables, Cultivation of important vegetables- Tomato, Brinjal. Pomology - Commercial Cultivation of fruit crops - Mango, Grapes. Role of Horticulture in Employment Generation and Rural Development. Value Addition in Horticulture: Food Processing, Packaging, and Marketing.

Course Outcomes:

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

CO1 *Know about the importance of Organic farming and Horticulture.*

CO2 *Understand about farming systems and green manure.*

CO3 *Acquire knowledge in plant propagation methods*

CO4 *Comprehend the types and components of gardens.*

CO5 *Learn the concepts of floriculture, olericulture and pomology.*

CO6 *Develop strategies inorganic farming and horticulture to contribute significantly to the Indian economy.*

Text Book:

- Kumar, N. (1987). Introduction to Horticulture. Rajalakshmi Publishers, Nagercoil.
- Manibushan Rao, K. (1991). Textbook of Horticulture. Macmillan Publishing Co., New York.
- Rao KM. 2000. Text Book of Horticulture, MacMillan India Ltd., New Delhi.
- Sathe, T.V. (2004). Vermiculture and Organic Farming. Daya publishers.

Reference:

- George Acquaah. (2002). Horticulture Principles and Practices. 2nd ed. Pearson Education, Delhi.
- Subha Rao, N.S. (2000). Soil Microbiology, Oxford & IBH Publishers, New Delhi.
- Vayas,S.C, Vayas, S. and Modi, H.A. (1998). Bio-fertilizers and organic Farming Akta Prakashan, Nadiad

Web Resources:

- https://ofrf.org/resources/
- https://www.agrimoon.com/wp-content/uploads/Fundamentals-of-Horticulture.pdf
- https://www.surendranathcollege.ac.in/newdocs/ORGANIC-FARMING.pdf
- https://agrimoon.com/wp-content/uploads/AgriMoon-AHT-111-Fundamentals-of-Horticulture.pdf

CO- PO Mapping (Course Articulation Matrix)

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	9	9	9	9	3	1
CO2	9	3	3	3	1	1
CO3	9	3	3	3	1	1
CO4	3	3	3	3	0	1
CO5	1	3	1	0	0	1
CO6	1	1	1	0	0	1
Weightage	**32**	**22**	**20**	**18**	**5**	**6**
Weighted percentage of Course contribution to POs	**31.07**	**21.36**	**19.42**	**17.48**	**4.85**	**5.83**

Level of Correlation between CO's and PO's } 1 – Low 3 – Medium 9 – High 0 – No Correlation
(Suggested by UGC as per Six Sigma Tool – Cause and Effect Matrix)

Course Outcomes mapped with Knowledge level (Revised Bloom's Taxonomy) and POs

CO/ K-Level	Level of Correlation			
	High	**Medium**	**Low**	**Zero**
CO1/ K1	PO3, PO4	PO1, PO2,	PO5	PO6
CO2/ K2	PO1	PO2, PO4,	PO3, PO6	PO5
CO3/ K3	PO2	PO1, PO3,	PO4, PO5_	PO6
CO4/ K4	PO1	PO2, PO3, PO4	PO5, PO6	
CO5/ K5	PO4	PO1, PO2, PO3, PO5	PO6	_
CO6/ K6	PO3, PO4	PO1, PO2	PO5,	PO6

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure:

K Levels	C1	C2	C3	C4	Total scholastic marks	Non Scholastic Marks C5	CIA Total	% of Assessment
	T1 5 Marks	T2 6 Marks	Assignment 4 Marks	Seminar 5 Marks	20 Marks	5 Marks	25 Marks	
K1	0	1			1	-	**1**	4
K2	1	1		1	3	-	**3**	12
K3	1	1	1	1	4	-	**4**	16
K4	1	1	1	1	4	-	**4**	16
K5	1	1	1	1	4	-	**4**	**16**
K6	1	1	1	1	4	-	**4**	**16**
Non Scholastic	--	--	--	--	--	5	**5**	20
Total	**5**	**6**	**4**	**5**	**20**	**5**	**25**	**100%**

***C = Component**

The COs and POs for the **ORGANIC FARMING AND HORTICULTURE** Elective course in the M**.Sc. Botany** Programme is effectively matched by the Course In-charge.

Signature of the Course In- charge Signature of the Coordinator

Sem.	Programme Code	Course Code	Course Type	Course Title	Category	Hrs. / Week	Credits
II	BOTPG1986	P25BO10E2	Elective Course	**ETHNOBOTANY**	Theory	6	4

Course Description:

This course introduces the principles and scope of ethnobotany as an interdisciplinary science studying the relationship between plants and indigenous communities. It emphasizes traditional plant uses among tribal groups in India, the methodologies used in ethnobotanical research, and its relevance in modern medicine. The course explores the role of ethnic communities in plant conservation and discusses legal frameworks including IPR, biopiracy, and benefit-sharing. Students will gain insights into both cultural heritage and the scientific potential of traditional plant knowledge.

Course Objectives:

1. *Understand the concept, scope, and interdisciplinary nature of ethnobotany.*
2. *Identify the ethnobotanical uses of plants in tribal communities for food, medicine, and cultural practices.*
3. *Learn the methodologies for ethnobotanical data collection, including fieldwork and ancient literature.*
4. *Examine the role of traditional knowledge in modern medicine and conservation of endangered plant species.*
5. *Analyze legal and ethical aspects of ethnobotany including IPR, biopiracy, and protection of indigenous rights*.

Unit- I: Introduction Ethnobotany (Teaching – 1 h / week)

Introduction, concept, scope and objectives of ethnobotany- Ethnobotany as an interdisciplinary science. The relevance of ethnobotany in the present context - Major and minor ethnic groups or Tribals of India and their life styles.

Unit - II: Ethnobotanical studies: (Teaching – 1 h / week)

Plants used by the tribals: Food plants, intoxicants and beverages, Resins and oils and miscellaneous uses.Methodology of Ethnobotanical studies - Field work -Herbarium - Ancient Literature - Archaeological findings - temples and sacred places.

Unit- III: Ethnobotany in modern Medicine: (Teaching – 2 h / week)

Role of ethnobotany in modern Medicine Medico-ethnobotanical sources in India - Significance of the following plants in ethno botanicalpractices with their habitat and morphology*Azadiractha indica*, *Ocimum sanctum*, *Vitex negundo*, *Gloriosa superba*, *Tribulusterrestris*, *Pongamia pinnata* and *Cassia auriculata*. Role of ethnobotany in modern medicine with special example *Rauvolfiasepentina*, *Trichopuszeylanicus*.

Unit- IV: Conservation (Teaching – 1 h / week)

Role of ethnic groups in conservation of plant genetic resources. Endangered taxa and forest management.

Unit- V: Ethnobotany and legal aspects (Teaching – 1 h / week)

Ethnobotany and legal aspects - Ethnobotany as a tool to protect interests of ethnic groups. Sharing of wealth concept with few examples from India. Biopiracy, Intellectual Property Rights and Traditional Knowledge.

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

CO1 *Understand the Fundamentals of Ethnobotany*

CO2 *Analyze Tribal Knowledge and Plant Uses*

CO3 *Apply Ethnobotanical Methodologies*

CO4 *Explore the Role of Ethnobotany in Modern Medicine*

CO5 *Understand Conservation Strategies*

CO6 *Analyze Legal and Ethical Aspects of Ethnobotany*

Text Books:

1. Faulks, P.J. 1958.An introduction to Ethnobotany, Moredale pub. Ltd
2. S.K. Jain, Manual of Ethnobotany, Scientific Publishers, Jodhpur, 1995.
3. Colton C.M. 1997. Ethnobotany - Principles and applications. John Wiley and sons - Chichester
4. Rama Ro, N and A.N. Henry (1996). The Ethnobotany of Eastern Ghats in AndhraPradesh, India.Botanical Survey of India. Howrah.

Reference Books:

1. https://tribal.nic.in
2. S.K. Jain (ed.) Glimpses of Indian. Ethnobotny, Oxford and I B H, New Delhi 1981
3. S.K. Jain (ed.) 1989. Methods and approaches in Ethnobotany. Society of Ethnobotanists, Lucknow, India.
4. S.K. Jain, 1990. Contributions of Indian ethnobotny.Scientific publishers, Jodhpur.

Rajiv K. Sinha - Ethnobotany The Renaissance of Traditional Herbal Medicine - INA -SHREE Publishers, Jaipur-1996

CO- PO Mapping (Course Articulation Matrix)

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	1	0
CO2	9	3	1	3	0	1
CO3	3	9	3	3	3	0
CO4	9	3	3	3	0	1
CO5	3	3	3	9	3	1
CO6	3	3	0	0	0	0
Weightage	**30**	**24**	**13**	**21**	**7**	**3**
Weighted percentage of Course contribution to POs	**30.61**	**24.49**	**13.27**	**21.43**	**7.14**	**3.06**

Level of Correlation between CO's and PO's } 1 - Low 3 - Medium 9 - High 0 - No Correlation
(Suggested by UGC as per Six Sigma Tool - Cause and Effect Matrix)

Course Outcomes mapped with Knowledge level (Revised Bloom's Taxonomy) and POs

CO/ K-Level	Level of Correlation			
	High	**Medium**	**Low**	**Zero**
CO1/ K1	-	PO1, PO2,PO3,PO4	PO5	PO6
CO2/ K2	PO1	PO2,PO4,	PO3,PO6	PO5
CO3/ K3	PO2	PO1, PO3, PO4 PO5	_	PO6
CO4/ K4	PO1	PO2, PO3,PO4	PO6	PO5,
CO5/ K5	PO4	PO1,PO2, PO3,PO5	PO6	_
CO6/ K6	-	PO1, PO2	-	PO3, PO4, PO5, PO6

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure:

K Levels	C1	C2	C3	C4	Total scholastic marks	Non Scholastic Marks C5	CIA Total	% of Assessment
	T1 5 Marks	T2 6 Marks	Assignment 4 Marks	Seminar 5 Marks	20 Marks	5 Marks	25 Marks	
K1	0	1			1	-	**1**	4
K2	1	1		1	3	-	**3**	12
K3	1	1	1	1	4	-	**4**	16
K4	1	1	1	1	4	-	**4**	16
K5	1	1	1	1	4	-	**4**	**16**
K6	1	1	1	1	4	-	**4**	**16**
Non Scholastic	--	--	--	--	--	5	**5**	20
Total	**5**	**6**	**4**	**5**	**20**	**5**	**25**	**100%**

***C = Component**

The COs and POs for the **ETHNOBOTANY** Elective course in the M**.Sc. Botany** Programme is effectively matched by the Course In-charge.

Signature of the Course In- charge

Signature of the Coordinator

Sem.	Programme Code	Course Code	Course Type	Course Title	Category	Hrs. / Week	Credits
II	BOTPG1986	P25BO10E3	Elective Course	**INDUSTRIAL BOTANY**	Theory	6	4

Course Description:

This elective course explores the vast potential of Industrial Botany, focusing on the cultivation, processing, and commercial use of plant resources. It introduces students to plant-based industries such as pharmaceuticals, food, cosmetics, agrochemicals, and biofuels. Emphasis is placed on the sustainable use of bioresources, quality control, and certification processes. The course also covers plant-derived industrial products, fermentation-based industries, and the role of fungi in industrial applications. Through modules on entrepreneurship, marketing, and policy frameworks, students gain practical insight into launching and managing plant-based ventures. The course aims to blend botanical knowledge with industry-relevant skills and innovation.

Course Objectives:

1. *To understand the scope, significance, and sustainability aspects of Industrial Botany.*
2. *To learn cultivation and processing techniques for medicinal, aromatic, oilseed, fibre, and timber-yielding plants.*
3. *To explore the industrial uses of plant-derived products such as dyes, gums, resins, and essential oils.*
4. *To study the role of plants and fungi in fermentation industries and bioenergy production.*
5. *To introduce entrepreneurship models and marketing strategies in plant-based industries.*
6. *To familiarise students with regulatory policies, certifications, and quality standards in industrial plant product manufacturing.*

UNIT I: Introduction to Industrial Botany: (Teaching - 1 h / week)

Scope and significance of Industrial Botany. Plant-based industries: Pharmaceuticals, Food, Cosmetics, and Agrochemicals. Sustainable utilization of plant resources. Industrial plantations and bioresource management

UNIT II: Cultivation and Processing of Industrially Important Plants: (Teaching - 1 h / week)

Cultivation techniques and post-harvest processing of: Medicinal and Aromatic Plants (e.g., Aloe vera, Ashwagandha, Sandalwood); Oilseed Crops (e.g., Sunflower, Oil Palm, Jatropha); Fiber Crops (e.g., Cotton, Jute, Coir);Timber and Pulpwood Plants (e.g., Teak, Eucalyptus, Bamboo). Quality control and certification in plant-based industries

UNIT III: Plant-Derived Industrial Products: (Teaching - 1 h / week)

Industrial applications of plant gums, resins, and latex. Natural dyes and pigments from plants. Essential oils and perfumes. Plant-based pharmaceuticals: Alkaloids, Flavonoids, and other bioactive compounds

UNIT IV: Fermentation and Bio-based Industries: (Teaching - 2 hrs / week)

Industrial applications of plant-based fermentation. Beverage industries (Tea, Coffee, Cocoa, Wine, and Beer). Edible and medicinal fungi in industry (Mushrooms, Yeasts). Production of biofuels and plant-based bioenergy resources.

UNIT V: Entrepreneurship and Marketing of Plant-Based Industries: (Teaching - 1 h / week)

Start-ups and business models in Industrial Botany. Challenges and opportunities in plant-based industries. Market trends and consumer preferences for botanical products. Policies and regulations related to plant-based industries.

Course Outcomes:

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

CO1 *Understand the scope and significance of Industrial Botany and its role in plant-based industries*
CO2 *Learn cultivation and processing techniques for medicinal, oilseed, fiber, and timber plants.*
CO3 *Explore plant-derived industrial products such as gums, resins, dyes, and bioactive compounds.*
CO4 *Analyze the role of fermentation and bio-based industries in beverage, fungi, and biofuel production.*
CO5 *Develop entrepreneurial skills in plant-based industries by understanding market trends and business models.*
CO6 *Examine policies and regulations governing sustainable utilization and commercialization of plant resources.*

Text Book:

- Trivedi, P.C. 2001. Algal Biotechnology. Point publisher, Jaipur. India.
- Dinabandhu, S and Kaushik. B.D. 2012. Algal Biotechnology and Environment. I.K. International, New Delhi.
- Poonam Singh and Ashok Pandey. 2009. Biotechnology for agro-Industrial residues utilization. Springer.
- Dilip K. Arora. 2003. Handbook of Fungal Biotechnology. CRC Press book.
- Vardhana, R. 2009. Economic Botany. 1st ed. Sarup Book Publishers Pvt Ltd. New Delhi.
- Dubey R.C. 2004. A text book of Biotechnology aspects of microbiology, British Sun Publication.
- Pelzer, M.J., Chan, E.C.S and Krieg, N.R. 1983. Microbiology, Tata MaGraw Hill Publishing House, New Delhi.

