Anekant Education Society's

Tuljaram Chaturchand College of Arts, Science & Commerce, Baramati

(Empowered Autonomous)

Three/Four Year Honours/Honours with Research B. Sc. Degree

Program in Botany

(Faculty of Science)

CBCS Syllabus

T. Y. B. Sc. (Botany) Semester - V

For Department of Botany

NEP 1.0

Choice Based Credit System Syllabus (2023 Pattern)

(As Per NEP 2020)

To be implemented from Academic Year 2025-2026

Title of the Programme: T.Y. B. Sc. (Botany)

Preamble

AES's Tuljaram Chaturchand College of Arts, Science and Commerce (Autonomous) has decided to change the syllabus of various faculties from June, 2023 by taking into consideration the guidelines and provisions given in National Education Policy (NEP), 2020. The NEP envisions making education more holistic and effective and to lay emphasis on the integration of general (academic) education, vocational education and experiential learning. The NEP introduces holistic and multidisciplinary education that would help to develop intellectual, scientific, social, physical, emotional, ethical and moral capacities of the students. The NEP 2020 envisages flexible curricular structures and learning based outcome approach for the development of the students. The credit structure and courses framework provided in the NEP are nationally accepted and internationally comparable.

The rapid changes in science and technology and new approaches in different areas of Botany and related subjects, the Board of Studies in Botany at Tuljaram Chaturchand College, Baramati - Pune, has prepare the syllabus of F.Y. B.Sc. Botany Sem. I and II the Choice Based Credit System (CBCS) by following the guidelines of NEP 2020, NCrF, NHEQF, Prof. R.D. Kulkarni's Report, GR of Government of Maharashtra dated 20th April, 16th May 2023 and 13th March 2024 and the Circular of SPPU, Pune dated 31st May 2023 and 2nd May, 2024.

A Botany degree equips students with the knowledge and skills necessary for a diverse range of fulfilling career paths. Graduates in Botany find opportunities in various fields, including urban planning, teaching, environmental science, all plant sciences, organic farming, nursery management, entrepreneurship, mushroom cultivation, medicinal plant, floriculture, horticulture, propagation methods and plant tissue culture method and many other domains. Throughout their three year degree program, students explore the significance of plant in life of each and every living organism on Earth. They learn tool, techniques, process which is required to set up agencies including pickles, jam, and jelly, medicinal plant, fruit processing, vegetable processing, organic product, organic fertilizer and pesticides producing industries also they can earn the knowledge to produce natural remedies for various diseases. They became expert in discovery and development of many new therapeutic compounds which are now used in pharmaceutical herbal cosmetics and other compound based industries.

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

Programme Specific Outcomes (PSOs)

PSO1. Knowledge and understanding of: 1. The range of plant diversity in terms of structure, anatomy, function and environmental relationships. 2. The evaluation of plant diversity. 3. Identification and classification and the flora of Maharashtra. 4. The role of plants in the functioning of the global ecosystem. 5. A selection of more specialized, optional topics. 6. Application of Statistics to solve biological problem.

PSO2. Intellectual skills – able to: 1. Think logically and organize tasks into a structured form. 2. Assimilate knowledge and ideas based on wide reading and through the internet. 3. Transfer of appropriate knowledge and methods from one concept to another within the subject. 4. Understand the evolving state of knowledge in a rapidly developing research field. 5. Construct and test hypothesis. 6. Plan, conduct and write a report on an independent term project.

PSO3. Practical skills: Students learn to carry out practical work, in the field and in the laboratory, with minimal risk. They gain introductory experience in applying each of the following skills and gain greater proficiency in a selection of them depending on their choice of optional modules. 1. Interpreting plant morphology and anatomy. 2. Plant identification. 3. Vegetation study techniques. 4. Analysis of chemical compounds in plant materials in the context of plant physiology and biochemistry. 5. Analyze data using appropriate statistical methods and computational packages. 6. Plant pathology to be added for lab to land farm.

PSO4. Transferable skills: 1. Use of IT (word-processing, use of internet, statistical packages and databases). 2. Communication of scientific ideas in writing and orally. 3. Ability to co-ordinate as part of team. 4. Ability to use library resources. 5. Time

PSO5. Scientific Knowledge: Apply the knowledge of basic plant science, life sciences and fundamental process of plants to study and analyze any plant form.

PSO6. Problem analysis: Identify the taxonomic position of plants, formulate the research literature and analyze PET structure and non-reported plants with substantiated conclusions using first principles and methods of nomenclature and classification in Botany.

PSO7. Design/development of solutions: Design solutions from medicinal plants to solve health problems, disorders and disease of human beings and animals

estimate the phytochemical content of plants which fulfil the specified needs to appropriate consideration for the public and animal health.

PSO8. Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and development of the information to provide scientific conclusions.

PSO9. Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern instruments and equipments for Biochemical estimation, Molecular Biology, Biotechnology, Bioinformatics, Biophysics, Biostatistics, Plant Tissue culture experiments, cellular and physiological activities of plants with an understanding of the application and

PSO10. The Botanist and society: Apply reasoning informed by the contextual knowledge to assess plant diversity, its importance for society, health, safety, legal and environmental issues and the consequent responsibilities relevant to the biodiversity conservation practice.

PSO11. Environment and sustainability: Understand the impact of the plant diversity in societal and environmental contexts, and demonstrate the knowledge of and need for sustainable agricultural and environmental development.

PSO12. Ethics: Apply ethical principles and commit to environmental ethics and responsibilities and norms of the biodiversity conservation.

PSO13. Individual and team work: Function effectively as an individual and as a member or leader in diverse teams and in multidisciplinary task settings.

PSO14. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as being able to comprehend and intertie effective reports and design documentation, make effective presentations and give and receive clear instructions.

PSO15. Project management and finance: Apply knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team to manage projects and in eco-friendly environments.

PSO16. Life-long learning: Identify the necessities and have the preparation and ability to engage in independent and life-long learning in the broadest context of upcoming advanced technology.

Credit Distribution Structure for Three/Four Year Honours/Honours with Research Degree Programme

Level/ Difficulty	Sem	Subject DSC-1	Subject DSC-2	Subject DSC-3	GE/OE	SEC	IKS	AEC	VEC	CC	Total
4.5/100	I	2(T)+2(P)	2(T)+2(P)	2(T)+ 2(P)	2(T)	2 (T/P)	2(T) (Generic)	2(T)	2(T)	--	22
	II	2(T)+2(P)	2(T)+2(P)	2(T)+2(P)	2(P)	2 (T/P)	--	2(T)	2(T)	2(T	22
Exit option: Award of UG Certificate in Major with 44 credits and an additional 4 credits core NSQF course/Internship OR Continue with Major and Minor **Continue option**: Student will select one subject among the (subject 1, subject 2 and subject 3) as major and other as minor and third subject will be dropped.											

Level/ Difficulty	Sem	Credits Related to Major				Minor	--	GE/OE	SEC	IKS	AEC	VEC	CC	Total
		Major Core	Major Elective	VSC	FP/OJT/CEP/RP									
5.0/200	III	4(T)+2(P)	--	2 (T/P)	2(FP)	2(T)+2(P)	--	2(T)	--	2(T)	2(T)	--	2(T)	22
	IV	4(T)+2(P)	--	2 (T/P)	2(CEP)	2(T)+2(P)	--	2(P)	2 (T/P)	--	2(T)	--	2(T)	22
Exit option: Award of UG Diploma in Major and Minor with 88 credits and an additional 4credits core NSQF course/Internship OR Continue with Major and Minor														
5.5/300	V	8(T)+4(P)	2(T)+2(P)	2 (T/P)	2(FP/CEP)	2(T)	--	--	--	--	--	--	--	22
	VI	8(T)+4(P)	2(T)+2(P)	2 (T/P)	4 (OJT)	--	--	--	--	--	--	--	--	22
Total 3Years		**44**	**8**	**8**	**10**	**18**	**8**	**8**	**6**	**4**	**8**	**4**	**6**	**132**
Exit option: Award of **UG Degree in Major** with 132 credits OR Continue with Major and Minor														
6.0/400	VII	6(T)+4(P)	2(T)+2 (T/P)	--	4(RP)	4(RM)(T)	--	--	--	--	--	--	--	22
	VIII	6(T)+4(P)	2(T)+2 (T/P)	--	6(RP)	--	--	--	--	--	--	--	--	22
Total 4Years		**64**	**16**	**8**	**22**	**22**	**8**	8	**6**	**4**	**8**	**4**	**6**	**176**
Four Year **UG Honours with Research Degree** in Major and Minor with 176 credits														
6.0/400	VII	10(T)+4(P)	2(T)+2 (T/P)	--	--	4(RM) (T)	--	--	--	--	--	--	--	22
	VIII	10(T)+4(P)	2(T)+2 (T/P)	--	4 (OJT)	--	--	--	--	--	--	--	--	22
Total 4Years		**72**	**16**	**8**	**14**	**22**	**8**	8	**6**	**4**	**8**	**4**	**6**	**176**
Four Year **UG Honours Degree** in Major and Minor with 176 credits														

T = Theory **P** = Practical **DSC** = Discipline Specific Course **OE** = Open Elective **SEC** = Skill Enhancement Course

IKS = Indian Knowledge System **AEC** = Ability Enhancement Course **VEC** = Value Education Course **CC** = Co-curricular Course

VSC= Vocational Skill Course **OJT**= On Job Training **CEP**= Community Engagement Project **FP**= Field Project **RP**= Research Project