Reference:

- Becker. E.W. 1994. Micro algae Biotechnology and Microbiology.Cambridge University press.
- Borowitzka, M.A. and borowizka, L.J. 1996. Microalgal Biotechnology. Cambridge University Press, Cambridge,
- Sahoo, D. 2000. Farming the ocean: seaweed cultivation and utilization. Aravali International, New Delhi.
- Mahendra Rai. 2009. Advances in Fungal Biotechnology. I.K. International Publishing House, New Delhi.
- Street, H.E. 1978. Essay in Plant Taxonomy, Academic Press, London, UK.
- Alexander N. Glazer and Hiroshi Nikaido. 1994. Microbial Biotechnology.
- Pandey, B.P. 2005. College Botany I: Including Algae, Fungi, Lichens, Bacteria, Viruses, Plant Pathology, Industrial Microbiology and Bryophyta. S Chand & Company.
- Chichister, U.K.J. 1999. Cultivation and Processing of Medicinal Plants, Wiley & Sons
- William Charles Evans.1989. Pharmacognosy, 14th ed. Harcourt Brace & Company.
- Kumar,H.D.1999. Introductory Phycology.Affiliated East-West Press, Delhi.
- Das,SandSaha,R.2020. Microbiology Practical Manual.CBS Publishers and Distributors (P) Ltd., New Delhi, India.
- Willie, J and Sherwood, L. 2016. Prescott's Microbiology McGraw-Hill Education; 10th
- Edition, ISBN: 978-1259281594
- Reinert, J. Bajaj. T.P.S. 1977. Applied and Fundamental Aspects of Plant cell, tissue and organ Culture. Springer – Verlaug.

Web resources:

- https://www.elsevier.com/books/algal-biotechnology/ahmad/978-0-323-90476-6
- https://www.amazon.in/Fungi-Biotechnology-Prakash-ebook/dp/B07PBF2R3D
- https://www.amazon.in/Plant-Based-Natural-Products-Derivatives-Applications-ebook/dp/B07438N1CJ
- https://link.springer.com/book/10.1007/978-981-16-5214-1
- https://link.springer.com/book/10.1385/0896031616

CO- PO Mapping (Course Articulation Matrix)

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	9	3	3	3	0
CO2	9	3	3	3	1	1
CO3	9	9	3	3	1	0
CO4	3	3	3	9	1	1
CO5	9	1	3	3	3	1
CO6	3	1	1	0	1	0
Weightage	**42**	**26**	**16**	**21**	**10**	**3**
Weighted percentage of Course contribution to POs	35.59	22.03	13.56	17.80	8.47	2.54

Level of Correlation between CO's and PO's } 1 – Low 3 – Medium 9 – High 0 – No Correlation (Suggested by UGC as per Six Sigma Tool – Cause and Effect Matrix)

Course Outcomes mapped with Knowledge level (Revised Bloom's Taxonomy) and POs

CO/ K-Level	Level of Correlation			
	High	**Medium**	**Low**	**Zero**
CO1/ K1	PO1	PO2, PO3, PO4,	PO5, PO6	_
CO2/ K2	PO1	PO3, PO4	PO5, PO6	_
CO3/ K3	PO1	PO2, PO3, PO4,	PO5	PO6
CO4/ K4	PO1	PO2, PO3, PO4	PO5	PO6
CO5/ K5		PO1, PO2	PO3, PO4	PO5, PO6
CO6/ K6		PO1, PO2	PO3, PO4,	PO5, PO6

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure:

K Levels	C1	C2	C3	C4	Total scholastic marks	Non Scholastic Marks C5	CIA Total	% of Assessment
	T1 5 Marks	**T2 6 Marks**	**Assignment 4 Marks**	**Seminar 5 Marks**	**20 Marks**	**5 Marks**	**25 Marks**	
K1	0	1			1	-	**1**	4
K2	1	1		1	3	-	**3**	12
K3	1	1	1	1	4	-	**4**	16
K4	1	1	1	1	4	-	**4**	16
K5	1	1	1	1	4	-	**4**	**16**
K6	1	1	1	1	4	-	**4**	**16**
Non Scholastic	--	--	--	--	--	5	**5**	20
Total	**5**	**6**	**4**	**5**	**20**	**5**	**25**	**100%**

***C = Component**

The COs and POs for the **INDUSTRIAL BOTANY** course in the M.Sc. Botany Programme is effectively matched by the Course In-charge.

Signature of the Course In-charge Signature of the Coordinator

Sem.	Programme Code	Course Code	Course Type	Course Title	Category	Hrs. / Week	Credits
III	BOTPG1986	P25BO11	Core Course	**BIOCHEMISTRY**	Theory	6	5

Course Description:

This course introduces fundamental concepts of biochemistry and biophysics relevant to plant science. It covers biomolecules such as carbohydrates, proteins, lipids, and enzymes along with their structure and functions. Students explore plant secondary metabolites and their biosynthetic pathways.Molecular biology topics include nucleic acids, transcription, translation, and gene regulation.

Course Objectives:

6. *Understand the principles of chemical bonding, bioenergetics, and thermodynamics in biological systems.*
7. *Classify and describe carbohydrates, proteins, lipids, and their roles in plants.*
8. *Explain enzyme structure, function, kinetics, and immobilization techniques.*
9. *Identify major classes of plant secondary metabolites and their biosynthetic pathways.*
10. *Describe the structure and function of nucleic acids and gene expression mechanisms.*

Unit I: Biochemistry Basics & Biophysics (Teaching - 1 h / week)

Definition and Scope: Importance of biochemistry in plant science. Chemical bonding. Basic concepts in Bio-energies and Thermodynamics.

Carbohydrates: Definition and importance of carbohydrates in living organisms. Classification of Carbohydrates Monosaccharides: Structure, classification based on carbon number (trioses, pentoses, hexoses) and functional groups (aldoses, ketoses). Examples: Glucose, fructose, ribose. Disaccharides: Structure and properties of sucrose, lactose, maltose. Oligosaccharides: Brief overview, role in glycoproteins and glycolipids. Polysaccharides: Homopolysaccharides: Starch, cellulose, glycogen. Heteropolysaccharides: Hemicellulose, pectins.

Unit II: Proteins, Enzymes and Lipids (Teaching - 1 h / week)

Structure and classification of amino acids. Peptide bond formation. Protein - Structure (Primary, Secondary, Tertiary and Quaternary) and classification. Protein degradation and function. Enzyme – Classification, properties, mode of action and inhibition. Enzyme kinetics – Km value, Vmax and Michaelis menten concept. Immobilization of enzymes: methods, effects and applications. Structure and behaviour – Biological importance of fatty acids. Fats, oils, waxes, phospholipids and Steroids. Functions of lipids.

Unit-III: Plant secondary metabolites (Teaching - 2 h / week)

Introduction to Plant Secondary Metabolites: Definition and characteristics - Difference between primary and secondary metabolites. Biosynthesis of Secondary Metabolites: Overview of biosynthetic pathways - Shikimic acid pathway - Mevalonate and MEP pathways - Polyketide synthesis pathway. Classification of Plant Secondary Metabolites: Alkaloids and their properties - Morphine, Vincristine, Vinblastine and Nicotine; Phenolics – flavonoids derivatives (Flavones, Flavonols and

Anthocyanidins) and tannins; Terpenes and their properties - monoterpenoid (Camphor), diterpenoid (Retinol), sesquiterpenoid and Tetraterpenoids (lutein): - Glycosides.

Unit IV: Nucleic acids (Teaching - 1 h / week)

Nucleic Acids: DNA types and functions: B form, A form and Z form, RNA types and functions: Messenger RNA, (mRNA); Transfer RNA (t RNA); Small nuclear RNAs; Regulatory RNAs; Transfer-Messenger RNA (tm RNA). Ribozymes (RNA enzymes) and Double stand RNA (ds RNA) Nucleic acids denaturation. Biological functions of nucleic acids. Method for Labelling nuclear DNA by DAPI.

Unit: V: Transcription and Translation (Teaching - 1 h / week)

Mechanism of Transcription – Transcriptional Factors and Post Transcriptional modifications in Prokaryotic and Eukaryotic cell. Translation and Post Translational Modifications. Gene expression and regulation processes - prokaryotic and Eukaryotic cell types.

Course outcomes:

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

CO1 *Understand the basic awareness about the concepts and fundamental aspects in Biochemistry.*

CO2 *Afford knowledge on structure and properties of carbohydrates.*

CO3 *Learn the concepts, structure and application of proteins and enzymes.*

CO4 *Provide the knowledge about lipid and nucleic acids, also gene expression & regulation.*

CO5 *Understand plant secondary metabolites and their properties.*

CO6 *Create concepts that may contribute to the solution for problems in agricultural and pharmaceutical sciences.*

Text Book:

- Wey, P.M. and Harbone, J.B. 2000. Plant biochemistry. Panima Educational Book agency, New Delhi.
- Davies P J. (2004). Plant Hormones: Biosynthesis, Signal Transduction, Action. 3rd Edition, Kluwer Academic Publisher, Dordrecht, The Netherlands.
- Heldt, H. W. and Piechulla, B. (2010). Plant Biochemistry. 4th Edition. Paperback. Academic Press.
- Campbell, M.K. (2012) Biochemistry, 7th ed., Published by Cengage Learning.

References:

- Buchanan, B., Gruissem, W. and Jones R. L. (Eds) (2015). Biochemistry and Molecular Biology of Plants. 2nd Edition. Paper back. Wiley-Blackwell.
- Cohn, E. E. and Stumpf, P. K. (1994). Outlines of Biochemistry. Wiley Eastern Ltd., New Delhi.
- Lehinger, A. L. et al. (1993). Principles of Biochemistry. CBS Publishers, New Delhi. Stryer, L. (1995). Biochemistry. 4th ed. W. H. Freeman Co., New York.
- Murray, R.K., Granner, D.K., Mayes, P.A. and Rodwell, V.W. 2003. Harper's Illustrated Biochemistry (26th ed.), The McGraw-Hill Companies, Inc., USA.

We Resources:

- http://www.whfreeman.com/lehninger/
- https://www.khanacademy.org/science/biology
- https://www.ncbi.nlm.nih.gov/books/
- https://archive.org/details/principlesofbiochemistrylehninger
- https://archive.org/details/BiochemistryStryer

CO- PO Mapping (Course Articulation Matrix)

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	9	9	9	9	0	0
CO2	9	3	3	3	1	1
CO3	9	3	3	3	1	0
CO4	3	3	3	3	1	1
CO5	3	3	1	1	0	0
CO6	3	3	0	0	0	1
Weightage	**36**	**21**	**19**	**19**	**3**	**3**
Weighted percentage of Course contribution to POs	**35.64**	**20.79**	**18.81**	**18.81**	**2.97**	**2.97**

Level of Correlation between CO's and PO's } 1 – Low 3 – Medium 9 – High 0 – No Correlation (Suggested by UGC as per Six Sigma Tool – Cause and Effect Matrix)

Course Outcomes mapped with Knowledge level (Revised Bloom's Taxonomy) and POs

CO/ K-Level	Level of Correlation			
	High	Medium	Low	Zero
CO1/ K1	PO1, PO4,	PO2	PO3	PO5, PO6
CO2/ K2	PO1	PO2, PO3	PO4	PO5, PO6
CO3/ K3	PO1, PO2	PO3, PO4		PO5, PO6
CO4/ K4	PO2, PO3	PO1, PO4	PO5,	PO6
CO5/ K5	PO4	PO2, PO3	PO1, PO6	PO5,
CO6/ K6	PO4, PO5,	PO2, PO3	PO1, PO6	-

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure:

K Levels	C1	C2	C3	C4	Total scholastic marks	Non Scholastic Marks C5	CIA Total	% of Assessment
	T1 5 Marks	T2 6 Marks	Assignment 4 Marks	Seminar 5 Marks	20 Marks	5 Marks	25 Marks	
K1	0	1			1	-	**1**	4
K2	1	1		1	3	-	**3**	12
K3	1	1	1	1	4	-	**4**	16
K4	1	1	1	1	4	-	**4**	16
K5	1	1	1	1	4	-	**4**	**16**
K6	1	1	1	1	4	-	**4**	**16**
Non Scholastic	--	--	--	--	--	5	**5**	20
Total	**5**	**6**	**4**	**5**	**20**	**5**	**25**	**100%**

***C = Component**

The COs and POs for the **BIOCHEMISTRY** course in the **M.Sc. Botany** Programme is effectively matched by the Course In-charge.

Signature of the Course In- charge Signature of the Coordinator

Sem.	Programme Code	Course Code	Course Type	Course Title	Category	Hrs. / Week	Credits
III	BOTPG1986	P25BO12	Core Course	**PLANT PHYSIOLOGY**	Theory	6	5

Course Description:

This course provides a fundamental knowledge of water and its relations in plants. Absorption and translocation of water, Photosynthesis and respiration. It explores the nitrogen metabolism in plants and Phytohormone. Abiotic stress - plant responses to abiotic stresses (resistance mechanisms and change the pattern of gene reproduction) Water stress and Salt stress – biochemical and physiological changes related with stress.

Course Objectives:

1. *To study the water and its relation in plants, permeability of membrane, mineral salt absorption.*
2. *To analyze the Photosynthetic pigment and their distribution.*
3. *To explain the photosynthetic apparatus and mechanism of photosynthesis.*
4. *To understand the phenomenon of respiration cycles and electron transport.*
5. *To study the nitrogen, sulfur metabolism, Phytohormone and stress physiology.*

Unit I: Water Potentials: (Teaching - 1 h / week)

Water and its relations in plants: Permeability of membrane to different substances and factor affecting permeability. Theories of cell membrane permeability. Difference between permeability and imbibitions. Diffusion, Osmosis (exo, endo) DPD definition, water potential and plasmolysis.

Absorption and Translocation of water: Mechanism of water absorption, active and passive absorptions. Factors affecting absorption of water.

Translocation of water and Sap: Direction of translocation of sap, mechanism of ascent of sap. Mineral nutrition and deficiency sympotms.

Unit II : Photosynthesis & Respiration: (Teaching - 2 h / week)

Photosynthetic pigments and their distribution Pigment system I and II and organization. Absorption and active spectrum. Excited singlet state, fluorescence and phosphorescence. Red drop and Emerson effect.

Mechanism of Photosynthesis:

Light Reaction: Photolysis of water, water oxidizing complex, Non-cyclic and cyclic electron transport system. Mechanism of photophosphorylation.

Dark Reaction: Path of Carbon in photosynthesis, C_3 pathway, mechanism and efficiency. RUBISCO, path of carbon in C_4 plants (Kranz anatomy). CAM photosynthesis, C_2 Photosynthesis, photorespiration.

Respiration: Different kinds of respiration. Biological significance of respiration. Respiration Quotient. Glycolysis, Kreb's cycle, Electron Transport, mechanism of oxidative phosphorylation. Pentose phosphate pathway.

Unit – III: Nitrogen and Sulfur metabolism (Teaching - 1 h / week)

Overview of nitrogen in biosphere and in plants. Interaction of nitrogen and carbon assimilation. Biological nitrogen fixation – Asymbiotic and symbiotic, site of nitrogen fixation. Mechanism of nitrogen fixation. Assimilation of ammonia, regulation of nitrogen fixation, protection of enzyme nitrogenase. Fate of fixed nitrogen: putrification, ammonification, nitrification and denitrification. Sulfate uptake and transport. Sulfate assimilation pathway and role of sulphur.

Unit IV: Phytohormones and Photomorphogenesis (Teaching - 1 h / week)

Brief account on growth hormone, growth regulators; animal hormones and phytohoromones. **Phytohoromones:** Distribution, biosynthesis, mode of action and physiological role: Auxins, Gibberellins**,** Cytokinins, Abscisic acid and Ethylene. Biological clock and plant rhythm.

Unit V: Abiotic stress (Teaching - 1 h / week)

Abiotic stress - plant responses to abiotic stresses (resistance mechanisms and change the pattern of gene reproduction) Water stress and Salt stress – biochemical and physiological changes related with stress. Brief account on light, Freezing, Heat and Oxidative stresses. Heat shock proteins.

Course Outcomes:

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

CO1 *Understand the mechanisms involved in water absorption in plants with respect to various physiological processes.*

CO2 *Recognize the importance of Carbon assimilation in photorespiration*

CO3 *To understand nitrogen and sulfur metabolism.*

CO4 *Acquire knowledge about the distribution, biosynthesis and mode of action of phytohormones.*

CO5 *Understand the abiotic stress in plant and know their biochemical and physiological changes.*

CO6 *Discuss on the effects of environmental change on local and large-scale ecological health.*

Text Book:

- Verma, S. K. (1999). Plant Physiology. S. Chand & Co., New Delhi.
- Dey, P.M. and Harborne, J.B. (2000). Plant biochemistry. Academic Press, UK.
- Jain, V. K. (2007). Fundamentals of Plant Physiology. S. Chand & Co., New Delhi.
- Ross and Salisbury. (2009). Plant Physiology. Cengage Learning (Thompson), New Delhi, India.

References

- Moore, T.C. 1979. Biochemistry and physiology of plant hormones. Narosabook Distributors, New Delhi.
- Campbell, M.K. and Farrell, S.O. (2007). Biochemistry. Thomson Brooks/cole, USA.
- Leopold, A. C. (1973). Plant Growth and Development. Tata McGraw Hill Publishing Co. Ltd., New Delhi.
- Taiz, L., Zeiger, E. Mollar, I. M. and Murphy, A. (2015). Plant physiology and Development 6th edition. Sinauer Associates Inc., USA.

Web Resources:

- https://uou.ac.in/sites/default/files/slm/MSCBOT-601.pdf
- http://www.esalq.usp.br/lepse/imgs/conteudo_thumb/Plant-Physiology-What-kinds-of-things-do-plants-do-and-how-do-they-live.pdf
- https://www.cambridge.org/core/books/plant-physiology/BB0CCE22440CB71F6A3B57C3E3BEE418
- https://www.ruhr-uni-bochum.de/botanyonline/

CO- PO Mapping (Course Articulation Matrix)

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	9	9	9	9	3	3
CO2	9	9	3	3	3	1
CO3	9	9	3	3	3	1
CO4	9	3	3	3	1	1
CO5	3	3	1	1	0	1
CO6	3	3	0	0	0	0
Weightage	**42**	**36**	**19**	**19**	**10**	**7**

Level of Correlation between CO's and PO's } 1 – Low 3 – Medium 9 – High 0 – No Correlation (Suggested by UGC as per Six Sigma Tool – Cause and Effect Matrix)

Course Outcomes mapped with Knowledge level (Revised Bloom's Taxonomy) and POs

CO/ K-Level	Level of Correlation			
	High	Medium	Low	Zero
CO1/ K1	PO1, PO2, PO3, PO4	PO5, PO6	-	PO6
CO2/ K2	PO1, PO2	PO3, PO4.PO5	PO6	PO5
CO3/ K3	PO1, PO2	PO3, PO4, PO5	PO6	PO6
CO4/ K4	PO1	PO2, PO3, PO4	PO5,PO6	-
CO5/ K5	-	PO1, PO2	PO3, PO4,PO6	PO5
CO6/ K6	-	PO1, PO2	-	PO3, PO4, PO5, PO6

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure:

K Levels	C1	C2	C3	C4	Total scholastic marks	Non Scholastic Marks C5	CIA Total	% of Assessment
	T1 5 Marks	T2 6 Marks	Assignment 4 Marks	Seminar 5 Marks	20 Marks	5 Marks	25 Marks	
K1	0	1			1	-	**1**	4
K2	1	1		1	3	-	**3**	12
K3	1	1	1	1	4	-	**4**	16
K4	1	1	1	1	4	-	**4**	16
K5	1	1	1	1	4	-	**4**	**16**
K6	1	1	1	1	4	-	**4**	**16**
Non Scholastic	--	--	--	--	--	5	**5**	20
Total	**5**	**6**	**4**	**5**	**20**	**5**	**25**	**100%**

***C = Component**

The COs and POs for the **PLANT PHYSIOLOGY** course in the **M.Sc. Botany** Programme is effectively matched by the Course In-charge.

Signature of the Course In- charge Signature of the Coordinator

Sem.	Programme Code	Course Code	Course Type	Course Title	Category	Hrs. / Week	Credits
III	BOTPG1986	P25BO13P	Core Course	**PRACTICAL – 3** (P25BO11, P25BO12, P25BO14E)	Practical	6	5

Course Description:

This integrated practical course equips students with experimental skills in plant physiology and biochemistry through analysis of water potential, pigments, proteins, lipids, and enzymes. It offers hands-on training in plant morphogenesis and tissue culture techniques including callus induction, organogenesis, and haploid production. Genetic engineering modules cover molecular techniques such as DNA isolation, PCR, electrophoresis, and cloning demonstrations. The course fosters foundational competencies for research and biotechnology applications in plant sciences.

Course Objectives:

1. Apply methods to estimate physiological parameters and biochemical compounds in plants.
2. Perform chromatography and spectrophotometric techniques for pigment and protein analysis.
3. Conduct plant tissue culture procedures including media preparation, culture initiation, and plant regeneration.
4. Observe developmental morphogenesis including wound healing and gall formation.
5. Execute molecular biology techniques such as DNA isolation, PCR, and gel-based separation methods.

Plant Physiology & Biochemistry

1. Determination of water potential by gravimetric method.
2. Determination of water potential by plasmolytic method.
3. Estimation of photosynthetic pigments.
4. Separation of leaf pigments by Column chromatography
5. Separation of amino acids by paper chromatography
6. Estimation of protein by Lowry's et al. method
7. Estimation of total lipids
8. Estimation of total phenols.
9. Estimation of Peroxidase
10. Estimation of total free Amino acids

Morphogenesis and Plant Tissue Culture

1. Study of wound healing (superficial and deep)-
2. Study of galls (leaf – *Pongamia;* Stem – *Coccinia*)
3. Preparation of media (MS medium).
4. Organ cultures (leaf, stem and node).
5. Callus induction, organogenesis, transfer of plants, hardening process.
6. Protoplast isolation by mechanical method.
7. Anther and pollen cultures - production of haploids.

Genetic Engineering Practicals

1. Isolation of genomic DNA from plant samples

2. Isolation of Plasmid DNA – Agarose gel electrophoresis

3. Isolation and separation of plant protein (PAGE)

4. DNA amplification by PCR

5. Gene cloning - demonstration

6. Blotting techniques - demonstration

Course Outcomes:

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

CO1 *Understand water potential and photosynthetic pigment of plants with respect to various physiological processes.*

CO2 *Know the methods to Separate and estimate the biomolecules from the plant samples.*

CO3 *Acquire knowledge about the plant morphogenesis and assess the wound healing properties in plants.*

CO4 *Understand the various techniques of in vitro methods in plant improvement.*

CO5 *Know the fundamental knowledge on the application of molecular tools and techniques for improvement of microbes and higher plants.*

CO6 *Propose ideas to improve the genetics of plants by developing novel genes of economic importance.*

CO- PO Mapping (Course Articulation Matrix)

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	9	9	9	9	3	3
CO2	9	9	3	3	3	1
CO3	9	9	3	3	3	1
CO4	9	3	3	3	1	1
CO5	3	3	1	1	0	1
CO6	3	3	0	0	0	0
Weightage	**42**	**36**	**19**	**19**	**10**	**7**

Level of Correlation between CO's and PO's } 1 – Low 3 – Medium 9 – High 0 – No Correlation (Suggested by UGC as per Six Sigma Tool – Cause and Effect Matrix)

Course Outcomes mapped with Knowledge level (Revised Bloom's Taxonomy) and POs

CO/ K-Level	Level of Correlation			
	High	**Medium**	**Low**	**Zero**
CO1/ K1	PO1, PO2, PO3, PO4	PO5,PO6	_	_
CO2/ K2	PO1, PO2	PO3, PO4, PO5	PO6	_
CO3/ K3	PO1, PO2	PO3, PO4, PO5	PO6	_
CO4/ K4	PO1	PO2, PO3, PO4	PO5, PO6	_
CO5/ K5	_	PO1, PO2,	PO3, PO4, PO6	PO5
CO6/ K6	_	_	PO1, PO2	PO3, PO4, PO5, PO6

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure:

K Levels	C1	C2	C3	C4	Total scholastic marks	Non Scholastic Marks C5	CIA Total	% of Assessment
	T1 4 Marks	T2 10 Marks	Assignment 6 Marks	Seminar 5 Marks	20 Marks	5 Marks	25 Marks	
K1	1	2	1	--	4	--	**4**	**16**
K2	1	2	1	--	4	--	**4**	**16**
K3	1	2	1	--	4	--	**4**	**16**
K4	1	2	1	--	4	--	**4**	**16**
K5		1	1	--	2	--	**2**	**8**
K6		1	1	--	2	--	**2**	**8**
Non Scholastic	--	--	--	--	--	**5**	**5**	**20**
Total	**4**	**10**	**6**	--	**20**	**5**	**25**	**100%**

***C = Component**

The COs and POs for the **PRACTICALS – 3 (CC - 9 & 10 and EC - 3 & 4)** course in the **M.Sc. Botany** Programme is effectively matched by the Course In-charge.

Signature of the Course In- charge

Signature of the Coordinator

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Sem.	Programme Code	Course Code	Course Type	Course Title	Category	Hrs. / Week	Credits
III	BOTPG1986	P25BO14E1	Elective Course	**MORPHOGENESIS AND PLANT TISSUE CULTURE**	Theory	6	4

Course Description:

This course explores the fundamental principles of plant morphogenesis and its relationship to cellular structure, genetic regulation, and environmental cues. It provides a comprehensive understanding of tissue culture methods including organogenesis, somatic embryogenesis, and synthetic seed technology. Special focus is given to advanced techniques such as haploid and protoplast cultures and their applications in plant breeding and biotechnology. The course also covers production of secondary metabolites using plant cell cultures and hairy root systems.

Course Objectives:

1. *Understand the cellular and molecular basis of morphogenesis and its physiological regulators.*
2. *Analyze nuclear-cytoplasmic interactions, tissue-level differentiation, and significance of plant galls.*
3. *Learn the preparation of media and aseptic techniques for initiating various types of plant cultures.*
4. *Apply micropropagation, organogenesis, and somatic embryogenesis in crop improvement.*
5. *Perform haploid and protoplast culture techniques and explore their role in somatic hybridization and metabolite production*.

UNIT-I: MORPHOGENESIS (Teaching - 1 h / week)

Definition - Morphogenesis and its relation to morphology. Turing's diffusion reaction theory - Morphogenetic factors - growth regulators - genetic and environment. Polarity. Molecular basis of morphogenesis - Cytosol and cytoskeleton, microtubules and microfilaments. Cellular level morphogenesis.

UNIT-II: MORPHOGENESIS (Teaching - 1 hr / week)

Nuclear-Cytoplasmic interaction - transplantation experiments in *Acetabularia*. Sach's and Errer's laws - Asymmetric divisions and their significance. Morphogenesis at tissue level - Differentiation, dedifferentiation and redifferentiation of vascular tissue *in vivo* and *in vitro* (eg.: wound healing process). Plant galls and their importance.

UNIT-III TISSUE CULTURE: (Teaching - 1 h / week)

Historical background: Tissue Culture Laboratory, Nutrient media composition and their preparation (MS, White's and Gamborg's).

Explant type, choice and preparation of explants, Explant sterilization. Culture initiation - Paper raft nurse technique, Microchamber techniques, cell suspension cultures - Synchronization of suspension culture. Application in agriculture, horticulture and forestry.

UNIT-IV TISSUE CULTURE TECHNIQUES: (Teaching - 1 h / week)

Micropropagation techniques and applications – Organogenesis – direct and indirect: Protocol, factors influencing organogenesis. Somatic embryogenesis - Process of somatic embryogenesis - embryoids, factors influencing embryogenesis, synthetic seeds.

UNIT-V HAPLOIDS AND PROTOPLAST TECHNIQUES AND SECONDARY METABOLITES PRODUCTION (Teaching - 2 h / week)

Haploid plants: Anther and pollen culture techniques –. Methods of production, significance and application. Diploidization Protoplast culture: Isolation of protoplasts (mechanical and enzymatic) - culture of protoplasts and viability. Protoplast fusion – spontaneous and induced. Selection of somatic hybrids and cybrids.

Secondary metabolites from cell culture, immobilized plant cells, hariy root culture.

Course Outcomes:

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

CO1 *Understand the various aspects in plant development*

CO2 *Develop the knowledge on the plant morphogenesis and plant galls.*

CO3 *To understand the basic principles and methodologies of plant tissue culture*

CO4 *Acquired knowledge on somatic embryogenesis and synthetic seeds.*

CO5 *To learn the knowledge on various methods of Tissue Culture and secondary metabolites production.*

CO6 *Propose tools and techniques for transformation of plants for the production of engineered compounds.*

Text Book:

- Bonner, J. T. (1965). Morphogenesis. Oxford & IBH Publications, Bombay.
- Bard, J. (1990). Morphogenesis. Cambridge University Press, London.
- Bhojwani, S.S. and Razdan, M.K., (1996). Plant Tissue Culture: Theory and Practice. Elsevier Science Amsterdam. The Netherlands.
- Hammoond, J., McGarvey, P. and Yusibov, V. (2000). Plant Biotechnology. Springer Verlag, New York.
- Ramawat, K. G. (2000). Plant Biotechnology. S. Chand & Co., New Delhi.
- Kalyankumar De (1997). Plant Tissue Culture. New Central Book Agency

References:

- Brouder, L. W. (1986). Development Order: A Comprehensive Treatise. Vol.2. The Cellular Basis of Morphogenesis. Plenum Press, New York.
- Bryant, J. A. and Francis, D. (1985). The Cell Division Cycle in Plants. Cambridge University Press, London.
- Burgess, J. (1985). An Introduction to Plant Cell Development. Cambridge University Press, London.

- Razdan, M. K. (2004). Introduction to Plant Tissue Culture. 2nd ed. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
- Santosh, N and A. Madhavi. (2010). Practical Book of Biotechnology and Plant Tissue Culture. S. Chand & Co.