With Multiple Entry and Exit options as per National Education Policy (2024 Pattern as per NEP 2020)

Course Structure for F. Y. B. Sc. Botany Semester I and II (2023 Pattern)

Sem	Course Type	Course Code	Title of Course	Theory/ Practical	No. of Credits
I	Major Mandatory	BOT-101-MJM	Diversity of Cryptogams	Theory	02
	Major Mandatory	BOT-102-MJM	Industrial Botany - I	Theory	02
	Major Mandatory	BOT-103-MJM	Botany Practical - I	Practical	02
	Open Elective (OE)	BOT-116-OE	Horticulture	Theory	02
	Open Elective (OE)	BOT-117-OE	Floriculture	Practical	02
	Vocational Skill Course (VSC)	BOT-121-VSC	Organic Farming	Theory	02
	Skill Enhancement Course (SEC)	BOT-126-SEC	Fruit Processing	Practical	02
	Ability Enhancement Course (AEC)	ENG-131-AEC	Functional English - 1	Theory	02
	Value Education Course (VEC)	BOT-135-VEC	Environmental Science	Theory	02
	Indian Knowledge System (IKS)	BOT-137-IKS	Botany in Ayurveda	Theory	02
	Co- curricular Course (CC)	--	To be selected from the Basket	Theory	02
	Total Credit Semester - I				**22**
II	Major Mandatory	BOT-151-MJM	Diversity of Phanerogams	Theory	02
	Major Mandatory	BOT-152-MJM	Industrial Botany - II	Theory	02
	Major Mandatory	BOT-153-MJM	Botany Practical - II	Practical	02
	Minor	BOT-161-MN	Gardening and Nursery Management	Theory	02
	Open Elective (OE)	BOT-166-OE	Economic Botany	Theory	02
	Open Elective (OE)	BOT-167-OE	Seed Technology	Practical	02
	Vocational Skill Course (VSC)	BOT-171-VSC	Plant Tissue Culture	Practical	02
	Skill Enhancement Course (SEC)	BOT-176-SEC	Mushroom Cultivation	Practical	02
	Ability Enhancement Course (AEC)	ENG-181-AEC	Functional English - 1	Theory	02
	Value Education Course (VEC)	BOT-185-VEC	Digital and Technological Solutions	Theory	02
	Co- curricular Course (CC)	--	To be selected from the Basket	Theory	02
	Total Credit Semester - II				**22**
	Cumulative Credits Semester I + Semester II				**44**

Course Structure for S. Y. B. Sc. Botany Semester III and IV (2023Pattern)

Sem.	Course Type	Course Code	Course Title	Theory/ Practical	Credits
III	Major Mandatory	BOT-201-MJM	Taxonomy of Angiosperms	Theory	02
	Major Mandatory	BOT-202-MJM	Plant Physiology - I	Theory	02
	Major Mandatory	BOT-203-MJM	Plant Biotechnology - I	Theory	02
	Major Mandatory	BOT-204-MJM	Practical - I	Practical	02
	Minor	BOT-241-MN	Floriculture - I	Theory	02
	Minor	BOT-242-MN	Floriculture - I	Practical	02
	Open Elective (OE)	BOT-216-OE	Bio-fertilizers	Theory	02
	Vocational Skill Course (VSC)	BOT-221-VSC	Herbal Cosmetics	Theory	02
	Ability Enhancement Course (AEC)	MAR-231-AEC HIN-231-AEC SAN-231-AEC	-	Theory	02
	Co-curricular Course (CC)	YOG/PES/CUL/NSS/NCC-239-CC	To be selected from the Basket	Theory	02
	Field Project (FP)	BOT-235-FP	-	Practical	02
	Generic IKS Course (IKS)	GEN-245-IKS	-	Theory	02
	Total Credits Semester - III				**24**
IV	Major Mandatory	BOT-251-MJM	Plant Anatomy	Theory	02
	Major Mandatory	BOT-252-MJM	Plant Embryology	Theory	02
	Major Mandatory	BOT-253-MJM	Plant Ecology	Theory	02
	Major Mandatory	BOT-254-MJM	Practical - II	Practical	02
	Minor	BOT-261-MN	Horticulture	Theory	02
	Minor	BOT-262-MN	Horticulture	Practical	02
	Open Elective (OE)	BOT-266-OE	Bio fertilizer	Practical	02
	Skill Enhancement Course (VSC)	BOT-276-SEC	Herbal Cosmetics	Practical	02
	Ability Enhancement Course (AEC)	MAR-281-AEC HIN-281-AEC SAN-281-AEC	-	Theory	02
	Co-curricular Course (CC)	YOG/PES/CUL/NSS/NCC-289-CC	To be selected from the Basket	Theory	02
	Community Engagement Project (CEP)	BOT-285-CEP	-	Practical	02
	Total Credits Semester - IV				**22**
	Cumulative Credits Semester III + Semester IV				**46**

Course Structure for T. Y. B. Sc. Botany Semester V and VI (2023 Pattern)

Sem.	Course Type	Course Code	Course Title	Theory/ Practical	Credits
V	Major Mandatory	BOT-301-MJM	Cryptogamic Botany	Theory	02
	Major Mandatory	BOT-302-MJM	Spermatophyta and Palaeobotany	Theory	02
	Major Mandatory	BOT-303-MJM	Cell Biology	Theory	02
	Major Mandatory	BOT-304-MJM	Molecular Biology	Theory	02
	Major Mandatory	BOT-305-MJM	Botany Practical - I	Practical	02
	Major Elective (MJE)	BOT-306-MJE(A)	Research Methodology	Theory (Any Two)	04
	Major Elective (MJE)	BOT-306-MJE(B)	Biostatistics		
	Major Elective (MJE)	BOT-306-MJE(C)	Plant Embryology		
	Minor	BOT-311-MN	Industrial Botany	Theory	02
	Minor	BOT-312-MN	Practical based on Industrial Botany	Practical	02
	Vocational Skill Course (VSC)	BOT-321-VSC	Practical based on Organic Farming	Practical	02
	Field Project (FP)	BOT-335-FP	Field Project	Practical	02
				Total Credits Semester - V	**22**
VI	Major Mandatory	BOT-351-MJM	Plant Physiology	Theory	02
	Major Mandatory	BOT-352-MJM	Plant Biotechnology	Theory	02
	Major Mandatory	BOT-353-MJM	Plant Genetics	Theory	02
	Major Mandatory	BOT-354-MJM	Plant Pathology	Theory	02
	Major Mandatory	BOT-355-MJM	Botany Practical - II	Practical	02
	Major Elective (MJE)	BOT-356-MJE(A)	Botanical Techniques	Theory (Any Two)	04
	Major Elective (MJE)	BOT-356-MJE(B)	Plant Breeding		
	Major Elective (MJE)	BOT-356-MJE(C)	Medicinal Botany		
	Minor	BOT-361-MN	Pharmacognosy	Theory	02
	Minor	BOT-362-MN	Practical based on Pharmacognosy	Practical	02
	On Job Training (OJT)	BOT-385-OJT	On Job Training	Practical	04
				Total Credits Semester - VI	**22**
				Total Credits Semester V + VI	**44**

Name of the Programme	**:**	**B.Sc. Botany**
Program Code	**:**	**USBT**
Class	**:**	**T. Y. B. Sc.**
Semester	**:**	**V**
Course Type	**:**	**Major Mandatory (Theory)**
Course Code	**:**	**BOT-301-MJM**
Course Title	**:**	**Cryptogamic Botany**
No. of Credits	**:**	**02**
No. of Teaching Hours	**:**	**30**

A) Learning Objectives:

1. To understand occurrence, thallus structure and reproduction with reference to algae, fungi, bryophytes and pteridophytes.
2. To give knowledge of various classification system of cryptogams.
3. To understand the morphology, anatomy and mode of nutrition in cryptogams.
4. To give knowledge of detail life cycle of cryptogams.
5. To give knowledge about economic importance of cryptogams.
6. To know the agricultural, ecological, medicinal and horticultural significance of cryptogams.
7. To impart the basic skills in the conservation diversity of cryptogams.

B) Course Outcome:

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

CO1. Identify habitat and habit of cryptogams.
CO2. Classify the algae, fungi, bryophytes and pteridophytes.
CO3. Understand external, internal structure and mode of nutrition in cryptogams
CO4. Understand life cycle of cryptogams.
CO5. Use the knowledge of industrially applications of cryptogams.
CO6 Apply the knowledge agricultural, ecological, medicinal and horticultural significance of cryptogams.
CO7. Explore basic skills in the conservation diversity of cryptogams.