Web resources:

- https://nptel.ac.in/courses/102/103/102103016/
- http://ugcmoocs.inflibnet.ac.in/ugcmoocs/spoc.php?coordinator=574
- https://www.youtube.com/watch?v=bi755vQVNx8
- https://www.elsevier.com/books/plant-tissue-culture/park/978-0-12-821120-5
- https://onlinelibrary.wiley.com/doi/book/10.1002/9780470686522

CO- PO Mapping (Course Articulation Matrix)

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	9	9	9	9	3	1
CO2	9	9	3	3	3	1
CO3	9	9	3	3	1	1
CO4	9	9	3	3	1	1
CO5	3	3	3	3	0	0
CO6	3	3	0	0	0	0
Weightage	**42**	**42**	**21**	**21**	**8**	**4**
Weighted percentage of Course contribution to POs	**30.43**	**30.43**	**15.22**	**15.22**	**5.80**	**2.90**

Level of Correlation between CO's and PO's } 1 – Low 3 – Medium 9 – High 0 – No Correlation (Suggested by UGC as per Six Sigma Tool – Cause and Effect Matrix)

Course Outcomes mapped with Knowledge level (Revised Bloom's Taxonomy) and POs

CO/ K-Level	Level of Correlation			
	High	**Medium**	**Low**	**Zero**
CO1/ K1	PO1, PO2, PO3,	PO4, PO5	PO6	_
CO2/ K2	PO1, PO2	PO3, PO4, PO5	PO6	_
CO3/ K3	PO1, PO2	PO3, PO4,	PO5	PO6
CO4/ K4	PO1	PO2, PO3, PO4	PO5, PO6	_
CO5/ K5	_	PO1, PO2,	PO3, PO4	PO5, PO6
CO6/ K6	_	PO1, PO2	PO3, PO4,	PO5, PO6

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure:

K Levels	C1	C2	C3	C4	Total scholastic marks	Non Scholastic Marks C5	CIA Total	% of Assessment
	T1 5 Marks	T2 6 Marks	Assignment 4 Marks	Seminar 5 Marks	20 Marks	5 Marks	25 Marks	
K1	0	1			1	-	**1**	4
K2	1	1		1	3	-	**3**	12
K3	1	1	1	1	4	-	**4**	16
K4	1	1	1	1	4	-	**4**	16
K5	1	1	1	1	4	-	**4**	**16**
K6	1	1	1	1	4	-	**4**	**16**
Non Scholastic	--	--	--	--	--	5	**5**	20
Total	**5**	**6**	**4**	**5**	**20**	**5**	**25**	**100%**

***C = Component**

The COs and POs for the **MORPHOGENESIS AND PLANT TISSUE CULTURE** course in the M.Sc. Botany Programme is effectively matched by the Course In-charge.

Signature of the Course In-charge

Signature of the Coordinator

Sem.	Programme Code	Course Code	Course Type	Course Title	Category	Hrs. / Week	Credits
III	BOTPG1986	P25BO14E2	Elective Course	**HERBAL MEDICINE**	Theory	6	4

Course Description:

This course provides a comprehensive overview of various traditional and modern medical systems including Ayurveda, Siddha, Unani, Naturopathy, and Yoga. It introduces phytochemistry and pharmacognosy with emphasis on plant-based drug discovery, standardization, quality control, and detection of adulterants. Students will explore the medicinal properties of key phytoconstituents and selected therapeutic plants with active principles. The course also familiarizes students with intellectual property rights, patent laws, and global frameworks protecting traditional knowledge and innovations.

Course Objectives:

1. *Understand the historical development and treatment principles of Indian and alternative systems of medicine.*
2. *Identify key phytochemicals, their sources, and learn techniques in pharmacognosy and drug authentication.*
3. *Perform analytical and chemical methods for phytochemical evaluation, standardization, and quality control.*
4. *Explore active principles of medicinal plants and their applications in treating major human disorders.*
5. Gain knowledge on intellectual property rights, international treaties, and patent filing relevant to herbal drug innovations.

Unit I: SYSTEM OF MEDICINE (Teaching - 1 h / week)

Systems of medicine: origin and development of biomedicine; Indian Systems of Medicine: Ayurveda: Historical perspective, disease management and treatment. Siddha: Historical perspective, disease management and treatment. Unani - Historical perspective, disease management and treatment. Naturopathy- Historical perspective, disease management and treatment. Yoga - Historical perspective and benefits.

Unit II: PHYTOCHEMISTRY AND PHARMACOGNOSY: (Teaching - 1 h / week)

Phytochemistry, important phytoconstituents, their plant sources, medicinal properties. Histochemistry – definition, principles, staining methods. Biological stains – bright field dyes and flurochromes, detection and localization of phytochemicals. Raw drugs, authenticity, study through physical, microscopic and analytical methods. Different types of formulations. Adulteration and Admixtures. Bioprospecting, drug discovery from plants, product development and quality control.

Unit III: ANALYSIS OF PHYTOCHEMICALS: (Teaching - 2 h / week)

Methods of Drug evaluation (Morphological, microscopic, physical and chemical). Phytochemical investigations – standardization and quality control of herbal drugs. Preliminary screening, Assay of Drugs – Biological evaluation/assays, Microbiological methods - Chemical Methods of Analysis,

Detection of Adulterants: Chemical estimations, Spectrophotometry and fluorescence analysis. Drug adulteration - Types of adulterants.

Unit IV: ACTIVE PRINCIPLES & DRUG DISCOVERY: (Teaching - 1 h / week)

Brief description of selected plants, Active principles, biochemical properties and medicinal uses of Guggul (*Commiphora*) for hypercholesterolemia, *Boswellia* for inflammatory disorders, Arjuna (*Terminalia arjuna*) for cardio protection, turmeric (*Curcuma longa*) for wound healing, antioxidant and anticancer properties, Kutaki (*Picrorhiza kurroa*) for hepatoprotection, Opium Poppy for analgesic and antitussive, *Salix* for analgesic, *Cinchona* and *Artemisia* for Malaria, *Rauwolfia* as tranquilizer, *Belladona* as anticholinergic, *Digitalis* as cardiotonic, *Podophyllum* as antitumor, *Stevia rebaudiana* for antidiabetic, *Catharanthus roseus* for anticancer.

Unit V: INTELLECTUAL PROPERTY RIGHTS: (Teaching - 1 h / week)

Intellectual Property Rights – Introduction, Kinds of Intellectual Property Rights- Patents, Trademarks, Copyrights, Trade Secrets. Need for intellectual property right, Advantages and Disadvantages of IPR. International Regime Relating to IPR – TRIPS, WIPO, WTO, GATTS. IPR in India genesis and development. Geographical Indication – introduction, types. Patent filing procedure for ordinary application.

Course Outcomes:

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

CO1 *Understand the origin and development of various medical systems including Ayurveda, Siddha, Unani, Naturopathy, and Yoga.*
CO2 *Explore phytochemistry and pharmacognosy by studying phytoconstituents, raw drugs, adulteration, and drug formulation.*
CO3 *Analyze phytochemical evaluation methods including morphological, microscopic, and spectrophotometric techniques.*
CO4 *Examine active principles and medicinal uses of selected plants in drug discovery and disease management.*
CO5 *Learn about drug discovery and development processes focusing on bioactive compounds and their therapeutic applications.*
CO6 *Understand Intellectual Property Rights (IPR) and patenting related to medicinal plants and drug development.*

Text Books:

- AYUSH, 2014. An overview of Ayurveda, Yoga and Naturopathy, Unani, Siddha and Homeopathy. New Delhi: Department of Ayurveda, Yoga & Naturopathy, Unani, Siddha and Homoeopathy, Ministry & Family Welfare, Govt. of India. (www.indianmedicine.nic.in)
- Bhat, S.V., Nagasampagi, B.A., & Meenakshi, S. 2009. Natural Products – Chemistry and Applications. Narosa Publishing House, India Ltd.
- Kapoor, L. D. 2001. Handbook of Ayurvedic medicinal plants. Boca Raton, FL: CRC Press.
- Sharma, R. 2003. Medicinal Plants of India-An Encyclopedia. Delhi: Daya Publishing House.
- Thakur, R. S., H. S. Puri, and Husain, A. 1989. Major medicinal plants of India. Central Institute of Medicinal and Aromatic Plants, Lucknow, India.

Reference Book:

- Bhattacharjee, S.K. 2004. Hand Book of Medicinal plants. Pointer Publishers, Jaipur.
- Jain, S.K. and Jain, Vartika. (eds.). 2017. Methods and Approaches in Ethnobotany: Concepts, Practices and Prospects. Deep Publications, Delhi
- Evans, W.C. 2009. Trease and Evans Pharmacognosy, 16th edn. Philadelphia, PA: Elsevier Saunders Ltd. Concepts, Practices and Prospects. Deep Publications, Delhi
- Handa, S.S and V.K. Kapoor. 1993. Pharmacognosy. Vallabh Prakashan, New Delhi.

Web resources:

1. https://www.amazon.in/Medical-Botany-Plants-Affecting-Health/dp/0471628824
2. https://www.amazon.in/Current-Trends-Medicinal-Botany-Muhammad/dp/9382332502
3. https://link.springer.com/book/10.1007/978-3-030-74779-4
4. https://www.elsevier.com/books/medicinal-plants/da/978-0-08-100085-4
5. https://www.pdfdrive.com/medicinal-plants-books.html

CO- PO Mapping (Course Articulation Matrix)

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	1	0
CO2	9	3	1	3	0	1
CO3	3	9	3	3	3	0
CO4	9	3	3	3	0	1
CO5	3	3	3	9	3	1
CO6	3	3	0	0	0	0
Weightage	**30**	**24**	**13**	**21**	**7**	**3**
Weighted percentage of Course contribution to POs	**30.61**	**24.49**	**13.27**	**21.43**	**7.14**	**3.06**

Level of Correlation between CO's and PO's } 1 - Low 3 - Medium 9 - High 0 - No Correlation (Suggested by UGC as per Six Sigma Tool - Cause and Effect Matrix)

Course Outcomes mapped with Knowledge level (Revised Bloom's Taxonomy) and POs

CO/ K-Level	Level of Correlation			
	High	**Medium**	**Low**	**Zero**
CO1/ K1	-	PO1, PO2,PO3,PO4	PO5	PO6
CO2/ K2	PO1	PO2,PO4,	PO3,PO6	PO5
CO3/ K3	PO2	PO1, PO3, PO4 PO5	_	PO6
CO4/ K4	PO1	PO2, PO3,PO4	PO6	PO5,
CO5/ K5	PO4	PO1,PO2, PO3,PO5	PO6	_
CO6/ K6	-	PO1, PO2	-	PO3, PO4, PO5, PO6

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure:

K Levels	C1	C2	C3	C4	Total scholastic marks	Non Scholastic Marks C5	CIA Total	% of Assessment
	T1 5 Marks	T2 6 Marks	Assignment 4 Marks	Seminar 5 Marks	20 Marks	5 Marks	25 Marks	
K1	0	1			1	-	**1**	4
K2	1	1		1	3	-	**3**	12
K3	1	1	1	1	4	-	**4**	16
K4	1	1	1	1	4	-	**4**	16
K5	1	1	1	1	4	-	**4**	**16**
K6	1	1	1	1	4	-	**4**	**16**
Non Scholastic	--	--	--	--	--	5	**5**	20
Total	**5**	**6**	**4**	**5**	**20**	**5**	**25**	**100%**

***C = Component**

The COs and POs for the **HERBAL MEDICINE** Elective course in the M**.Sc. Botany** Programme is effectively matched by the Course In-charge.

Signature of the Course In- charge

Signature of the Coordinator

Sem.	Programme Code	Course Code	Course Type	Course Title	Category	Hrs. / Week	Credits
III	BOTPG1986	P25BO14E3	Elective Course	**FLORICULTURE AND LANDSCAPING**	Theory	6	4

Course Description:

This course introduces students to the historical evolution and styles of gardening, including formal, informal, Persian, and Chinese gardens. It covers essential landscape design principles, elements, site analysis, and the preparation of garden features using landscape drawings and symbols. Students will learn practical methods of plant propagation, plant protection, and integrated pest management. The course also emphasizes the commercial aspects of floriculture including cultivation of economically important flowers, cut flower industry, and floral decorations.

Course Objectives:

1. *Understand the history and various styles of traditional and modern gardening.*
2. *Apply design principles, analyze garden sites, and identify landscape elements in garden planning.*
3. *Develop garden features and landscape drawings using appropriate symbols and planning steps.*
4. *Learn propagation techniques and plant protection methods including IPM strategies.*
5. *Explore commercial floriculture practices and gain skills in flower cultivation and decoration.*

Unit I: Styles of Gardening (15 Hours)

Introduction, History of landscape gardening, styles of gardening - formal gardening, informal gardening, other garden styles, Persian garden, Chinese garden, parts of modern garden.

Key words/Extra reading: Allee, Backfill, Curbing

Unit II: Principles, Elements and Site Analysis (15 Hours)

Principles of Landscape design, Elements of landscape design, Physical properties of plants. Site analysis and preparation-Types of soil, Analysis, Preparation and, Measurement of site.

Key words/Extra reading: Dethatch, Dry-laid, Espalier

Unit III: Preparation and development of garden features (15 Hours)

Types of Garden design, types of Landscape drawing, Landscape symbols, steps in creating a garden plan, Garden features

Key words/Extra reading: Flagstone, Gazebo, Moongate

Unit IV: Plant Propagation and Plant Protection (30 Hours)

Plant propagation methods - cutting, layering, grafting, budding, micropropagation, plant protection-causatic agents and control measures- integrated pest management.

Key words/Extra reading: Orchard, Pavers, Rill

Unit V: Commercial Floriculture (15 Hours)

Economic flowers - cultivation of jasmines, Chrysanthemum, rose, Gerbera - cut flowers and cut flower industry in India, flower arrangement and dry decorations.

Key words/Extra reading: Sod, Tsukubai, Xeriscaping

Course Outcomes:

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

CO 1	*Understand the history and styles of gardening including formal, informal, Persian, and Chinese gardens.*
CO2	*Learn the principles and elements of landscape design along with site analysis and soil preparation.*
CO3	*Develop skills in garden planning and design using landscape symbols and various garden features.*
CO4	*Explore plant propagation techniques such as cutting, grafting, and micropropagation for garden development.*
CO5	*Understand plant protection methods including integrated pest management for maintaining healthy gardens.*
CO6	*Gain knowledge of commercial floriculture focusing on the cultivation, trade, and decoration of economic flowers.*

List of Text Books:

- Balaji, S. Kulkarni (2016). Floriculture and Landscaping. AGRO India Publications, Allahabad.
- Ashraff, A.M. (2012). A Handbook of Landscape Gardening and Environment. AGROBIOS, India.
- Kumar, N. (1977). Introduction to Horticulture. Rajalakshmi Publications, Nagercoil, India.
- Edmond, J.B., Sen, T.L., MacVean, F.S., & Hallgare, R.G. (1979). Fundamentals of Horticulture (Fourth edition). Tata McGraw Hill Publishing Co., New Delhi.
- Jitendra Singh (2002). Basic Horticulture. Kalyani Publishers, Hyderabad.

List of Reference Books:

- Shree, S. (n.d.). Commercial Floriculture. Enkat Publication. (Accn. No. 22017066)
- Darrell, & Weyman, V. (1977). Landscape Processes. George Allen and Unwin Ltd. (Accn. No. 00049013)
- Nambisan, K. M. P. (1992). Design Elements of Landscape Gardening. Oxford & IBH. (Accn. No. 00055066)
- Ramanujan, A. K. (1995). Interior Landscape. Oxford University. (Accn. No. 33006715)

Digital Open Educational Resources:

- http://www.indiaagronet.com/horticulture/CONTENTS/LANDSCAPE.htm
- https://www.agrifarming.in/landscape-gardening-ideas-principles-design-guide
- http://ecoursesonline.iasri.res.in/mod/page/view.php?id=121692
- https://agrimoon.com/wp-content/uploads/Principles-of-Landscape-Gardening.pdf
- https://extension.psu.edu/soil-management-in-home-gardens-and-landscapes
- https://www.britannica.com/art/garden-and-landscape-design/Time-climate-and-season
- https://drive.google.com/file/d/1mAukw_9OTerVgbeBSzPIB3e32Xyy|K2B/view
- https://www.youtube.com/watch?v=ZQudikeVBHO
- https://www.youtube.com/watch?v=T4hX4qzH6dc

Correlation Levels:

Mapping COs consistency with POs: Course Articulation Matrix

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	9	1	3	1	1	1
CO2	9	1	3	1	1	1
CO3	9	1	3	1	1	1
CO4	9	1	3	1	1	1
CO5	9	1	3	1	1	1
CO6	9	1	3	1	1	1
Weightage	54	6	18	6	6	6
Weighted percentage of Course contribution to POs	56.25%	6.25%	18.75%	6.25%	6.25%	6.25%

Course Outcomes mapped with Knowledge level (Revised Bloom's Taxonomy) and POs

CO / K - Level	Level of Correlation			
	High	**Medium**	**Low**	**Zero**
CO 1/K1, K2, K3	PO1, PO3	PO2	PO4, PO5, PO6	-
CO 2/K1, K2, K3	PO1, PO3	PO2	PO4, PO5, PO6	-
CO 3/K1, K2, K3	PO1, PO3	PO2	PO4, PO5, PO6	-
CO 4/K1, K2, K3	PO1, PO3	PO2	PO4, PO5, PO6	-
CO 5/K1, K2, K3	PO1, PO3	PO2	PO4, PO5, PO6	-
CO 6/K1, K2, K3, K4	PO1, PO3	PO2	PO4, PO5, PO6	-

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure:

K Levels	C1	C2	C3	C4	Total scholastic marks	Non Scholastic Marks C5	CIA Total	% of Assessment
	T1 5 Marks	T2 6 Marks	Assignment 4 Marks	Seminar 5 Marks	20 Marks	5 Marks	25 Marks	
K1	0	1			1	-	**1**	4
K2	1	1		1	3	-	**3**	12
K3	1	1	1	1	4	-	**4**	16
K4	1	1	1	1	4	-	**4**	16
K5	1	1	1	1	4	-	**4**	**16**
K6	1	1	1	1	4	-	**4**	**16**
Non Scholastic	--	--	--	--	--	5	**5**	20
Total	**5**	**6**	**4**	**5**	**20**	**5**	**25**	**100%**

***C = Component**

The COs and POs for the **Floriculture and Landscaping** course in the M.Sc. Programme is effectively matched by the Course In-charge.

Signature of the Course In-charge

Signature of the Coordinator

Sem.	Programme Code	Course Code	Course Type	Course Title	Category	Hrs. / Week	Credits
III	BOTPG1986	P25BO15E1	Elective Course	**GENETIC ENGINEERING**	Theory	6	4

Course Description:

This course introduces the fundamentals of genetic engineering, covering key enzymes, cloning vectors, and rDNA technology. It emphasizes gene transfer methods, selection and screening of recombinants, and PCR-based cloning strategies. Students will explore modern sequencing technologies, molecular markers, and genomic tools. Applications in agriculture, ethical considerations, and intellectual property rights are also discussed.

Course Objectives:

1. *To understand the principles and tools of genetic engineering, including enzymes and cloning vectors.*
2. *To demonstrate methods for recombinant DNA generation and gene transfer techniques.*
3. *To identify recombinant cells using selection strategies and molecular screening techniques.*
4. *To apply PCR-based cloning, DNA sequencing methods, and molecular markers in gene analysis.*
5. *To evaluate the applications of genetic engineering in plants and examine associated bioethical issues.*

UNIT I: ENZYMES AND CLONING VECTORS (Teaching – 2hrs / week)

Introduction to Genetic Engineering: Definition, history, scope, and applications. Tools for Genetic Engineering: Restriction enzymes, alkaline phosphatase, polynucleotide kinase, DNA ligase, polymerases, and topoisomerases. Vectors in Genetic Engineering: Plasmids (pBR322, pUC18), Cosmids, Viral vectors for plants (CaMV), Expression Vectors, Shuttle Vectors (YEPs).

UNIT II: DNA CLONING (Teaching – 1 hr / week)

Generation of rDNA molecules - cutting and joining DNA molecules – Linkers – Adaptors. Methods of Gene Transfer – direct gene transfer method (transformation, electroporation, microinjection, microprojectiles). Indirect gene transfer (*Agrobacterium* mediated gene transfer).

UNIT III: SCREENING OF RECOMBINANTS (Teaching – 1 hr / week)

Selection and screening of recombinants –marker / reporter genes – antibiotic resistance, alpha complementation, Blue – white selection, GUS, luciferase, GFP, blotting (Southern, Northern and Western) and hybridization.

UNIT IV: PCR AND SEQUENCING (Teaching – 1 hr / week)

Polymerase Chain Reaction (PCR): Types, applications, and optimization. PCR based cloning – cDNA synthesis, cloning and genomic library, site directed mutagenesis. DNA & RNA probes - Chemical synthesis of oligo-nucleotides. RAPD, RFLP, SNPs and DNA fingerprinting. DNA sequencing – Sanger sequencing, Next-Generation Sequencing (NGS), whole genome sequencing.

UNIT V: GENETIC ENGINEERING IN PLANTS AND BIOETHICS (Teaching – 1 hr / week)

Engineered resistance against herbicide – pest (Bt cotton) and viral infection. Edible vaccines - Flavr Savr tomato. Modification of lipid metabolism and storage proteins in plants. Bioethics – Ethical implications of GM crops. Intellectual Property Right (IPR).

Course Outcomes:

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

CO1 *Understand the core concepts and fundamentals of genetic engineering*

CO2 *Develop their competency on tools and techniques employed in rDNA technology*

CO3 *Analyze the enzymes and vectors for genetic manipulations*

CO4 *Examine gene cloning and evaluate different methods of gene transfer*

CO5 *Critically analyze the major concerns and applications of Genetic engineering.*

CO6 *Discuss the current scenario on national and global status of transgenic plants*

Text Books:

- Dubey, R. C. (2008). A Textbook of Biotechnology. S. Chand & Co. Ltd., New Delhi.
- Primrose, S. B. (1994). Molecular Biotechnology. Blackwell Scientific Publishing, Oxford
- Sambrook, J., Fritsch, E. F. and Maiatis, T. (2000). Molecular Cloning: A Laboratory Manual. Spring Harbor Laboratory Press, New York.
- Satyanarayana, V. (2005). Biotechnology, Books and Allied (P) Ltd., Kolkata.

References:

- Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.
- Old RN and Primrose S B. 2004, Principles of Gene Manipulation - Blackwell Sci.,USA.
- Slater, A., Scott, N.W. and M.R. Fowler (2008). Plant Biotechnology. Second Edition. Oxford.

Web Resources:

- Tools of Genetic Engineering](https://www.yourgenome.org/facts/what-is-genetic-engineering/)
- Plasmid Tools](https://www.addgene.org/mol-bio-reference/plasmid-vector/)
- NCBI – Recombinant DNA Technology](https://www.ncbi.nlm.nih.gov/books/NBK21065/)
- Nature – Gene Transfer Methods](https://www.nature.com/articles/nrg1831)

CO- PO Mapping (Course Articulation Matrix)

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	9	9	9	9	3	1
CO2	9	9	3	3	3	1
CO3	9	3	3	3	1	1
CO4	3	3	3	3	1	1
CO5	3	3	0	3	0	0
CO6	3	3	0	0	0	0
Weightage	**36**	**30**	**18**	**21**	**8**	**4**
Weighted percentage of Course contribution to POs	30.77	25.64	15.38	17.95	6.84	3.42

Level of Correlation between CO's and PO's: 1 – Low, 3 – Medium, 9 – High, 0 – No Correlation (Suggested by UGC as per Six Sigma Tool – Cause and Effect Matrix)

Course Outcomes mapped with Knowledge level (Revised Bloom's Taxonomy) and POs

CO/ K-Level	Level of Correlation			
	High	**Medium**	**Low**	**Zero**
CO1/ K1	PO1	PO2,PO3, PO6	PO4, PO5	-
CO2/ K2	PO1, PO3	PO2,PO4, PO6	PO5	-
CO3/ K3	PO3	PO1, PO4, PO5, PO6	_PO2	-
CO4/ K4	PO1	PO2, PO3, PO4	PO5	PO6
CO5/ K5	PO4	PO1, PO2, PO3, PO5	PO6	_
CO6/ K6	PO3, PO4,	PO1,	PO2	PO1, PO5

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure:

K Levels	C1	C2	C3	C4	Total scholastic marks	Non Scholastic Marks C5	CIA Total	% of Assessment
	T1 5 Marks	T2 6 Marks	Assignment 4 Marks	Seminar 5 Marks	20 Marks	5 Marks	25 Marks	
K1	0	1			1	-	**1**	4
K2	1	1		1	3	-	**3**	12
K3	1	1	1	1	4	-	**4**	16
K4	1	1	1	1	4	-	**4**	16
K5	1	1	1	1	4	-	**4**	**16**
K6	1	1	1	1	4	-	**4**	**16**
Non Scholastic	--	--	--	--	--	5	**5**	20
Total	**5**	**6**	**4**	**5**	**20**	**5**	**25**	**100%**

***C = Component**

The COs and POs for the **GENETIC ENGINEERING** Elective course in the M**.Sc. Botany** Programme is effectively matched by the Course In-charge.

Signature of the Course In- charge

Signature of the Coordinator

Sem.	Programme Code	Course Code	Course Type	Course Title	Category	Hrs. / Week	Credits
III	BOTPG1986	P25BO15E2	Elective Course	**BIOPROSPECTING. DRUG DISCOVERY AND PRODUCT DEVELOPMENT**	Theory	6	4

Course Description:

This course explores both traditional and cutting-edge strategies in drug discovery, including natural sources and modern tools such as high-throughput screening, pharmacogenomics, and proteomics. It covers the formulation and evaluation of various dosage forms including tablets, capsules, emulsions, and injectables, with emphasis on preformulation studies and optimization techniques. Students will learn in vitro and in vivo performance evaluation methods, bioavailability testing, and kinetic principles governing drug stability. The course concludes with an overview of national and international drug regulatory frameworks, patents, clinical trials, and pharmacopoeial standards.

Course Objectives:

1. Understand conventional and advanced methods in drug discovery, including screening technologies and molecular approaches.
2. Learn the design, formulation, and evaluation of various conventional and novel pharmaceutical dosage forms.
3. Analyze preformulation parameters affecting drug stability, bioavailability, and product development.
4. Apply techniques for performance evaluation of dosage forms including dissolution, stability, and bioavailability studies.
5. Gain knowledge of drug regulatory systems, legal frameworks, clinical trials, and documentation procedures for drug approval.

Unit I: Conventional and new approaches in drug discovery (Teaching – 1 hr / week)

Historical approaches in drug discovery: Natural, Synthetic and Semisynthetic sources. New approaches in drug discovery: combinatorial chemistry, high throughput screening, ultra high throughput screening and high content screening, technologies for high throughput screening, pharmacogenomics, proteomics and array technology.

Unit II: Drug delivery systems and dosage form development (Teaching – 1 hr / week)

Brief introduction on Conventional and novel drug delivery modules. Design, development, formulation, evaluation and validation methods for pharmaceutical operations involved in the production of following pharmaceutical products: Capsules, Tablets, Powders, Suppository, Liquid Dosage forms, Solutions, Suspensions, Emulsions, Semisolid Dosage forms, Ointments, Cream and Parental Products.

Unit III: Preformulation studies (Teaching – 2 hr / week)

Study of physical properties of drug like physical form, particle size, shape, density, wetting dielectric constant, solubility, dissolution and organoleptic property and their effect on formulation, stability and bioavailability. Study of chemical properties of drugs like hydrolysis, oxidation, reduction, racemization, polymerization etc., and their influence on formulation and stability of products. Study of pro-drugs in solving problems related to stability, bioavailability and elegancy of formulations.

Optimization Techniques in Pharmaceutics, Formulation and Processing, Optimization parameters, statistical design and other application.

Unit IV: Performance evaluation methods (Teaching – 1 hr / week)

In vitro dissolution studies for solid dosage forms methods, interpretation of dissolution data. Bioavailability studies and bioavailability testing protocol and procedures. *In vivo* methods of evaluation and statistical treatment. Kinetic principles and stability testing: Order of reaction, Influence of pH, temperature, Acid base catalysis. Effect of Ionic strength on degradation, complex reactions, amide hydrolysis, ring alteration, oxidation reduction, chemical and physical stability of dosage forms, influence of packaging components on dosage form stability.

Unit V: Drug regulatory affairs (Teaching – 1 hr / week)

Federal food, drug and cosmetic act; Kafaurver Harre's amendments, new drug application, drug efficacy study, implementation review, OTC drug review, drug listing. Drug amendments, patents, copy right, trademarks, drug recalls, product liability, clinical trials based on formulations of Siddha-Ayurveda pharmacopoeias.

Course Outcomes:

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

CO1: *Understand the historical and contemporary approaches to drug discovery.*
CO2: *Demonstrate knowledge of conventional and novel drug delivery systems by designing, developing, and evaluating pharmaceutical dosage forms.*
CO3: *Conduct pre-formulation studies by analyzing the physical and chemical properties of drugs.*
CO4: *Apply in vitro and in vivo performance evaluation techniques for pharmaceutical products.*
CO5: *Utilize optimization techniques in pharmaceutics, employing statistical design methods and parameters to enhance the formulation and processing of pharmaceutical products.*
CO6: *Demonstrate a comprehensive understanding of drug regulatory affairs*

References

- Armstrong, N. A. and James, K. C. (1996). Pharmaceutical Experimental Design and Interpretation. Taylor and Francis, London.
- Baird, R. M., Hodges, N. A. and Denyer, S. P. (2000). Handbook of Microbiological Quality Control: Pharmaceuticals and Medical Devices. Taylor and Francis, London.
- Banker, G. S. and Rhodes, C. T. (2002). Modern Pharmaceutics (4th ed.). Marcel Dekker, New York.
- Harburn, K. (1990). Quality Control of Packaging Materials in the Pharmaceutical Industry. Marcel Dekker, New York.