Credit - I : Algae and Fungi **(15L)**
Unit – 1

Algae:

1.1 General characters, classification (Chapman and Chapman, 1973) up to classes and economic importance. **2L**

1.2 Study of following life cycle pattern of algae with reference to taxonomic position, occurrence, thallus structure, reproduction and alternation of generation : **5L**

a) *Oscillatora*
b) *Batrachospermum*
c) *Volvox*
d) *Voucheria*
e) *Sargassum*

Fungi:

1.3 General characters, classification up to classes (Ainsworth, 1973) and economic importance. **2L**

1.4 Study of following life cycle pattern of fungi with reference to taxonomic position, occurrence, thallus structure, reproduction and alternation of generation : **6L**

a) *Stemonitis*
b) *Pythium*
c) *Mucor*
d) Yeast
e) *Puccinia*
f) *Cercospora*

Credit – II : Bryophytes and Pteridophytes (15L)

Unit – 2 : Bryophytes

2.1 General characters, classification up to classes (G.M. Smith, 1955) and economic importance. **2L**

2.2. Study of following life cycle pattern of bryophytes wrt. taxonomic position, occurrence, thallus structure (morphology and anatomy), reproduction, sporophyte structure and alternation of generation : **6L**

a) *Marchantia*
b) *Anthoceros*
c) *Polytrichum*

Unit – 3: Pteridophytes

3.1 General characters, classification up to classes (K. R. Sporne, 1975) and economic importance **2L**

3.2 Study of following life cycle pattern of pteridophytes wrt. Taxonomic position, occurrence, morphology, anatomy, reproduction, gametophyte, sporophyte structure and alternation of generation : **5L**

a) *Psilotum*
b) *Selaginella*
c) *Equisetum*

Reference Books:

Algae:

1. Brodie J. and Lewis J. (2007). (Ed.) Unravelling the algae: the past, present and future of algal systematics. CRC press, New York, pp 335.
2. Bellinger E.G. and Sigee D. C. (2010). Freshwater algae: Identification and use as bioindicators, Willey-Blackwell, UK, pp. 271.
3. Cole K. M. and Sheath R. G. (1990). Biology of the red algae. Cambridge University Press. USA. pp. 503.
4. Desikachary T. V. (1959). Cyanophyta. ICAR, New Delhi.
5. Graham L. E. and Wilcox L. W. (2000). Algae. Penticce-Hall, Inc, pp. 640
6. Krishnamurthy V. (2000). Algae of India and neighboring countries I. Chlorophycota, Oxford & IBH, New Delhi.
7. Lee R. E. (2008). Phycology. Cambridge University Press, pp. 547.
8. Misra J. N. (1996). Phaeophyceae in India. ICAR, New Delhi.
9. Prescott G. W. (1969). The algae.
10. Smith G. M. (1950). The fresh water algae of the United States, Mc-graw Hill NewYork. 11. Srinivasan K.S. (1969). Phycologia India.Vol.I & II, BSI, Calcutta.
11. Das Dutta and Gangulee.College Botany Vol I, Central Book Depot.

12. Vashista B. R, Sinha A. K and Singh V. P. (2005). Botany for degree students – Algae, S. Chand Publication.
13. Sharma O.P. Algae.

Fungi:

1. Ainsworth, Sussman and Sparrow (1973). The fungi. Vol IV A & IV B. Academic Press.
2. Alexopolous C. J., Minms C. W. and Blackwell M. (1999). (4th edn) Introductory Mycology. Willey, New York, Alford
3. R. A. Deacon J. W. (2006). Fungal Biology (4thEd.) Blackwell Publishing, ISBN. 1405130660.
4. Kendrick B. (1994). The fifth kingdom (paperback), North America, New York Publisher: 3rd edn, ISBN- 10: 1585100226.
5. Kirk *et al.*, (2001). Dictionary of fungi, 9th edn, Wallingford: CABI, ISBN: 085199377X.
6. Mehrotra R. S. and Aneja K. R. (1990). An introduction to mycology. New Age Publishers, ISBN 8122400892.
7. Miguel U., Richard H., and Samuel A. (2000). Illustrated dictionary of the Mycology. Elvira Aguirre Acosta, Publisher: St. Paul, Minn: APS press, ISBN 0890542570.
8. Webster J. and Ropland W. (2007). Introduction to fungi (3rd Edn.) Cambridge University Press, 978-0-521-80739-5.

Bryophytes:

1. Cavers F. (1976). The interrelationships of the Bryophytes. S. R. Technic, Ashok Rajpath, Patana.
2. Chopra R. N. and Kumar P. K. (1988). Biology of Bryophytes. John Wiley & Sons, New York, NY.
3. Kashyap S. R. (1929). Liverworts of the Western Himalayas and the Punjab Plain. Part 1, Chronica Botanica, New Delhi.
4. Kashyap S. R. (1932). Liverworts of the Western Himalayas and the Punjab Plain (illustrated): Part 2. Chronica Botanica, New Delhi.
5. Parihar N. S. (1980). Bryophytes: An Introduction to Embryophyta. Vol. I. Central Book Depot, Allahabad.
6. Prem Puri (1981). Bryophytes: Morphology, Growth and Differentiation. Atma Ram and Sons, New Delhi.
7. Udar R. (1975). Bryology in India. Chronica Botanica, New Delhi.
8. Udar R. (1970). Introduction to Bryophytes. Shashidhar Malaviya Prakashan. Lucknow.
9. Watson E. V. (1971). Structure and Life of Bryophytes. 3rd Edn. Hutchinson University Library, London.
10. Vashista B. R., Sinha A. K., Kumar A. (2008). Botany for degree students – Bryophyta, S. Chand Publication.

Pteridophytes:

1. Rashid A (1999) an introduction to Pteridophyta. Vikas Publishing house Pvt. Ltd. New Delhi.
2. Sharma O. P. (1990) textbook of Pteridophyte. Mac Millan India Ltd. Delhi.
3. Smith G. M. (1955) Cryptogamic Botany Vol. II Mac Grew Hill.

4. Sporne K. R. (1986) the morphology of Pteridophytes. Hutchinson University Press. London.
5. Sundara Rajan S. (1999) Introduction to Pteridophyta. New Age International Publishers, New Delhi.
6. Surange K. R. (1966) Indian fossil Pteridophytes. Council of Scientific and Industrial Research.
7. Parihar, N. S. (1976) Biology and morphology of the Pteridophytes. Central Book Depot.
8. Trivedi, A. N. (2002) Advances in Pteridology.
9. Bierhorst, D.W. (1971) Morphology of Vascular plants.
10. Eames A. J. and E. M. Giffard (1950) - Comparative morphology of vascular plants.
11. Rashid A. (1978) - An introduction of Pteridophytes.
12. Sporne, K. R. (1966) - Morphology of Pteridophytes.
13. Bower, F. O. (1963) - The Ferns.
14. Jermy, A. G. (1973) - The Phylogeny and Classification of ferns.
15. Vashishta, B.R. (1996) - Botany for degree students – Pteridophytes.
16. Parihar, N.S. (1959) - An Introduction to Pteridophyta.

Mapping of Program Outcomes with Course Outcomes

Class: T.Y. B. Sc. (Sem. V) **Subject**: Botany
Course: Cryptogamic Botany **Course Code**: BOT-301-MJM
Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation

	Programme Outcomes (POs)												
Course Outcomes	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13
CO 1	-			3					1	3	3	3	3
CO 2	3			-					1				
CO 3	3			-					1				
CO 4	-	2		3					1	3			
CO 5	-			3					1	3			
CO 6	-			3	2			2	1	2			
CO 7	-			3		2		2	1	3			

Justification for the mapping

PO1. Comprehensive Knowledge and Understanding
CO2. Classify the algae, fungi, bryophytes and pteridophytes.
CO3. Understand external, internal structure and mode of nutrition in cryptogams
PO2. Practical, Professional, and Procedural Knowledge
CO4. Understand life cycle of cryptogams.
PO3. Entrepreneurial Mind-set and Knowledge
P04. Specialized Skills and Competencies
CO1. Identify habitat and habit of cryptogams.
CO4. Understand life cycle of cryptogams.
CO5. Use the knowledge of industrially applications of cryptogams.

CO6. Apply the knowledge agricultural, ecological, medicinal and horticultural significance of cryptogams.
CO7. Explore basic skills in the conservation diversity of cryptogams.
PO5. Capacity for Application, Problem-Solving, and Analytical Reasoning

CO6. Apply the knowledge agricultural, ecological, medicinal and horticultural significance of cryptogams.
PO6 Personal and professional competence.
CO7. Explore basic skills in the conservation diversity of cryptogams.
PO7. Research-related Skills
PO8 Environment and Sustainability
CO5. Use the knowledge of industrially applications of cryptogams.
CO6. Apply the knowledge agricultural, ecological, medicinal and horticultural significance of cryptogams.
PO9 Self-directed and Life-long learning.
CO1. Identify habitat and habit of cryptogams.
CO2. Classify the algae, fungi, bryophytes and pteridophytes.
CO3. Understand external, internal structure and mode of nutrition in cryptogams
CO4. Understand life cycle of cryptogams.
CO5. Use the knowledge of industrially applications of cryptogams.
CO6. Apply the knowledge agricultural, ecological, medicinal and horticultural significance of cryptogams.
CO7. Explore basic skills in the conservation diversity of cryptogams.
PO10 Multicultural Competence, Inclusive Spirit, and Empathy CO2. Classify the algae, fungi, bryophytes and pteridophytes.
CO3. Understand external, internal structure and mode of nutrition in cryptogams
CO4. Understand life cycle of cryptogams.
PO11. Value Inculcation and Environmental Awareness
CO5. Use the knowledge of industrially applications of cryptogams.
CO6. Apply the knowledge agricultural, ecological, medicinal and horticultural significance of cryptogams.
PO12 Autonomy, Responsibility, and Accountability
CO5. Use the knowledge of industrially applications of cryptogams.
CO6. Apply the knowledge agricultural, ecological, medicinal and horticultural significance of cryptogams.
PO13. Community Engagement and Service
CO5. Use the knowledge of industrially applications of cryptogams.
CO6. Apply the knowledge agricultural, ecological, medicinal and horticultural significance of cryptogams.