Online Resources:

- https://onlinelibrary.wiley.com/doi/book/10.1002/0471728780?utm_source=chatgpt.com "Drug Discovery Handbook | Wiley Online Books"
- https://www.iajps.com/pdf/october2015/6.prasanna%2Breview.pdf?utm_source=chatgpt.com "[PDF] An Overview on Preformulation Studies - iajps"
- https://ijpsr.com/bft-article/a-review-on-pharmaceutical-preformulation-studies-in-formulation-and-development-of-new-drug-molecules/?utm_source=chatgpt.com "A REVIEW ON PHARMACEUTICAL PREFORMULATION STUDIES ..."
- https://lapinjournals.com/index.php/jmtbas/article/view/52?utm_source=chatgpt.com "Regulatory Affairs and Regulatory Requirements for New Drug ..."
- https://rudiapt.files.wordpress.com/2017/08/ansels-pharmaceutical-dosage-forms-and-drug-delivery-systems-10th-ed.pdf?utm_source=chatgpt.com "[PDF] Ansel's pharmaceutical dosage forms and drug delivery systems"

CO- PO Mapping (Course Articulation Matrix)

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	9	9	9	9	0	0
CO2	9	3	3	3	1	1
CO3	9	3	3	3	1	0
CO4	3	3	3	3	1	1
CO5	3	3	1	1	0	0
CO6	3	3	0	0	0	1
Weightage	**36**	**21**	**19**	**19**	**3**	**3**
Weighted percentage of Course contribution to POs	**35.64**	**20.79**	**18.81**	**18.81**	**2.97**	**2.97**

Level of Correlation between CO's and and Effect Matrix) } 1 – Low PO's 3 – Medium 9 – High 0 – No Correlation (Suggested by UGC as per Six Sigma Tool – Cause

Course Outcomes mapped with Knowledge level (Revised Bloom's Taxonomy) and POs

CO/ K-Level	Level of Correlation			
	High	Medium	Low	Zero
CO1/ K1	PO1, PO4,	PO2	PO3	PO5, PO6
CO2/ K2	PO1	PO2, PO3	PO4	PO5, PO6
CO3/ K3	PO1, PO2	PO3, PO4		PO5, PO6
CO4/ K4	PO2, PO3	PO1, PO4	PO5,	PO6
CO5/ K5	PO4	PO2, PO3	PO1, PO6	PO5,
CO6/ K6	PO4, PO5,	PO2, PO3	PO1, PO6	-

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure:

K Levels	C1	C2	C3	C4	Total scholastic marks	Non Scholastic Marks C5	CIA Total	% of Assessment
	T1 5 Marks	T2 6 Marks	Assignment 4 Marks	Seminar 5 Marks	20 Marks	5 Marks	25 Marks	
K1	0	1			1	-	**1**	4
K2	1	1		1	3	-	**3**	12
K3	1	1	1	1	4	-	**4**	16
K4	1	1	1	1	4	-	**4**	16
K5	1	1	1	1	4	-	**4**	**16**
K6	1	1	1	1	4	-	**4**	**16**
Non Scholastic	--	--	--	--	--	5	**5**	20
Total	**5**	**6**	**4**	**5**	**20**	**5**	**25**	**100%**

***C = Component**

The COs and POs for the **BIOPROSPECTING DRUG DISCOVERY AND PRODUCT DEVELOPMENT** course in the **M.Sc. Botany** Programme is effectively matched by the Course In-charge.

Signature of the Course In- charge Signature of the Coordinator

Sem.	Programme Code	Course Code	Course Type	Course Title	Category	Hrs. / Week	Credits
III	BOTPG1986	P25BO15E3	Elective Course	**FOOD PROCESSING AND PRESERVATION**	Theory	6	4

Course Description:

This course provides a foundational understanding of the principles and practices in processing and preserving plant-based foods. It covers the causes of food spoilage and the traditional and modern techniques used to extend shelf life, including temperature control, dehydration, fermentation, and innovative preservation technologies. The course also emphasizes food packaging, regulatory standards, and post-harvest storage, along with sustainability practices in packaging. Through case studies and practical examples, students will gain insight into the transformation of raw plant materials into safe, nutritious, and value-added food products.

Course Objectives:

1. Understand the scope, importance, and challenges in food processing and preservation of plant-derived materials.
2. Learn various preservation techniques including thermal processing, chemical preservatives, and emerging technologies.
3. Apply principles and methods of drying and dehydration to extend shelf life and maintain food quality.
4. Explore the role of microbial fermentation and biotechnology in producing nutritious, plant-based fermented foods.
5. Examine packaging strategies and storage systems that maintain food safety, quality, and sustainability.

Unit 1: Introduction to Food Processing and Preservation (Teaching – 1 hr / week)

Definition, scope, and importance of food processing and preservation in plant-based foods. Characteristics of plant-derived raw materials for food processing. Overview of food spoilage: biological, chemical, and physical factors. Traditional vs. modern methods of food preservation. Regulatory standards for food safety.

Unit 2: Principles of Food Preservation (Teaching – 1 hr / week)

Preservation by temperature control: freezing, chilling, and thermal processing (canning, pasteurization). Role of pH, water activity (Aw), and other intrinsic factors in food preservation. Use of preservatives: natural and synthetic. Emerging techniques in food preservation: Hurdle technology, irradiation, and high-pressure processing. Role of plant biochemistry in extending shelf life.

Unit 3: Drying and Dehydration of Foods (Teaching – 1 hr / week)

Principles and techniques of drying and dehydration of plant-based foods. Types of dryers: tray dryers, spray dryers, freeze-dryers. Impact of drying on the nutritional and sensory properties of food. Applications in fruits, vegetables, and spices. Case studies: Preservation of herbal medicines and botanicals

Unit 4: Fermentation and Bioprocessing (Teaching – 2 hr / week)

Principles of fermentation in food processing. Role of microorganisms in plant-based food fermentation. Fermented plant products: bread, wine, pickles, and soy products. Biotechnological applications in food processing (enzymes, probiotics). Nutritional and therapeutic benefits of fermented foods.

Unit 5: Packaging and Storage (Teaching – 1 hr / week)

Principles of food packaging: materials and types of packaging for plant-based products. Biodegradable and eco-friendly packaging materials derived from plants. Role of modified atmosphere and controlled atmosphere storage. Post-harvest handling and storage of fruits, vegetables, and grains. Challenges and advancements in packaging for food preservation.

Course Outcomes:

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

CO1*: Explain the principles and significance of food processing and preservation in the context of plant-based foods.*
CO2*: Evaluate the methods of thermal and non-thermal preservation for extending the shelf life of plant-derived food products.*
CO3*: Apply knowledge of post-harvest handling and preservation techniques to maintain the nutritional and sensory quality of plant-based products.*
CO4*: Design sustainable packaging and storage solutions for preserving plant-based foods while minimizing environmental impact.*
CO5*: Assess food safety and quality standards in compliance with national and international regulations for plant-based food products.*
CO6*: Develop innovative approaches and strategies to address challenges in food processing and preservation using sustainable practices.*

Textbooks

- Fellows, P. (2017). *Food Processing Technology: Principles and Practice*. Woodhead Publishing.
- Potter, N. N., & Hotchkiss, J. H. (1998). *Food Science*. Springer.
- Manay, N. S., & Shadaksharaswamy, M. (2004). *Foods: Facts and Principles*. New Age International.
- Sivasankar, B. (2002). *Food Processing and Preservation*. Prentice-Hall of India.
- Ramaswamy, H. S., & Marcotte, M. (2005). *Food Processing: Principles and Applications*. CRC Press.

Reference Books

- Gould, G. W. (2013). *New Methods of Food Preservation*. Springer.
- Jay, J. M., Loessner, M. J., & Golden, D. A. (2005). *Modern Food Microbiology*. Springer.
- Subbulakshmi, G., & Udipi, S. A. (2006). *Food Processing and Preservation*. New Age International.
- Leistner, L., & Gould, G. W. (2002). *Hurdle Technologies: Combination Treatments for Food Stability, Safety, and Quality*. Springer.

Online Resources:

- https://onlinelibrary.wiley.com/journal/jfpp?utm_source=chatgpt.com "Journal of Food Processing and Preservation - Wiley Online Library"
- https://www.researchgate.net/publication/368851618_Impact_of_Emerging_Food_Processing_Technologies_on_Structural_and_Functional_Modification_of_Proteins_in_Plant-Based_Meat_Alternatives_An_Updated_Review?utm_source=chatgpt.com "Impact of Emerging Food Processing Technologies on Structural ..."

- https://www.mdpi.com/2071-1050/16/18/8223?utm_source=chatgpt.com "Innovative and Sustainable Food Preservation Techniques - MDPI"
- https://pmc.ncbi.nlm.nih.gov/articles/PMC7915777/?utm_source=chatgpt.com "Plant-Based Phenolic Molecules as Natural Preservatives in ..."
- https://www.mdpi.com/2304-8158/12/5/1057?utm_source=chatgpt.com "Sustainable and Bio-Based Food Packaging: A Review on Past and ..."

CO- PO Mapping (Course Articulation Matrix)

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	9	9	9	9	3	1
CO2	9	9	3	3	3	1
CO3	9	3	3	3	1	1
CO4	3	3	3	3	1	1
CO5	3	3	0	3	0	0
CO6	3	3	0	0	0	0
Weightage	**36**	**30**	**18**	**21**	**8**	**4**
Weighted percentage of Course contribution to POs	**30.77**	**25.64**	**15.38**	**17.95**	**6.84**	**3.42**

Level of Correlation between CO's and PO's } 1 – Low 3 – Medium 9 – High 0 – No Correlation (Suggested by UGC as per Six Sigma Tool – Cause and Effect Matrix)

Course Outcomes mapped with Knowledge level (Revised Bloom's Taxonomy) and POs

CO/ K-Level	Level of Correlation			
	High	**Medium**	**Low**	**Zero**
CO1/ K1	PO1	PO2,PO3,	PO4, PO5	PO6
CO2/ K2	PO1, PO3	PO2,	PO5	PO4, PO6
CO3/ K3	PO3	PO1, PO4,	PO2	PO5, PO6
CO4/ K4	PO1	PO2, PO3, PO4	PO5	PO6
CO5/ K5	PO4	PO1, PO2, PO3, PO5	PO6	_
CO6/ K6	PO3, PO4,	PO1,	PO2	PO1, PO5

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure:

K Levels	C1	C2	C3	C4	Total scholastic marks	Non Scholastic Marks C5	CIA Total	% of Assessment
	T1 5 Marks	T2 6 Marks	Assignment 4 Marks	Seminar 5 Marks	20 Marks	5 Marks	25 Marks	
K1	0	1			1	-	**1**	4
K2	1	1		1	3	-	**3**	12
K3	1	1	1	1	4	-	**4**	16
K4	1	1	1	1	4	-	**4**	16
K5	1	1	1	1	4	-	**4**	**16**
K6	1	1	1	1	4	-	**4**	**16**
Non Scholastic	--	--	--	--	--	5	**5**	20
Total	**5**	**6**	**4**	**5**	**20**	**5**	**25**	**100%**

***C = Component**

The COs and POs for the **FOOD PROCESSING AND PRESERVATION** Elective course in the M**.Sc. Botany** Programme is effectively matched by the Course In-charge.

Signature of the Course In- charge Signature of the Coordinator

Sem.	Programme Code	Course Code	Course Type	Course Title	Category	Hrs. / Week	Credits
IV	BOTPG1986	P25BO16	Core Course	**RESEARCH METHODOLOGY**	Theory	6	5

Course Description:

This course introduces foundational concepts and practices in research methodology, emphasizing the importance, types, and ethical considerations in scientific research. Students will gain proficiency in data collection, presentation, statistical analysis, and probability theory. Special focus is given to tests of significance, correlation, and regression methods for data interpretation. The course also covers the structure and writing of research reports, funding proposals, and understanding research metrics.

Course Objectives:

1. *Understand the fundamental concepts, objectives, and importance of research in various disciplines.*
2. *Differentiate among types of research, data, and appropriate methods of data collection.*
3. *Apply methods of data presentation and compute central values and measures of variation.*
4. *Analyze data using probability, hypothesis testing, ANOVA, correlation, and regression.*
5. *Develop skills to write, edit, and evaluate research reports, proposals, and identify ethical research practices.*

UNIT I: RESEARCH CONCEPTS AND DATA COLLECTION (Teaching - 1 h / week)

Definition, Objectives, and Importance of Research. Types of Research: Basic, Applied, Descriptive, Analytical, and Experimental. Research Approaches: Qualitative, Quantitative, and Mixed Methods Characteristics of Good Research. Ethical Considerations in Research. Role of Research in Decision-Making and Policy Formulation. Types of Data: Primary and Secondary. Methods of Data Collection: surveys, interviews, experiments, and observational studies.

UNIT II: DATA PRESENTATION AND MEASURES OF CENTRAL VALUE (Teaching - 1 h / week)

Presentation of data - Bar graphs, pie charts, dot plots, line graphs, scatter plots, pictographs, histograms, frequency distribution, cumulative tables. Central value - Arithmetic Mean, Median, Mode. Variation and Dispersion - Standard Deviation and Standard Error.

UNIT III: PROBABILITY (Teaching - 1 h / week)

Probability – definition. The basic counting principle – Relative frequency. Events and Complement. Event Types – Independent, Dependent, Tree Diagrams, Mutually Exclusive events. Permutations and Combinations – False positives and False Negatives - Bayes Theorem. Confidence Intervals. Distribution – Binomial – Normal.

UNIT IV: TEST OF SIGNIFICANCE (Teaching - 2 hrs / week)

Test of significance - Chi-square test and uses. p value. Student 't'-test and uses. ANOVA – types and uses. Correlation – Definition. Types – positive – negative - NO correlation. Regression analysis – Least square regression.

UNIT V : RESEARCH REPORTS (Teaching - 1 h / week)

Structure and Components of Research Report – Types- (Abstract, Full paper, Short communication and Review article, Thesis writing) – Styles – Drafting – Editing, Evaluation of Good Research Report. Research Papers - Indexing and abstracting, Impact factors, h-index, i10 index. Plagiarism. Research

proposal / Grant- definition, structure, budget allocation, specific aims, background and significance. Funding agencies in India.

Course Outcomes:

At the end of the course the students will be able to:

CO1 *Understand the concept of research and different types of research in the context of biology*

CO2 *Develop skills relevant to data presentation and interpretation.*

CO3 *Comprehend the fundamental concepts of biostatistics.*

CO4 *Develop their competence in hypothesis testing and interpretation.*

CO5 *Analyze the ethical aspects of research*

CO6 *Compile the role of Biostatistics in both conventional and modern plant sciences.*

Text Book:

- Kothari, C. R. (1991). Research Methodology: Methods and Techniques. Wiley Eastern Ltd., New Delhi.
- Misra, R.P, 2000. Research Methodology - A Handbook, Concept Pub. Company, New Delhi.
- Rastogi, V. B. (2006). Fundamentals of Biostatistics. Ane Book India, New Delhi.
- Gupta, S.C, 2013. Fundamentals of statistics, Himalaya Publishers, Mumbai.

References:

- Dawson, C. (2002). Practical research methods. UBS Publishers, New Delhi.
- Sree Ramulu, V. S. (1988). Thesis Writing. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
- Stapleton, P., Yondeowei, A., Mukanyange, J., Houten, H. (1995). Scientific writing for agricultural research scientists – a training reference manual. West Africa Rice Development Association, Hong Kong.