Name of the Programme : B.Sc. Botany
Program Code : USBT
Class : T. Y. B. Sc.
Semester : V
Course Type : Major Mandatory (Theory)
Course Code : BOT-302-MJM
Course Title : Spermatophyta and Palaeobotany
No. of Credits : 02
No. of Teaching Hours : 30

A) Learning Objectives:

1. To learn plant families and classification systems of seed plants.
2. To learn different theories of origin of Angiosperms.
3. To learn the evolutionary history of seed plants and their role in shaping past terrestrial ecosystems.
4. To understand the morphology and anatomy of fossilized seed plants.
5. To know the evolutionary adaptations.
6. To evaluate research literature in spermatophyte evolution and Palaeobotany.
7. To learn use of flora, use of computer and preparation of plant identification keys for plant identification.

B) Course Outcomes:

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

CO1. Know the different families and classification systems of plants.
CO2. Understand the origin of Angiosperms.
CO3. Understand the history of gymnosperms and angiosperms evolution.
CO4. Know the morphological and anatomical differences in structures of plants.
CO5. Draw evolutionary tree by fossil knowledge.
CO6. Know the fossil specimens and recent research trends of fossils.
CO7. Know local flora, digitization in plant identification and also key preparation for plant identification.

Credit - I

Unit-I: Gymnosperms and Angiosperms (15L)

1.1. Introduction, general characters, economic importance of Gymnosperms. **2L**

1.2 Study of life cycle of *Gnetum* with reference to distribution, morphology, anatomy, reproduction, gametophyte, sporophyte, seed structure and life cycle. **3L**

1.3 Origin of angiosperms: Origin with reference to time, place and ancestry- Pteridosperms theory, Bennettitalean theory and Gnetalean theory. **2L**

1.4 Study of following families according to Bentham and Hooker's System: With reference to systematic position, distinguishing characters, economic importance, general floral formula, floral diagram of following families (any one plant of each family): Magnoliaceae, Asteraceae, Acanthaceae, Lamiaceae, Nyctaginaceae, Orchidaceae and Poaceae. **6L**

1.5 Plant identification and QR (Quick Response): Use of flora, Preparation of artificial keys, practicing Indented and bracketed keys, Plant authentication QR Code. **2L**

Credit II

Unit-II: Palaeobotany **(15L)**

2.1 Geological time scale. **1L**

2.2 Fossil- Definition, process of fossil formation, types of fossils -Impression, Compression, Petrifaction, Coal ball. **4L**

2.3 Study of following fossil groups. **10L**

a. Psilopsida - Salient features of order Psilophytales, external and internal structure of *Rhynia*.
b. Lycopsida - Salient features of order Lepidodendrales, external and internal structure of *Lepidodendron.*
c. Sphenopsida - Salient features of Calamitales, external and internal structure of *Calamites.*

d) Pentoxylae - Salient feature, external and internal structure of stem [*Pentoxylon*].

References:

1. Sporne K. R. 1991. The Morphology of Pteridophytes. B. I. Publishing Pvt. Ltd. Bombay.
2. Stewart W. N. and Rathwell G. W. 1993. 'Paleobotany and the Evolution of plants'. *Cambridge University Press*.
3. Bhatnagar S. P. and Moitra Alok 1996. 'Gymnosperms'. New Age International Pvt. Ltd. Publishers, New Delhi, 470 pp.
4. Biswas C. and Johari B. M. 2004. 'The Gymnosperms'. *Narosa Publishing House*, New Delhi.
5. Sporne K. R. 1965. 'The Morphology of Gymnosperms' London, pp. 216.
6. Chamberlain C. J. 1934. 'Gymnosperms-Structure and Evolution', Chicago.
7. Coulter J. M. and Chamberlain C. J. 1917. 'Morphology of Gymnosperms', Chicago.
8. Foster A. S. and Gifford E. M. 1959. 'Comparative Morphology of Vascular Plants'.
9. Vashishta P. C., A. R. Sinha, Anil Kumar. 2006. 'Gymnosperms'. S. Chand.
10. Vashishta P. C. 2006. 'Pteridophytes'. S. Chand.
11. Parihar N. S. 1996. 'Biology and Morphology of Pteridophytes'. Central Book Depot, Allahabad.
12. Arnold C. R.-An Introduction to Palaeobotany.
13. E. H. N. Andrews-Studies in Palaeobotany (Botany for Degree Students Vol.-V)
14. Shukla A. C. and Mishra S. P.- 'Essentials of Palaeobotany'.
15. Stewart W. N. and Rathwell G. W. 1993. 'Paleobotany and the Evolution of plants'. *Cambridge University Press*.
16. Davis P. H. and Heywood 1963. 'Principles of Angiosperm Taxonomy'. *Oliver and Boyd* London.
17. Heywood V. H. 1967. 'Plant Taxonomy', London.

Mapping of Program Outcomes with Course Outcomes

Class: T. Y. B.Sc. (Sem. V) **Subject** : Botany

Course: Spermatophyta and Palaeobotany **Course Code** : **BOT-302-MJM**

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

	Programme Outcomes (POs)												
Course Outcomes	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13
CO 1	2								1	3	3	3	3
CO 2					3				2	2			
CO 3				3					2				
CO 4						2						2	2
CO 5		2									2		
CO 6			2	3						2			
CO 7							3						

Justification for the mapping

PO1 Disciplinary Knowledge
CO1 Know the different families and classification systems of plants.
PO2 Critical Thinking and Problem solving
CO5 Draw evolutionary tree by fossil knowledge.
PO3 Social competence
CO6 Know the fossil specimens and recent research trends of fossils.
PO4 Research-related skills and Scientific temper.
CO3 Understand the history of gymnosperms and angiosperms evolution.
CO6 Know the fossil specimens and recent research trends of fossils.
PO5 Trans-disciplinary knowledge.
CO2 Understand the origin of Angiosperms.
PO6 Personal and professional competence.
CO4 Know the morphological and anatomical differences in structures of plants.
PO7 Effective Citizenship and Ethics.
CO7 Know local flora, digitization in plant identification and also key preparation for plant identification.
P08. Learning How to Learn Skills
CO1. Know the different families and classification systems of plants.
CO2. Understand the origin of Angiosperms.
CO3. Understand the history of gymnosperms and angiosperms evolution.
CO4. Know the morphological and anatomical differences in structures of plants.
CO5. Draw evolutionary tree by fossil knowledge.
CO6. Know the fossil specimens and recent research trends of fossils.
CO7. Know local flora, digitization in plant identification and also key preparation for plant identification.
PO10 Multicultural Competence, Inclusive Spirit, and Empathy
CO1. Know the different families and classification systems of plants.
CO2. Understand the origin of Angiosperms.
PO11. Value Inculcation and Environmental Awareness
CO2. Understand the origin of Angiosperms.
CO3. Understand the history of gymnosperms and angiosperms evolution.
PO12 Autonomy, Responsibility, and Accountability
CO2. Understand the origin of Angiosperms.
CO3. Understand the history of gymnosperms and angiosperms evolution.
PO13. Community Engagement and Service
CO2. Understand the origin of Angiosperms.
CO3. Understand the history of gymnosperms and angiosperms evolution.

Name of the Programme : B.Sc. Botany
Program Code : USBT
Class : T. Y. B. Sc.
Semester : V
Course Type : Major Mandatory (Theory)
Course Code : BOT-303-MJM
Course Title : Cell Biology
No. of Credits : 02
No. of Teaching Hours : 30

A) Learning Objectives:

1. To acquaint students with scope of cell biology.
2. To give knowledge of chemical organization of cell.
3. To acquaint students with structure of cell.
4. To give knowledge of structure and composition of cell organelles.
5. To give knowledge of structure and composition of nucleus.
6. To give knowledge of structure of chromosome.
7. Acquaint students with different cytological techniques.

B) Learning Outcome:

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

CO1. Familiar with scope of cell biology.
CO2. Know chemical organization of cell.
CO3. Learn structure of cell.
CO4. Know structure and composition of cell organelles.
CO5. Know structure and composition of nucleus.
CO6. Know structure of chromosome.
CO7. Familiar with different cytological techniques.

Credit - I (15L)
Unit - I
1.1 Cell Biology: An Introduction 6L

1. Definition and brief history.
2. Units of measurement of cell.
3. Prokaryotic and Eukaryotic Cell.
4. Physical nature of cytoplasmic matrix.
5. Chemical organization- organic and inorganic compounds of cytoplasmic Matrix.

1.2 Plant Cell - Nucleus and Chromosomes 9L

Nucleus - Morphology, Ultrastructure, Nucleoplasm, Nucleolus, Functions
Chromosome - Morphology and structure, Karyotype and ideogram.

Credit - II (15L)
Unit - II
2.1 Plant Cell - Cytoplasmic Constituents 15L

Morphology, Ultrastructure, Chemical composition and Functions of Cell wall, Plasma membrane, Endoplasmic Reticulum, Golgi apparatus, Mitochondria, Chloroplast, Lysosome, Vacuoles, Ribosomes, Peroxisomes and Glyoxysomes.

References:

1. Molecular Biology of the cell– Bruce Alberts – J.D. Watson et al Garland publishing Inc., N.Y., 4th edition (2002) and recent edition.

2. Cell and Molecular Biology – De Robertis and Saunders, 8th edition (2017).

3. The cell – C.P. Swanson, Prentice Hall (1989)

4. Cell Biology – C.J. Avers, Addision Wesley Co. (1986).

5. Molecular biology by Lodish and Baltimore, 4th edition (2000). Cell Structure and Function by Loewy and Gallant.

6. Genes X, 10th edition (2009), Benjamin Lewin, Publisher - Jones and Barlett Publishers Inc. USA

7. Molecular Biology of the Gene, 6th Edition (2008), James D. Watson, Tania Baker, Stephen P. Bell, Alexander Gann, Michael Levine, Richard Lodwick, Pearson Education, Inc. and Dorling Kindersley Publishing, Inc. USA

8. Molecular Biology, 5th Edition (2011), Weaver R., Publisher-McGrew Hill Science. USA

9. Fundamentals of Molecular Biology, (2009), Pal J.K. and Saroj Ghaskadbi, Oxford University Press. India

Mapping of Program Outcomes with Course Outcomes

Class: T.Y.B. Sc. (Sem. V) **Subject** : Botany

Course: Cell Biology **Course Code : BOT-303-MJM**

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

	Programme Outcomes (POs)												
Course Outcomes	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13
CO 1	3	3					3			3	3	3	3
CO 2	3	2					2			2			
CO 3	3	3											
CO 4	3	3					3			3			
CO 5	3	2		3			3			3			
CO 6	3	3		2			2			2			
CO 7	3	2	3	3	3		3	3		3			

Justification for the mapping

PO1. Comprehensive Knowledge and Understanding

CO1. Familiar with scope of cell biology.
CO2. Know chemical organization of cell.
CO3. Learn structure of cell.
CO4. Know structure and composition of cell organelles.
CO5. Know structure and composition of nucleus.
CO6. Know structure of chromosome.
CO7. Familiar with different cytological techniques.

PO2. Practical, Professional, and Procedural Knowledge
CO1. Familiar with scope of cell biology.
CO2. Know chemical organization of cell.
CO3. Learn structure of cell.
CO4. Know structure and composition of cell organelles.
CO5. Know structure and composition of nucleus.
CO6. Know structure of chromosome.
CO7. Familiar with different cytological techniques.
PO3. Entrepreneurial Mind-set and Knowledge
CO7. Familiar with different cytological techniques.
P04. Specialized Skills and Competencies
CO5. Know structure and composition of nucleus.
CO6. Know structure of chromosome.
CO7. Familiar with different cytological techniques.
PO5. Capacity for Application, Problem-Solving, and Analytical Reasoning
CO7. Familiar with different cytological techniques.
PO7. Research-related Skills
CO2. Know chemical organization of cell.
CO3. Learn structure of cell.
CO4. Know structure and composition of cell organelles.
CO5. Know structure and composition of nucleus.
CO6. Know structure of chromosome.
CO7. Familiar with different cytological techniques.
P08. Learning How to Learn Skills
CO7. Familiar with different cytological techniques.
PO10 Multicultural Competence, Inclusive Spirit, and Empathy
CO1. Familiar with scope of cell biology.
CO2. Know chemical organization of cell.
CO3. Learn structure of cell.
CO4. Know structure and composition of cell organelles.
CO5. Know structure and composition of nucleus.
CO6. Know structure of chromosome.
CO7. Familiar with different cytological techniques.
PO11. Value Inculcation and Environmental Awareness
CO1. Familiar with scope of cell biology.
PO12 Autonomy, Responsibility, and Accountability
CO1. Familiar with scope of cell biology.
PO13. Community Engagement and Service
CO1. Familiar with scope of cell biology.

Name of the Programme : B.Sc. Botany
Program Code : USBT
Class : T. Y. B. Sc.
Semester : V
Course Type : Major Mandatory (Theory)
Course Code : BOT-304-MJM
Course Title : Molecular Biology
No. of Credits : 02
No. of Teaching Hours : 30

A) Learning Objectives:

1. Introduce the fundamental concepts of molecular biology, including its history, scope and importance.
2. Explain the nature of genetic material and the experimental evidence proving DNA and RNA as genetic material.
3. Elucidate the mechanisms of DNA replication and experimental proof of semi-conservative replication.
4. Provide knowledge about DNA damage, types of mutations, and DNA repair mechanisms.
5. Discuss gene organization, including promoters, terminators, enhancers, and split gene and explain transcription, including RNA types, transcription machinery, and transcription process in prokaryotes.
6. Describe the mechanism of translation, including initiation, elongation and termination steps.
7. Introduce gene action and regulation through models like the Lac Operon and Britten and Davidson's model.

B) Learning Outcome:

By completing this course students will be able

CO1. To understand the fundamental concepts of molecular biology, including its history, scope and importance.
CO2. To explain the nature of genetic material and the experimental evidence proving DNA and RNA as genetic material.
CO3. To elucidate the mechanisms of DNA replication and experimental proof of semi-conservative replication.
CO4. To understand about DNA damage, types of mutations, and DNA repair mechanisms.
CO5. To discuss gene organization, including promoters, terminators, enhancers, and split gene and explain transcription, including RNA types, transcription machinery, and transcription process in prokaryotes.
CO6. To describe the mechanism of translation, including initiation, elongation, and termination steps.
CO7. Get knowledge about gene action and regulation through models like the Lac Operon and Britten and Davidson's model.

Credit I

Unit – I **(15 L)**

1.1 Molecular Biology – Introduction **(3L)**

Definition, History, Scope and Importance of Molecular Biology, Central Dogma of molecular Biology.

1.2 Nature of Genetic Material **(4L)**

Characteristics of genetic material, Watson and Cricks Model of DNA, Forms of DNA - A, B and Z, C -Value Parodox, RNA as genetic material –TMV

1.3 DNA Replication **(4L)**

Introduction and types, Messelson and Stahl's Experiment of semi-conservative DNA replication.

1.4 DNA Damage and Repair **(4L)**

Introduction, Causes and types, DNA repair system – Photoreactivation , Dark excision repair and Mismatch repair .

Credit II

Unit- II **(15 L)**

2.1 Gene Organization **(3L)**

Promoter-structure and function in prokaryotes, Terminators, Units of Gene, Enhancers, Split genes, jumping genes.

2.2 Transcription **(5L)**

Definition, Structure and role of m-RNA, r-RNA, t-RNA, Transcription apparatus, Mechanism of Transcription in Prokaryotes.

2.3 Genetic Code and Translation **(7L)**

Genetic Code - Definition, Concept , Properties of Genetic code

Translation - Definition, Mechanism of translation - Initiation, Elongation and Termination

References :

1. Molecular Biology of the cell– Bruce Alberts – J.D. Watson et al Garland publishing Inc., N.Y., 4th edition (2002) and recent edition.

2. Cell and Molecular Biology – DeRobertis and Saunders, 8th edition (2017).

3. The cell – C.P. Swanson, Prentice Hall (1989)

4. Cell Biology – C.J. Avers, Addision Wesley Co. (1986).

5. Molecular biology by Lodish and Baltimore, 4th edition (2000). Cell Structure and Function by Loewy and Gallant.

6.Genes X, 10th edition (2009), Benjamin Lewin, Publisher - Jones and Barlett Publishers Inc. USA

7. Molecular Biology of the Gene, 6th Edition (2008), James D. Watson, Tania Baker, Stephen P. Bell, Alexander Gann, Michael Levine, Richard Lodwick, Pearson Education, Inc. and Dorling Kindersley Publishing, Inc. USA

8. Molecular Biology, 5th Edition (2011), Weaver R., Publisher-McGrew Hill Science. USA

9. Fundamentals of Molecular Biology, (2009), Pal J.K. and Saroj Ghaskadbi, Oxford University Press. India

Mapping of Program Outcomes with Course Outcomes

Class: T.Y.B. Sc. (Sem. V) **Subject**: Botany

Course: Molecular Biology **Course Code**: BOT-304-MJM

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

	Programme Outcomes (POs)												
Course Outcomes	PO1	PO2	PO 3	PO 4	PO 5	PO 6	PO7	PO8	PO9	PO10	PO11	PO12	PO13
CO 1	3												
CO 2	3						3						
CO 3	3			3	3		3						
CO 4	3			3	3		3				3		
CO 5	3			3	3		3	3					
CO 6	3			3	3			3					
CO 7				3	3			3					

Justification for the mapping

PO1: Comprehensive Knowledge and Understanding

CO1. To understand the fundamental concepts of molecular biology, including its history, scope and importance.

CO2. To explain the nature of genetic material and the experimental evidence proving DNA and RNA as genetic material.

CO3. To elucidate the mechanisms of DNA replication and experimental proof of semi-conservative replication.

CO4. To understand about DNA damage, types of mutations, and DNA repair mechanisms.

CO5. To discuss gene organization, including promoters, terminators, enhancers, and split gene and explain transcription, including RNA types, transcription machinery, and transcription process in prokaryotes.

CO6. To describe the mechanism of translation, including initiation, elongation, and termination steps.

PO4:Specialized Skills and Competencies

CO3. To elucidate the mechanisms of DNA replication and experimental proof of semi-conservative replication.

CO4. To understand about DNA damage, types of mutations, and DNA repair mechanisms.

CO5. To discuss gene organization, including promoters, terminators, enhancers, and

split gene and explain transcription, including RNA types, transcription machinery, and transcription process in prokaryotes.
CO6. To describe the mechanism of translation, including initiation, elongation, and termination steps.
CO7. Get knowledge about gene action and regulation through models like the Lac Operon and Britten and Davidson's model.