Web Resources:

- https://methods.sagepub.com/
- https://www.khanacademy.org/math/statistics-probability
- https://statistics.laerd.com/
- https://owl.purdue.edu/owl/research_and_citation/resources.html
- https://www.indiascienceandtechnology.gov.in/

CO- PO Mapping (Course Articulation Matrix)

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	9	9	9	9	3	1
CO2	9	9	3	3	3	1
CO3	9	9	3	3	1	1
CO4	3	3	3	3	1	1
CO5	3	3	3	3	1	1
CO6	3	3	1	1	0	0
Weightage	**36**	**36**	**22**	**22**	**9**	**5**
Weighted percentage of Course contribution to POs	27.69	27.69	16.92	16.92	6.92	3.85

Level of Correlation between CO's and PO's: 1 – Low, 3 – Medium, 9 – High, 0 – No Correlation (Suggested by UGC as per Six Sigma Tool – Cause and Effect Matrix)

Course Outcomes mapped with Knowledge level (Revised Bloom's Taxonomy) and POs

CO/ K-Level	Level of Correlation			
	High	**Medium**	**Low**	**Zero**
CO1/ K1	PO1	PO2,PO3, PO6	PO4, PO5	-
CO2/ K2	PO1, PO3	PO2,PO4, PO6	PO5	-
CO3/ K3	PO3	PO1, PO4, PO5, PO6	PO2	-
CO4/ K4	PO1	PO2, PO3, PO4	PO5	PO6
CO5/ K5	PO4	PO1, PO2, PO3, PO5		PO6
CO6/ K6	PO1,PO2	PO6,	PO3, PO4,	PO5

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure:

K Levels	C1	C2	C3	C4	Total scholastic marks	Non Scholastic Marks C5	CIA Total	% of Assessment
	T1 5 Marks	T2 6 Marks	Assignment 4 Marks	Seminar 5 Marks	20 Marks	5 Marks	25 Marks	
K1	0	1			1	-	**1**	4
K2	1	1		1	3	-	**3**	12
K3	1	1	1	1	4	-	**4**	16
K4	1	1	1	1	4	-	**4**	16
K5	1	1	1	1	4	-	**4**	**16**
K6	1	1	1	1	4	-	**4**	**16**
Non Scholastic	--	--	--	--	--	5	**5**	20
Total	**5**	**6**	**4**	**5**	**20**	**5**	**25**	**100%**

***C = Component**

The COs and POs for the **RESEARCH METHODOLOGY** Elective course in the M**.Sc. Botany** Programme is effectively matched by the Course In-charge.

Signature of the Course In- charge

Signature of the Coordinator

Sem.	Programme Code	Course Code	Course Type	Course Title	Category	Hrs. / Week	Credits
IV	BOTPG1986	P25BO17	Core Course	**BIOPROCESS TECHNOLOGY**	Theory	6	5

Course Description:

This course provides an in-depth understanding of bioprocess technology, focusing on the principles, techniques, and applications of microbial fermentation. Students learn about upstream processing, including microbial isolation, strain improvement, and media formulation. It covers the design and functioning of fermentors and bioreactors, modes of operation, and process control. Emphasis is placed on downstream processing, including product recovery, purification, and drying. The course also highlights industrial applications, such as the production of antibiotics, enzymes, organic acids, and biofuels, along with insights into fermentation economics. This course prepares students for careers in industrial microbiology, biotechnology, and applied plant sciences.

Course Objectives:

1. *To understand the history, concepts, and stages of fermentation and upstream processing.*
2. *To gain knowledge on microbial strain selection, improvement, and media formulation for industrial use.*
3. *To study the types, components, and design of fermentors and bioreactors.*
4. *To learn the principles and methods involved in downstream processing and product recovery.*
5. *To explore the microbial production of commercially important products like antibiotics, enzymes, and biofuels.*
6. *To understand the basics of fermentation economics and its role in large-scale bioprocess development.*

UNIT I: UPSTREAM PROCESS (Teaching - 1 hr / week)

Brief history of fermentation. General concepts of respiration and fermentation. Isolation of industrially important microbes – Primary and Secondary metabolites Screening. Strain improvement and slection. Production medium – synthetic – non synthetic or crude – components - media formulation for industrial fermentation. Sterilization of Fermentor / Bioreactor - air and media sterilization. Preservation of industrially important Microorganisms.

UNIT II: FERMENTATION AND FERMENTOR / BIOREACTOR (Teaching - 1 hr / week)

Requirement of Fermentor and Bioreactor`. Standing cultures and shaking flasks. Concepts of basic modes of operation of a Bioreactor. Effect of mode of operation in product synthesis. Fermentation kinetics. Fermentation process control – biosensors – controllers.

UNIT III: BIOREACTOR DESIGN AND OPERATIONS (Teaching - 1 hr / week)

Requirement of Bioreactor types - function, design, components and body construction of Mechanical - Stirred tank bioreactors, submerged, Airlift reactors - Bubble driven, Immobilized Reactors - Packed Bed and Fluidized Bed, Photo- bioreactors. Solid state fermentation.

UNIT IV: DOWNSTREAM PROCESSING (Teaching - 2 hrs. / week)

Objectives and criteria of product recovery - precipitation methods. Filter systems - filtration devices and filter aids. Disintegration of microorganisms. Centrifugation and Ultra filtration. Advanced Chromatography in downstream processing. Extraction – Crystallization and Drying – Yield.

UNIT V: INDUSTRIAL PRODUCTION AND ECONOMICS (Teaching – 1 hr. / week)

Brewing Industry – Beer Production. Ethanol Fermentation. Production of Antibiotics – Tetracycline; Microbial enzymes – Bacterial and Fungal Proteases; Amino Acid - Glutamic Acid; Organic Acid - Lactic Acid. Overview of Biofuel production. Fementation Economics.

Course Outcomes:

At the end of the course the students will be able to:

CO1 *To introduce the principle, importance and components of a fermentation process*

CO2 *To study the basic concepts of bioreactor operations and types.*

CO3 *To understand the techniques involved in product recovery*

CO4 *To study the production strategies of commercial products.*

CO5 *To solve complex bioprocess problems*

CO6 *Create new protocols involved in the production of bioproducts and methods to improve modern biotechnology.*

Text Book:

- Stanbury, P F & Whitaker, A, 1995, Principles of Fermentation Technology, Pergamon.
- Wulf Crueger & Anneliese Cruger, 2004, Biotechnology: A Textbook of Industrial Microbiology, 2nd Edn.,Panima Publishing Co.
- Shuler, M. L and F. Kargi. 2002. *Bioprocess Engineering,* Prentice Hall Inc.
- Doran, P.M. 1995. *Bioprocess Engineering Principles*, Elsevier.
- Kaufman, P.B. L. J. Cseke, S. Warler, J. A. Duke, and H. L. Brielmann. 1999. *Natural Products from Plants*, CRC Press LLC.
- Casia, J.R.L.E. 2009. Industrial Microbiology. New Age International (P) Ltd. Publisher, New Delhi.
- Stanbury, P. F., Whitaker, A. and Hall, S.J. 1979. Principles of Fermentation Technology. Aditya Books (P) Ltd., New Delhi.
- Potter, N. N. 2007. Food Science. CBS Publishers.

References:

- Schuler ML &Fikret Kargi, 2002, Bioprocess Engg: Basic Concepts, PrenticeHall, NJ.
- El-Mansi, E.MT. & C F A Bryce, 2002, Fermentation Microbiology and Biotechnology, Taylor & Francis Co., USA.
- Bailley & Ollis, 1986, Biochemical Engg Fundamentals, McGraw Hill, New York.
- Coulson, J M & Richardson, S F, 1984, Chemical Engg, Pergamon Press.

Web resources:

- https://link.springer.com/book/9783642673627
- https://www.elsevier.com/books/secondary-plant-products/stumpf/978-0-12-675407-0
- https://www.amazon.in/Secondary-Plant-Products-Comprehensive-Biochemistry-ebook/dp/B01E3II0E2
- https://www.pdfdrive.com/principles-of-fermentation-technology-e40900163.html
- https://link.springer.com/book/10.1007/978-3-030-16230-6

CO- PO Mapping (Course Articulation Matrix)

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	9	9	9	9	3	1
CO2	9	9	3	3	3	1
CO3	9	3	3	3	1	1
CO4	3	3	3	3	1	1
CO5	3	3	0	3	1	1
CO6	3	3	1	1	0	0
Weightage	**36**	**30**	**19**	**22**	**9**	**5**
Weighted percentage of Course contribution to POs	29.75	24.79	15.70	18.18	7.44	4.13

Level of Correlation between CO's and PO's } 1 – Low 3 – Medium 9 – High 0 – No Correlation (Suggested by UGC as per Six Sigma Tool – Cause and Effect Matrix)

Course Outcomes mapped with Knowledge level (Revised Bloom's Taxonomy) and POs

CO/ K-Level	Level of Correlation			
	High	**Medium**	**Low**	**Zero**
CO1/ K1	PO1, PO2	PO3, PO4, PO5	PO6	_
CO2/ K2	PO1, PO2	PO3, PO4	PO5, PO6	_
CO3/ K3	PO1, PO2	PO3, PO4,	PO5, PO6	-
CO4/ K4	PO1, PO2	PO3, PO4	PO5, PO6	-
CO5/ K5	PO1, PO2	PO3, PO4	PO5, PO6	-
CO6/ K6	PO1, PO2	PO3, PO4	PO5, PO6	-

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure:

K Levels	C1	C2	C3	C4	Total scholastic marks	Non Scholastic Marks C5	CIA Total	% of Assessment
	T1 5 Marks	**T2 6 Marks**	**Assignment 4 Marks**	**Seminar 5 Marks**	**20 Marks**	**5 Marks**	**25 Marks**	
K1	0	1			1	-	**1**	**4**
K2	1	1		1	3	-	**3**	**12**
K3	1	1	1	1	4	-	**4**	**16**
K4	1	1	1	1	4	-	**4**	**16**
K5	1	1	1	1	4	-	**4**	**16**
K6	1	1	1	1	4	-	**4**	**16**
Non Scholastic	--	--	--	--	--	5	**5**	**20**
Total	**5**	**6**	**4**	**5**	**20**	**5**	**25**	**100%**

***C = Component**

The COs and POs for the **BIOPROCESS TECHNOLOGY** course in the M.Sc. Botany Programme is effectively matched by the Course In-charge.

Signature of the Course In-charge Signature of the Coordinator

Sem.	Programme Code	Course Code	Course Type	Course Title	Category	Hrs. / Week	Credits
IV	BOTPG1986	P25BO18E1	Elective Course	**BIOINFORMATICS**	Theory	6	4

Course Description:

This course introduces the foundational concepts and applications of bioinformatics in modern biological research. It covers key bioinformatics databases for nucleic acids and proteins, sequence alignment techniques, and phylogenetic analysis tools. Students will gain exposure to major biological databases like NCBI, EMBL, and GenBank, and use tools such as BLAST and ClustalW. The course also explores emerging fields in omics technologies and their applications in healthcare, agriculture, and drug discovery, preparing students to navigate the growing role of AI and computational tools in life sciences.

Course Objectives:

1. *Understand the scope, importance, and future of bioinformatics in life sciences.*
2. *Explore major biological databases and tools for DNA and protein sequence retrieval and analysis.*
3. *Perform sequence alignments and construct phylogenetic trees using standard bioinformatics methods.*
4. *Familiarize with OMICS technologies and their integration with computational tools.*
5. *Apply bioinformatics in areas like disease research, microbial genomics, and crop improvement.*

UNIT I: INTRODUCTION TO BIOINFORMATICS (Teaching - 1 h / week)

Bioinformatics - Definition, Use of information technology for studying Biosciences, Emerging areas in Bioinformatics, Future prospects of Bioinformatics. Plant Genome Project – Arabidopsis and Maize, Biological Software, Public Database, GenBank - overview.

UNIT II: NUCLEIC ACID DATABASE (Teaching - 1 h / week)

Databases – definition - Biological Databases - Classification format of Biological Databases, Biological Database Retrieval System. NCBI - EMBL - DDBJ. Tools and Databases of NCBI, Database Retrieval Tool, Basic local alignment search tool (BLAST). Submit sequence data to NCBI.

UNIT III: PROTEIN DATABASE (Teaching - 1 h / week)

Protein database – PDB. Protein Information Resource (PIR) - Resources of PIR, Databases of PIR, Data Retrieval in PIR. Swiss-Prot - Introduction and Salient Features.

UNIT IV: SEQUENCE ALIGNMENT and Phylogeny (Teaching - 2 hrs / week)

Definition of sequence alignment and its importance in bioinformatics. Types of alignments: global, local, pairwise, multiple sequence alignment – Clustal W. Scoring Matrices: Percent Accepted Mutation (PAM) - Blocks of Amino Acid Substitution Matrix (BLOSUM) and gap penalty strategies. Phylogeny and Evolutionary Inference: Concepts of phylogeny, evolutionary relationships, and

phylogenetic trees. Phylogenetic tree construction methods: UPGMA, Neighbor Joining. Software for Phylogenetic Analyses. AI tools in research.

UNIT V: OMICS AND APPLICATIONS OF BIOINFORMATICS (Teaching - 1 h / week)

OMICS Concepts – the fundamentals of various OMICS technologies: genomics, epigenomics, transcriptomics, proteomics, metabolomics, and phenomics. Bioinformatics in disease research, drug discovery / design, Microbial genome applications and Crop improvement. Challenges faced in Bioinformatics.

Course Outcomes:

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

CO1 *Understand the importance and potential of Bioinformatics in biological research*

CO2 *Acquire the knowledge on the concept of databases and use of different public domain for DNA and proteins sequence retrieval*

CO3 *Understand the concept of pairwise alignment of DNA sequences using algorithms.*

CO4 *Distinguish the structure of proteins homology modeling approach using SWISS MODEL and SWISS-PDB.*

CO5 *Compare and contrast between advanced tools available for computational experiments*

CO6 *Solve problems with relevant to plant drug discovery*

Text Books:

- Arthur M. Lesk. (2003). Introduction to Bioinformatics, Oxford University Press, Indian edition.
- Irfan Ali Khan and Attiya Khanum (eds.). (2004). Introductory Bioinformatics. Ukaaz Publications, Hyderabad.
- Rastogi, S.C., Mediratta, N. and Rastogi. P. (2004). Bioinformatics, methods and applications, genomics, proteomics and drug discovery, Prentice hall of India, pvt. Ltd., Delhi.
- Imtiaz Alam Khan. (2005). Elementary bioinformatics. Pharma Book Syndicate, Hyderabad.
- Ignacimuthu S (2006). Basic Bioinformatics. Narosa Publishing House, New Delhi.

References:

- Attwood, T. K. and Parry-Smith, D. J. (2001). Introduction to Bioinformatics Delhi. Pearson Education (Singapore) Ptd. Ltd.
- Baxevanis, A. D. and Ouellettee, B. F. F. (2002). Bioinformatics: A Practical Guide to the analysis of Genes and Proteins. (2nd Ed.), New York, John Wiley & Sons, Inc. Publications.
- Des Higgins and Willie Taylor. (2000). Bioinformatics, Sequence, structure and databanks. A practical approach. Oxford University Press, Indian edition, Second impression, New Delhi.
- Krane Dan, E. and Raymer M.L. (2004). Fundamental concepts of Bioinformatics. Pearson education. New Delhi. Second Indian reprint.