PO7:Research-related Skills
CO2. To explain the nature of genetic material and the experimental evidence proving DNA and RNA as genetic material.
CO3. To elucidate the mechanisms of DNA replication and experimental proof of semi-conservative replication.
CO4. To understand about DNA damage, types of mutations, and DNA repair mechanisms.
CO5. To discuss gene organization, including promoters, terminators, enhancers, and split gene and explain transcription, including RNA types, transcription.

O8:Learning How to Learn Skills
CO5. To discuss gene organization, including promoters, terminators, enhancers, and split gene and explain transcription, including RNA types, transcription machinery, and transcription process in prokaryotes.
CO6. To describe the mechanism of translation, including initiation, elongation, and termination steps.
CO7. Get knowledge about gene action and regulation through models like the Lac Operon and Britten and Davidson's model.

PO11:Value Inculcation and Environmental Awareness
CO4. To understand about DNA damage, types of mutations, and DNA repair mechanisms.

Name of the Programme	**:**	**B.Sc. Botany**
Program Code	**:**	**USBT**
Class	**:**	**T. Y. B. Sc.**
Semester	**:**	**V**
Course Type	**:**	**Major Mandatory (Practical-I)**
Course Code	**:**	**BOT-305-MJM**
Course Title	**:**	**Botany Practical I**
No. of Credits	**:**	**02**
No. of Teaching Hours	**:**	**60**

A) Learning Objectives:

1. To study habitat and habit of cryptogams.
2. To give knowledge of identification and classification of cryptogams.
3. To make students expert in slide preparation.
4. To give knowledge about cytological techniques in cell biology.
5. To expert in identification and characterization various stages of mitosis and meiosis in plant cells.
6. To study extraction of DNA and RNA in biological experiments.
7. To aware and conserve the biodiversity of lower and higher plants. (Cryptogams)

B) Course Outcome:

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

CO1. Identify habitat and habit of cryptogams.
CO2. Identify and classify of cryptogams with respect to algae, Fungi, Bryophytes and Pteridophytes.
CO3. Expert in slide preparation and permanent slide also.
CO4. Use various cytological techniques in cell biology.
CO5. Identify stages of mitosis and meiosis in plant cells.
CO6. Understand the extraction of DNA and RNA in biological experiments.
CO7. Conserve the biodiversity of lower and higher plants. (Cryptogams)

Practical based on BOT-301-MJM : Cryptogamic Botany (04 Prac.)

1. Study of Algae with respect to systematic position thallus structure and reproduction of *Oscillatora* and *Batrachospermum.*
2. Study of Fungi respect to systematic position thallus structure and reproduction of *Mucor* and *Puccinia*.
3. Study of Bryophytes with respect to systematic position thallus structure and reproduction of *Anthoceros* and *Polytrichum*.
4. Study of Pteridophytes with respect to systematic position, sporophyte morphology and anatomy, reproductive structures of *Psilotum* and *Selaginella*.

Note : Excursion tour to study cryptogams is compulsory.

Practical based on BOT-302-MJM : Spermatophyta and Palaeobotany (04 Prac.)

1. Study of *Pinus* w.r.t. : External morphology, T. S. of stem, T. S. of needle, Morphology of male cone and mounting of pollen grains. Morphology of female cone and T. S. & L. S. of female cone, V. S. of matured ovule.
2. Study of *Gnetum* w.r.t. : External morphology, T. S. of stem, T. S. of leaf, Morphology of male cone, Morphology of female cone, V. S. of matured ovule.

3. Study of the fossil specimens with the help of slides and or specimens : i) Impression ii) Compression iii) Petrifaction and iv) Coal ball.
4. Study of the fossil specimens with the help of slides and or specimens : i) *Rhynia* ii) *Pentoxylon* iii) *Nipaniophyllum* and iv) *Lepidodendron*.

Practical based on BOT-303-MJM : Cell Biology and BOT-304-MJM : Molecular Biology (04 Prac.)

1. Study of various stages of mitosis.
2. Study of various stages of meiosis.
3. Plant Genomic DNA extraction from Cauliflower.
4. Extraction and estimation of RNA by Orcinol Method.

Mapping of Program Outcomes with Course Outcomes

Class: T.Y.B. Sc. (Sem. V) **Subject**: Botany

Course: Botany Practical I **Course Code**: BOT-305-MJM

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

	Programme Outcomes (POs)												
Course Outcomes	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13
CO 1	3									3	3	3	3
CO 2	3												
CO 3				3									
CO 4								3					
CO 5						2							
CO 6					3								
CO 7	2						2						

Justification for the mapping

PO1: Comprehensive Knowledge and Understanding

CO2. Identify and classify of cryptogams with respect to algae, Fungi, Bryophytes and Pteridophytes.

CO3. Expert in slide preparation and permanent slide also.

CO7. Conserve the biodiversity of lower and higher plants. (Cryptogams)

PO2: Practical, Professional, and Procedural Knowledge

PO3: Entrepreneurial Mindset and Knowledge

PO4: Specialized Skills and Competencies

CO3. Expert in slide preparation and permanent slide also.

PO5: Capacity for Application, Problem-Solving, and Analytical Reasoning

CO6. Understand the extraction of DNA and RNA in biological experiments.

PO6: Communication Skills and Collaboration

CO5. Identify stages of mitosis and meiosis in plant cells.

PO7: Research-related Skills

CO7. Conserve the biodiversity of lower and higher plants (Cryptogams).

PO8: Learning How to Learn Skills
CO3. Expert in slide preparation and permanent slide also.
PO9: Digital and Technological Skills
CO3. Expert in slide preparation and permanent slide also.
PO10: Multicultural Competence, Inclusive Spirit, and Empathy
CO3. Expert in slide preparation and permanent slide also.
PO11: Value Inculcation and Environmental Awareness
CO3. Expert in slide preparation and permanent slide also.
PO12: Autonomy, Responsibility, and Accountability
CO3. Expert in slide preparation and permanent slide also.
PO13: Community Engagement and Service
CO3. Expert in slide preparation and permanent slide also.

Name of the Programme : B.Sc. Botany
Program Code : USBT
Class : T. Y. B. Sc.
Semester : V
Course Type : Major Elective Theory
Course Code : BOT-306-MJE(A)
Course Title : Research Methodology
No. of Credits : 02
No. of Teaching Hours : 30

A) Learning Objectives:

1. To identify need of research in Botany
2. To understand the terminologies in research
3. To identify of research problem
4. To aware the students about the research methodologies.
5. To give idea for collection of data for research
6. To use analysis data for research project.
7. To use terminologies of research for writing of research project.

B) Course Outcome:

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

CO1. Students will have comprehensive knowledge in research areas.
CO2. Students will be able to use research terminologies for their study.
CO3. Students will use methodologies for collection and interpretation of data.
CO4. Students will understand use of reference material for writing different parts research projects.
CO5. Students will be able to represent data in different ways.
CO6. Students will be able to write Manuscript, Review article and Project Report.
CO7. Students will get train in writing research projects in scientific temperament.

Credit I

Unit- I **(15L)**

1.1 Definition, Objectives of Research, types of Research, Significance of Research, **3L**
1.2 Identification and defining the Research problem. **2L**
1.3 Characteristics of research: Qualitative and Quantitative. **2L**
1.4 Research Questions and Hypothesis: Characteristics of good Hypothesis. Basis for hypotheses, formulation of hypotheses- Directional and Non-directional hypotheses. **6L**

Credit II

Unit- II **(15L)**

2.1 Methods of Data Collections: Observation, Experimental and questionnaire, Primary Data, Secondary Data, Selection of appropriate method for data collection. **4L**
2.2 Research design: Concepts, Need, Features of Good Design. **2L**
2.3 Methods of Research: Survey, Philosophical, Historical, Experimental, Case Studies. **2L**
2.4 Preparation of Project Report: Title, Introduction, Review of Literature, Materials and Methods, Table and Graphs, Results, Discussions, Summary, Bibliography,

Acknowledgments

7L

References:

1. John W. Creswell, Research Design: Qualitative, Quantitative, and Mixed Methods Approaches, SAGE Publication, 2002, ISBN: 9780761924425.
2. Robert K. Y. in Case Study Research: Design and Methods (Applied Social Research Methods), SAGE Publications, 2002, ISBN: 9780761925538.
3. Kothari,C.R.ResearchMethodology(MethodsandTechniques),NewAgePublisher.2004
4. Virginia Braun, Victoria Clarke, Successful Qualitative Research: A Practical Guide for Beginners, SAGE Publication, 2013, ISBN: 9781847875822
5. R. Panneerselvam, Research Methodology, Kindle edition, 2014
6. P. S. Narayana, D. Varalakshmi & T. Pullaiah, Research Methodology In Plant Science 2nd Edition. Scientific Publishers, 2021, ISBN No. 9789389832266.

Mapping of Program Outcomes with Course Outcomes

Class: T.Y.B. Sc. (Sem. V) **Subject** : Botany

Course: Research Methodology **Course Code : BOT-306-MJE(A)**

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

	Programme Outcomes (POs)												
Course Outcomes	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13
CO 1	1									3	3	3	3
CO 2				3									
CO 3				2									
CO 4				3				3					1
CO 5					2					2		2	
CO 6						3					2		
CO 7				2			2						

Justification for the mapping

PO1: Comprehensive Knowledge and Understanding

CO1. Comprehensive knowledge in research areas

PO4: Specialized Skills and Competencies

CO1. Students will get train in writing research projects in scientific temperament

CO2. Students will be able to use research terminologies for their study.

CO3. Students will use methodologies for collection and interpretation of data.

CO4. Students will understand use of reference material for writing different parts research projects.

PO5: Capacity for Application, Problem-Solving, and Analytical Reasoning

CO1. Students will be able to represent data in different ways.

PO6: Communication Skills and Collaboration

CO1. Students will be able to write Manuscript, Review article and Project Report.

PO7: Research-related Skills

CO7. Students will get train in writing research projects in scientific temperament.

PO8: Learning How to Learn Skills

CO5. Students will be able to represent data in different ways.

PO9: Digital and Technological Skills

CO5. Students will be able to represent data in different ways.

PO10: Multicultural Competence, Inclusive Spirit and Empathy

CO5. Students will be able to represent data in different ways.

PO11: Value Inculcation and Environmental Awareness

CO7. Students will get train in writing research projects in scientific temperament.

PO12: Autonomy, Responsibility and Accountability

CO5. Students will be able to represent data in different ways.

Name of the Programme : B. Sc. Botany
Program Code : USBT
Class : T. Y. B. Sc.
Semester : V
Course Type : Major Elective Theory
Course Code : BOT-306-MJE(B)
Course Title : Biostatistics
Credit : 02
No. of Teaching Hours : 30

A) Learning Objectives:

1) To study the information technology.
2) To study the various statistical skills.
3) To understand basic concepts of computer and statistics useful for botany.
4) To understand various sampling methods useful to set experiments.
5) To solve botanical problems.
6) To understand knowledge about different branches of biology.
7) To study about techniques of seed germination and plant growth indices.

B) Course Outcome:

CO1. Students will be expert in use of IT. to solve biological problems.
CO2. Students can be master in solving biological problems with the help of statistics techniques.
CO3. Students will apply their knowledge in various branches of biology.
CO4. Students will be expert in use of sampling methods setting experiments in research.
CO5. Students can be master in solving biological problems with the help of statistics.
CO6. Students will apply their knowledge in various branches of life sciences.
CO7. Students' expertise in seed germination and growth indices techniques.

Credit – I (15L)

Unit - I

1.1 **Introduction to Biostatistics** **3L**

a. Definition.
b. Statistical terms: Population, sample, primary and secondary data, qualitative and quantitative data, parameter and statistics, attributes, variables, discrete and continuous variables, statistical error, linear and non-linear functions of statistics, frequency, and its distribution
c. Scope, applications, Limitations and uses of biostatistics.

1.2 Sample and sampling 4L

a) Definition.
b) Sampling unit, sample and population.
c) Types of sampling
    i. Random sampling – with replicates, without replicates, systematics sampling, stratified sampling.
    ii. Non-random sampling- Purpose, quota sampling
d. Need of randomness
e. Achieving randomness

i. Lottery methods
ii. Use of random number table

f. Merits and demerits of sampling

1.3 Collection and representation of data 5L

a. Classification of data
i. Meaning and need of classification
ii. Objectives of classification
iii. Classification according to class interval
iv. Overlapping and non-overlapping frequency table

b. Methods of representation of statistical data.
v. Essential features of tabular presentation
vi. Advantages of tabular presentation
vii. Graphic representation of data and its advantages
viii. Types of graphic representation

- Histogram
- Frequency polygon
- Frequency curve
- Scatter or dot diagram
- Merits and limitations of graphic representation
- Diagrammatic representation of data
- Line diagram
- Bar diagram
- Pie diagram

1.4 Measures of central tendency of grouped and ungrouped data 3L

a. Simple arithmetic mean, its merits and demerits
b. Averages of position: Median and mode, their merits and demerits

Credit – II **(15 L)**

Unit- 2

2.1 Measures of dispersion **5L**

a. Meaning of dispersion
i. Range: Computation in individual, discrete and continuous series, coefficient of range, Merits and limitations
ii. Mean deviation and standard deviation: computation for grouped and ungrouped data, Merits and limitation
iii. Variance: Definition, coefficient of variance
iv. Skewness and Kurtosis

2.2 Correlation and regression 4L

a) Definition and types of correlation
b) Coefficient of correlation and its properties
c) Methods of studying correlation: Scatter diagram and Karl Pearson's Coefficient of Correlation
d) Coefficient of determination (r^2)
e) Regression analysis

2.3 Definition and types of regression

a) Linear regression
b) Similarities and dissimilarities between correlation and regression
c) Probability and types of theoretical probability distribution
d) Concept of probability

e) Binomial distribution
f) Poisson distribution
g) Normal distribution
   a) Normal distribution curve
   b) Relationship between normal curve area and standard deviation
   c) Properties of normal distribution curve.

2.4 Tests of significance of mean 3L

a. Introduction
b. Statistic and its standard error
c. Meaning of statistical hypothesis, level of significance, null hypothesis and alternative hypothesis
d. Student's 't' test: unpaired and paired test
e. Chi Square test as a test of goodness of fit and its significance

Computation of seed germination and plant growth indices 3L

a) 2.5 Seed germination and early seedling growth.
   i. Germination percentage
   ii. Mean germination time (MGT)
   iii. Germination index (GI)
   iv. Germination speed (GS)
   v. Vigor index (VI).

b) Seed germination and early seedling growth under stress
   vi. Promptness index (PI)
   vii. Germination stress tolerance index (GSI),
   viii. Plant height stress tolerance index (PHSI)
   ix. Root length stress tolerance index (RLSI)
   x. Dry matter stress tolerance index (DMSI)

NOTE – For Biostatistics, emphasis be given on methodology and numerical problem solving rather than derivations and proofs.

References:

1. Introduction to biostatistics, Pranab Kumar Banerjee.
2. Fundamentals of biostatistics, Khan and Khanum.
3. Methods in Biostatistics for medical students and research workers, B. K. Mahajan.
4. ABC of Research Methodology and Applied Biostatistics, M. N. Parikh and Nithya Gogtay.
5. Biostatistics in brief, K. Viswesara Rao.
6. Introduction to Biometry, S. G. Purohit, V. D. Ranade and A. V. Dusane
7. Biostatistics-Basic Concepts and Methodology for the Health Sciences, Wayne W
8. Daniel. Basic statistics, B. L. Agarwal
9. Biostatistics – Principle and Practice, B. Antonisamy, Soloman Chrostopher and P
10. Prasanna Samuel. Introduction to biostatistics and research methods, PSS Sundar Raand J. Richards.

Mapping of Program Outcomes with Course Outcomes

Class: T.Y.B. Sc. (Sem. V) **Subject** : Botany
Course:Major Biostatistics **Course Code : BOT-306-MJE(B)**

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

	Programme Outcomes (POs)												
Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO 7	PO 8	PO9	PO10	PO11	PO12	PO13
CO 1	3	2	1	2	2	1	2	3	3	1	1	2	1
CO 2	3	3	1	3	3	1	3	2	2	1	1	2	1
CO 3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO 4	3	3	3	3	3	3	3	3	3	3	3	3	3
CO 5	3	3	3	3	3	3	3	3	3	3	3	3	3
CO 6	3	3	3	3	3	3	3	3	3	3	3	3	3
CO 7	3	3	3	3	3	3	3	3	3	3	3	3	3

Justification for the mapping

PO1: Comprehensive Knowledge and Understanding

CO3. Students will apply their knowledge in various branches of biology.

PO2: Practical, Professional, and Procedural Knowledge

CO2. Students can be master in solving biological problems with the help of statistics techniques.

CO3. Students will apply their knowledge in various branches of biology.

PO3: Entrepreneurial Mindset and Knowledge

CO3. Students will apply their knowledge in various branches of biology.

PO4: Specialized Skills and Competencies

CO1. Students will be expert in use of IT. to solve biological problems.

PO5: Capacity for Application, Problem-Solving, and Analytical Reasoning

CO2. Students can be master in solving biological problems with the help of statistics techniques.

CO3. Students will apply their knowledge in various branches of biology.

PO6: Communication Skills and Collaboration

CO1. Students will be expert in use of IT. to solve biological problems.

PO7: Research-related Skills

PO8: Learning How to Learn Skills

CO1. Students will be expert in use of IT. to solve biological problems.

CO2. Students can be master in solving biological problems with the help of statistics techniques.

PO9: Digital and Technological Skills

CO3. Students will apply their knowledge in various branches of biology.

PO10: Multicultural Competence, Inclusive Spirit and Empathy

CO1. Students will be expert in use of IT. to solve biological problems.

PO11: Value Inculcation and Environmental Awareness

CO3. Students will apply their knowledge in various branches of biology.

PO12: Autonomy, Responsibility and Accountability

CO1. Students will be expert in use of IT. to solve biological problems.

PO13: Community Engagement and Service

CO1. Students will be expert in use of IT. to solve biological problems.

CO2. Students can be master in solving biological problems with the help of statistics techniques.

Name of the Programme : B. Sc. Botany
Programme Code : USBT
Class : T. Y. B. Sc.
Semester : V
Course Type : MJE - Major Elective (Theory)
Course Code : BOT-306-MJE(C)
Course Title : Plant Embryology
No. of Credits : 02
No. of Teaching Hours : 30

A) Learning Objectives:

1. To introduce students with importance and scope of plant embryology.
2. To study structure of microsporangium and male gametophyte.
3. To study developmental aspects of male gametophyte.
4. To study developmental aspects of female gametophyte.
5. Aquent students with fertilization process in plant.
6. To study development of embryo in plant.
7. To study structure of monocot and dicot embryo in plant.