Web resources:

- https://www.ebooks.com/en-us/subjects/computers/
- https://it.careers360.com/download/ebooks
- http://www.aun.edu.eg/molecular_biology/Procedure%20Bioinformatics22.23-4-2015/Xiong%20-%20Essential%20Bioinformatics%20send%20by%20Amira.pdf
- http://www.freebookcentre.net/Biology/BioInformatics-Books.html
- https://courses.cs.ut.ee/MTAT.03.242/2017_fall/uploads/Main/Basics_of_Bioinformatics.pdf

CO- PO Mapping (Course Articulation Matrix)

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	9	9	9	9	3	1
CO2	9	9	9	3	3	1
CO3	9	3	3	3	1	1
CO4	3	3	3	3	1	1
CO5	3	3	3	3	1	1
CO6	3	3	1	1	1	1
Weightage	**36**	**30**	**28**	**22**	**10**	**6**
Weighted percentage of Course contribution to POs	**27.27**	**22.73**	**21.21**	**16.67**	**7.58**	**4.55**

Level of Correlation between CO's and PO's } 1 – Low 3 – Medium 9 – High 0 – No Correlation (Suggested by UGC as per Six Sigma Tool – Cause and Effect Matrix)

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure:

CO/ K-Level	Level of Correlation			
	High	**Medium**	**Low**	**Zero**
CO1/ K1	PO1, PO2, PO3	PO4, PO5	PO6	_
CO2/ K2	PO1, PO2	PO3, PO4	PO5, PO6	_
CO3/ K3	PO1, PO2	PO3, PO4,	PO5, PO6	-
CO4/ K4	PO1, PO2	PO3, PO4	PO5, PO6	-
CO5/ K5	PO1, PO2	PO3, PO4	PO5, PO6	-
CO6/ K6	PO1, PO2	PO3, PO4	PO5, PO6	-

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure:

K Levels	C1	C2	C3	C4	Total scholastic marks	Non Scholastic Marks C5	CIA Total	% of Assessment
	T1 5 Marks	T2 6 Marks	Assignment 4 Marks	Seminar 5 Marks	20 Marks	5 Marks	25 Marks	
K1	0	1			1	-	**1**	4
K2	1	1		1	3	-	**3**	12
K3	1	1	1	1	4	-	**4**	16
K4	1	1	1	1	4	-	**4**	16
K5	1	1	1	1	4	-	**4**	**16**
K6	1	1	1	1	4	-	**4**	**16**
Non Scholastic	--	--	--	--	--	5	**5**	20
Total	**5**	**6**	**4**	**5**	**20**	**5**	**25**	**100%**

***C = Component**

The COs and POs for the **BIOINFORMATICS** course in the M.Sc. Botany Programme is effectively matched by the Course In-charge.

Signature of the Course In-charge Signature of the Coordinator

Sem.	Programme Code	Course Code	Course Type	Course Title	Category	Hrs. / Week	Credits
IV	BOTPG1986	P25BO18E2	Elective Course	**ENTREPRENEURIAL OPPORTUNITIES IN BOTANY**	Theory	6	4

Course Description:

`This elective course introduces students to various entrepreneurial opportunities rooted in botanical knowledge and plant-based technologies. It covers the preparation and use of organic manures and bio-fertilisers, basic plant propagation techniques, and the design and maintenance of different types of gardens. Students also learn about the packaging and preservation of fruits and vegetables, and the production of value-added botanical products such as wine, vinegar, and dairy-based items. Special focus is given to mushroom cultivation and processing, promoting small-scale agribusiness ventures. The course aims to instil practical skills, innovative thinking, and self-reliance through sustainable plant-based entrepreneurship.

Course Objectives:

1. To *understand the preparation, types, and application of organic manures and biofertilisers.*
2. *To learn basic and advanced plant propagation methods for nursery and horticultural use.*
3. *To explore different types of gardens and techniques of ornamental garden design.*
4. *To gain practical knowledge on post-harvest handling, packaging, and preservation of plant produce.*
5. *To learn the techniques and economic potential of mushroom cultivation and value-added products.*
6. *To encourage self-employment and agribusiness opportunities through botanical knowledge and skills.*

Unit I: (Teaching - 1 hr / week)

Organic manures and fertilizers. Composition of fertilizer, NPK content of various fertilizers. Common organic manures bone meal, cow dung, poultry waste, oil cakes, organic mixtures and compost. Preparation of compost, aerobic and anaerobic – advantages. Vermicompost preparation, vermiwash. Panchakaviyam.

Unit II: (Teaching - 1 hr / week)

Common garden tools. Methods of plant propagation by seeds. Vegetative propagation, cutting, grafting, budding and layering. Use of growth regulators for rooting.

Unit III: (Teaching - 2 hrs / week)

Gardening – types of garden, ornamental, indoor garden, kitchen garden, terrace garden, vegetable garden for marketing. Rockery and artificial ponds. Ornamental garden designing, garden components flower beds, borders, hedges, edges, drives, paths, garden adornments.

Unit IV: (Teaching - 1 hr / week)

Packaging of fruits, vegetables. Preservation techniques drying, heat treatment, low temperature storage and by chemicals. Preparation of wine, vinegar and dairy products.

Unit V: (Teaching - 1 hr / week)

Significance of mushrooms. Types of mushrooms (button mushroom, oyster mushroom). Spawn isolation and preparation. Cultivation. Value added products from mushroom – pickles, candies and dried mushrooms.

Course Outcomes:

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

CO1 *Explain the composition of fertilizers, NPK content, and various organic manures, including their preparation and benefits.*

CO2 *Demonstrate the use of common garden tools and methods of plant propagation, including the role of growth regulators.*

CO3 *Classify different types of gardens and ornamental components, applying design principles for effective landscaping.*

CO4 *Analyze packaging and preservation techniques for fruits and vegetables, including storage methods and value-added processing.*

CO5 *Describe the significance, types, and cultivation methods of mushrooms along with their value-added products.*

CO6 *Apply composting, vermicomposting, and bio-fertilizer techniques to enhance soil health and sustainability.*

Textbooks:

- Chmielewski, J.G and Krayesky, D. 2013. General Botany laboratory Manual. AuthorHouse, Bloomington, USA.
- Russell, T. 2012. Nature Guide: Trees: The world in your hands(Nature Guides). Mukherjee D. Gardening in India, Oxford IBH publishing co, New Delhi.
- Kumar, N. 1997. Introduction to Horticulture, Rajalakshmi Publications, Nagercoil.
- Webster, J and Weber, R. 2007. Introduction to Fungi, 3rd Ed. Cambridge UniversityPress, Cambridge.
- Bendre, M. Ashok and Ashok Kumar, A. 2020. Text Book of Practical Botany 1 (10th ed).Rastogi Publications, Meerut.
- Singh, R and U.C. Singh 2020. Modern mushroom cultivation, 3d Edition Agrobios (India), Jodhpur.

Reference Books:

- Adams, C.R. Banford, K.M. and Early, M.P. 1993. Principles of Horticulture.
- Sathe,T.V. 2004. Vermiculture and Organic farming, Daya Publishers.
- Peter, K.V. 2017. Basic Horticulture.
- Hartman, H.T. and D.F. Kestler. 1976. Plant propagation principles and practice. Prentice Hall of India, New Delhi.
- Jules Janick, 1982. Horticulture Science. Surjeet publications, New Delhi.
- Ignacimuthu, S.1998. Plant Biotechnology. Tata Mc Graw Hill Ltd., New Delhi.
- Gupta. P.K.,1998. Elements of Biotechnology. Rastogi publications, Meerut.
- Edmond Musser and Andres, Fundamentals of Horticulture, McGraw Hill Book Co., New Delhi.

Web resources:

- https://www.kobo.com/in/en/ebook/composting-process-organic-manures-through-eco-friendly-waste-management-practices
- https://books.google.co.in/books/about/Plant_Propagation.html?id=K-gQh6OI7GcC&redir_esc=y
- https://www.ebooks.com/en-us/subjects/gardening/
- https://www.amazon.in/Preservation-Techniques-Publishing-Technology-Nutrition-ebook/dp/B00RXCXB3Q
- https://www.elsevier.com/books/food-preservation-techniques/zeuthen/978-1-85573-530-9

CO- PO Mapping (Course Articulation Matrix)

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	9	3	3	3	0
CO2	9	3	3	3	1	1
CO3	9	9	3	3	1	0
CO4	3	3	3	9	1	1
CO5	9	1	3	3	3	1
CO6	3	1	1	0	1	0
Weightage	**42**	**26**	**16**	**21**	**10**	**3**
Weighted percentage of Course contribution to POs	35.59	22.03	13.56	17.80	8.47	2.54

Level of Correlation between CO's and PO's } 1 – Low 3 – Medium 9 – High 0 – No Correlation (Suggested by UGC as per Six Sigma Tool – Cause and Effect Matrix)

Course Outcomes mapped with Knowledge level (Revised Bloom's Taxonomy) and POs

CO/ K-Level	Level of Correlation			
	High	**Medium**	**Low**	**Zero**
CO1/ K1	PO1	PO2, PO3, PO4,	PO5, PO6	_
CO2/ K2	PO1	PO3, PO4	PO5, PO6	_
CO3/ K3	PO1	PO2, PO3, PO4,	PO5	PO6
CO4/ K4	PO1	PO2, PO3, PO4	PO5	PO6
CO5/ K5		PO1, PO2	PO3, PO4	PO5, PO6
CO6/ K6		PO1, PO2	PO3, PO4,	PO5, PO6

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure:

K Levels	C1	C2	C3	C4	Total scholastic marks	Non Scholastic Marks C5	CIA Total	% of Assessment
	T1 **5 Marks**	**T2** **6 Marks**	**Assignment** **4 Marks**	**Seminar** **5 Marks**	**20 Marks**	**5 Marks**	**25 Marks**	
K1	0	1			1	-	**1**	4
K2	1	1		1	3	-	**3**	12
K3	1	1	1	1	4	-	**4**	16
K4	1	1	1	1	4	-	**4**	16
K5	1	1	1	1	4	-	**4**	**16**
K6	1	1	1	1	4	-	**4**	**16**
Non Scholastic	--	--	--	--	--	5	**5**	20
Total	**5**	**6**	**4**	**5**	**20**	**5**	**25**	**100%**

***C = Component**

The COs and POs for the **ENTREPRENEURIAL OPPORTUNITIES IN BOTANY** course in the M.Sc. Botany Programme is effectively matched by the Course In-charge.

Signature of the Course In-charge Signature of the Coordinator

Sem.	Programme Code	Course Code	Course Type	Course Title	Category	Hrs. / Week	Credits
IV	BOTPG1986	P25BO18E3	Elective Course	**INTELLECTUAL PROPERTY RIGHTS AND PATENTING**	Theory	6	4

Course Description:

This course offers a comprehensive overview of Intellectual Property Rights (IPRs) with a focus on their application in biotechnology. It introduces students to various forms of IPR such as patents, copyrights, trademarks, and plant breeders' rights. Students will explore the national and international legal frameworks governing IPR, including the Budapest Treaty, TRIPS, and CBD. The course further examines ethical issues associated with bioprospecting, biodiversity, and traditional knowledge, and covers contemporary challenges related to synthetic biology and patenting biotech inventions. Special attention is given to patent processes, licensing, trade secrets, and regulatory bodies that influence biotech innovation globally.

Course Objectives:

1. *To introduce the fundamentals and types of IPR with a focus on their relevance in the modern technological and biotechnological era.*
2. *To analyze the processes of patenting and trade secret protection, including national and international frameworks.*
3. *To evaluate ethical issues surrounding biodiversity, traditional knowledge, GMOs, and biopiracy through real-world case studies.*
4. *To understand the global and national governance mechanisms related to biodiversity and intellectual property, including key organizations and treaties.*
5. *To explore the complexities of patenting synthetic biology innovations and their impact on the future of biotechnology*

Unit I INTRODUCTION: (Teaching-1 hr/week)

Introduction to IPR – Types of IPR: Patents, Copyrights, Trademarks, Plant Breeder"s rights – Importance of IPRs In Today"s Technological World, Budapest Treaty – Application of IPR in Bio-Inventions.

Unit II PATENTING AND TRADE SECRETS: (Teaching-1 hr/week)

Patenting – Types of Patents – Exclusive Rights and Licencing Inventions vs. Discoveries: International and National Perspectives – Technology – Development – Patent Process and Filing Procedure – PCT route – Patent vs. Trade Secret.

Unit III THE ETHICAL CONCERNS: (Teaching-1 hr/week)

Biodiversity and Traditional Knowledge Protection – Cases: San People, Hoodia Plant, Bt. Cotton in India and GMOs – Decision Making and MNCs.

Unit IV INTERNATIONAL AND NATIONAL GOVERNANCE OF BIODIVERSITY: (Teaching-1 hr/week)

WIPO – IGC – TRIPS – CBD – NBD – SSB – Plant Varieties for Food Agriculture – UPOV – FAO Treaty – * The African Model Law.

Unit V SYNTHETIC BIOLOGY: (Teaching-1 hr/week)

Synthetic Biology, patenting issues with special reference to biotech products and activities.

Course Outcomes:
On the completion of the course the student will be able to

CO1 Deal with several sorts of intellectual property and patent rights.

CO2 Identify various types of patents.

CO3 Understand how to conserve traditional knowledge in biodiversity.

CO4 Make knowledgeable about patent-related actions.

CO5 Solve problems about biotechnological products and processes.

CO6 Analyze various Ethical Concerns in Biodiversity.

Recommended References:

1. May, C. and Sell, S.K. (2005). Intellectual Property Rights: A critical history. Lynne Rienner Publications.
2. Padmanabhan, A. (2012). Intellectual Property Rights-Infringement and Remedies.

Related Online Contents:

- https://www.rienner.com/title/Intellectual_Property_Rights_A_Critical_History
- http://journals.sagepub.com/doi/10.1177/030981680608800103
- World Intellectual Property Organization (WIPO) – IPR and Biotechnology - https://www.wipo.int

CO- PO Mapping (Course Articulation Matrix)

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6
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CO2	9	9	3	9	3	1
CO3	9	3	3	3	1	0
CO4	9	3	1	3	1	1
CO5	3	1	3	3	1	0
CO6	3	1	1	0	3	1
Weightage	**42**	**26**	**14**	**28**	**12**	**3**
Weighted percentage of Course contribution to POs	**33.60**	**20.80**	**11.20**	**22.40**	**9.60**	**2.40**

Level of Correlation between CO's and PO's } 1 – Low 3 – Medium 9 – High 0 – No Correlation (Suggested by UGC as per Six Sigma Tool – Cause and Effect Matrix)

Course Outcomes mapped with Knowledge level (Revised Bloom's Taxonomy) and POs

CO/ K-Level	Level of Correlation			
	High	**Medium**	**Low**	**Zero**
CO1/ K1	PO1, PO2, PO3,	PO4 ,PO5	PO6	-
CO2/ K2	PO1, PO4	PO2, PO5	PO3, PO4,PO6	_
CO3/ K3	PO1, PO2	PO3,PO4 PO5	_	PO6
CO4/ K4	PO2, PO3,	PO1, PO4	PO5, PO6	-
CO5/ K5	PO1,PO3, PO4	PO2, PO5	PO6	_
CO6/ K6	PO2, PO3	PO1	PO4, PO5, PO6	-

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure:

K Levels	C1	C2	C3	C4	Total scholastic marks	Non Scholastic Marks C5	CIA Total	% of Assessment
	T1 5 Marks	T2 6 Marks	Assignment 4 Marks	Seminar 5 Marks	20 Marks	5 Marks	25 Marks	
K1	0	1			1	-	**1**	4
K2	1	1		1	3	-	**3**	12
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K5	1	1	1	1	4	-	**4**	**16**
K6	1	1	1	1	4	-	**4**	**16**
Non Scholastic	--	--	--	--	--	5	**5**	20
Total	**5**	**6**	**4**	**5**	**20**	**5**	**25**	**100%**

***C = Component**

The COs and POs for the **Intellectual Property Rights and Patenting** course in the **M.Sc. Botany** Programme is effectively matched by the Course In-charge.

Signature of the Course In-charge

Signature of the Coordinator

Sem.	Programme Code	Course Code	Course Type	Course Title	Category	Hrs. / Week	Credits
IV	BOTPG1986	P25BOP19	-	**PROJECT WORK**	Project	12	5