B) Course Outcome:

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

CO1. Students get knowledge of importance and scope of plant embryology.
CO2. Students learnt structure of microsporangium and male gametophyte.
CO3. Students learnt developmental aspects of male gametophyte.
CO4. Students learnt developmental aspects of female gametophyte.
CO5. Students get knowledge of fertilization in plant.
CO6. Students learnt development of embryo in plant.
CO7. Students get knowledge of monocot and dicot embryo in plant.

Unit - I **(10L)**

1. **Plant Embryology introduction** **(2L)**
   Definition and scope of plant embryology.

2. **Microsporangium and male gametophyte** **(8L)**
   a. Microsporangium**:** structure of tetrasporangiate anther, types of tapetum, sporogenous tissue.
   b. Microsporogenesis: process and its types, types of microspore tetrad.
   c. Male gametophyte: structure and development of male gametophyte.

Unit - II **(8L)**

1. Megasporangium and female gametophyte:

a) Megasporangium: structure, types of ovules - anatropous, orthotropous, amphitropous, campylotropous, circinotropous.
b) Megasporogenesis: process and its types, types of megaspore tetrads.
c) Female gametophyte: structure of typical embryo sac, types of embryo sacs with examples - monosporic, bisporic and tetrasporic.

Unit - III **(12L)**

1. Fertilization: **(6L)**

Mechanism of pollination - entomophily, anemophily, hydrophily, zoophily,

germination of pollen grain, double fertilization (syngamy and triple fusion) and its significance.

2. Endosperm and embryo (6L)
   a) Endosperm: Types - nuclear, helobial and cellular.
   b) Embryogeny**:** structure of dicot and monocot embryo and seed formation

References

1. Pandey S N and Chadha A, 2005, Plant Anatomy and Embryology, Vikas Publishing House, Pvt, Ltd, New Delhi
2. Bhojwani S S and Bhatnagar S P, 2010, An Embryology of Angiosperms, S. Chand and Co. Ltd, New Delhi
3. Maheshwari P, 2005, An introduction to Embryology of Angiosperm, S. Chand and Co. Ltd, New Delhi
4. Pandey B P, 1987, Plant Anatomy, S. Chand and Co. Ltd, New Delhi

Mapping of Program Outcomes with Course Outcomes

Class: T.Y.B. Sc. (Sem. V) **Subject** : Botany
Course: Plant Embryology **Course Code : BOT-306-MJE(C)**
Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation

	Programme Outcomes (POs)												
Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO 7	PO 8	PO9	PO10	PO11	PO12	PO13
CO 1	3	1	3							3	3	3	3
CO 2	2	2		3		3	3	3	3				
CO 3	2	3		3	3	3	3	3	3				
CO 4	2	2		2	2	2	2	2	2				
CO 5	3	2	2										
CO 6	2	1		2	2	2	2	2	2				
CO 7	2	3											

Justification for the mapping

PO1. Comprehensive Knowledge and Understanding
CO1. Students get knowledge of importance and scope of plant embryology.
CO2. Students learnt structure of microsporangium and male gametophyte.
CO3. Students learnt developmental aspects of male gametophyte.
CO4. Students learnt developmental aspects of female gametophyte.
CO5. Students get knowledge of fertilization in plant.
CO6. Students learnt development of embryo in plant.
CO7. Students get knowledge of monocot and dicot embryo in plant.

PO2. Practical, Professional, and Procedural Knowledge
CO1. Students get knowledge of importance and scope of plant embryology.
CO2. Students learnt structure of microsporangium and male gametophyte.
CO3. Students learnt developmental aspects of male gametophyte.
CO4. Students learnt developmental aspects of female gametophyte.
CO5. Students get knowledge of fertilization in plant.

CO7. Students get knowledge of monocot and dicot embryo in plant.

PO3. Entrepreneurial Mindset and Knowledge

CO1. Students get knowledge of importance and scope of plant embryology.
CO5. Students get knowledge of fertilization in plant.

PO4. Specialized Skills and Competencies

CO2. Students learnt structure of microsporangium and male gametophyte.
CO3. Students learnt developmental aspects of male gametophyte.
CO4. Students learnt developmental aspects of female gametophyte.
CO6. Students learnt development of embryo in plant.

PO5. Capacity for Application, Problem-Solving, and Analytical Reasoning

CO3. Students learnt developmental aspects of male gametophyte.
CO4. Students learnt developmental aspects of female gametophyte.
CO6. Students learnt development of embryo in plant.

PO6. Communication Skills and Collaboration

CO2. Students learnt structure of microsporangium and male gametophyte.
CO3. Students learnt developmental aspects of male gametophyte.
CO4. Students learnt developmental aspects of female gametophyte.
CO6. Students learnt development of embryo in plant.

PO7. Research-related Skills

CO2. Students learnt structure of microsporangium and male gametophyte.
CO3. Students learnt developmental aspects of male gametophyte.
CO4. Students learnt developmental aspects of female gametophyte.
CO6. Students learnt development of embryo in plant.

P08. Learning How to Learn Skills

CO2. Students learnt structure of microsporangium and male gametophyte.
CO3. Students learnt developmental aspects of male gametophyte.
CO4. Students learnt developmental aspects of female gametophyte.
CO6. Students learnt development of embryo in plant.

PO9. Digital and Technological Skills

CO2. Students learnt structure of microsporangium and male gametophyte.
CO3. Students learnt developmental aspects of male gametophyte.
CO4. Students learnt developmental aspects of female gametophyte.
CO6. Students learnt development of embryo in plant.

PO10 Multicultural Competence, Inclusive Spirit, and Empathy

CO1. Students get knowledge of importance and scope of plant embryology.

PO11. Value Inculcation and Environmental Awareness

CO1. Students get knowledge of importance and scope of plant embryology.

PO12 Autonomy, Responsibility, and Accountability

CO1. Students get knowledge of importance and scope of plant embryology.

PO13. Community Engagement and Service

CO1. Students get knowledge of importance and scope of plant embryology.

Name of the Programme : B. Sc. Botany
Programme Code : USBT
Class : T. Y. B. Sc.
Semester : V
Course Type : Minor (Theory)
Course Code : BOT-311-MN
Course Title : Industrial Botany
No. of Credits : 02
No. of Teaching Hours : 30

A) Learning Objectives

1. Use of recent techniques.
2. Knowledge of Industrial Crop
3. Crop Management and Agronomy.
4. Exploring the economic significance of Industrial Crops.
5. Processing and Utilization of Industrial Crops.
6. Sustainable uses of techniques.
7. Industrial applications of techniques.

B) Course Outcome:

By the end of course, student will be able to:
CO1. Prepare different garden at personal level and to encourage people
CO2. Expert in hydroponic techniques.
CO3. Start the own business in cold storage, packing of flowers and fruits.
CO4. Develop plant tissue culture industry.
CO5. Get expertise to develop agro based industries.
CO6. Get expertise in field of Industrial Botany.
CO7.Understand basics of plant resource based industries.

Credit–I (16L)

1. Soilless Farming Techniques
   a) Hydroponics: History and origin of soil less culture, its advantages and disadvantages, Techniques: Nutrient Film Technique (NFT), Passive sub-irrigation, Ebb and flow or flood and drain irrigation, Run to waste, Deep water culture, Bubbleponics.
   b) Media used for Hydroponics. 6L
   c) Aeroponics, Introduction, Concept, Types commercial application. 2L
   d) Gardening
   e) Nursery tools and techniques. 2L
   f) Definition, Principles, objectives and scope of garden designing. 2L
   g) Different types of gardening – Terrace / Vertical/ rock garden/ /bottle. 2L
   h) Indoor gardening: Bonsai, Terrarium, dish, Kokedama, Hugelkultur. 2L

Credit–II (14L)

2. Post-Harvest Technology 8L
   a) Introduction Need, Scope
   b) Post-harvest operations: Primary Operation: Harvesting, Handling, cleaning, grading and sorting, milling, size reduction, storage and Transportation.
   c) Secondary Operation: extraction, blending, freezing, chilling, dehydration, canning, thermal processing, Pickling, fermentation, salting
   d) Canning and packaging.
   e) Introduction to cosmetics and personal care 4L

f) Plant based ingredient, Extraction and formulation of plant based products for skin care, hair care and fragrance.

References:

1. Post-harvest handling of tropical fruit, B. R. Champ, E. Highley & G. I. Johnson (eds), Australian Centre for International Agricultural Research.
2. Post-harvest technology of fruits and vegetables: Handling, processing, fermentation and waste management, L. R. Verma and V. K. Joshi, Indus Publishing Company.
3. Postharvest biology and technology of tropical and subtropical fruits: Volume 1: Fundamental issues, Edited by E Yahia, Universidad Autónoma de Querétaro, Mexico, Wood head Publishing Series in Food Science, Technology and Nutrition No. 206
4. Processing of Fruits and Vegetables for Value Addition, Vijay Sethi, B.C. Dekka, Vijay Sethi, Shruti Sethai, Shruti Sethi, Indus Publishing.
5. Post-Harvest Technology of fruits & Vegetables, Thompson, CBS Publishers and Distributors
6. Hand book of Fruits and Fruit Processing, Y.H. Hui, John Wiley& Sons.
7. Advances in Fruit Processing Technologies, Sueli Rodrigues, Fabiano Andre Narciso Fernandes, CRC Press.
8. Quality Control in Fruit and Vegetable Processing, Issue39, Food& Agriculture Org.
9. Small Scale Food Processing: A Guide to Appropriate Equipment, Peter Fellows, Ann Hampton, Intermediate Technology Publicatio ns.
10. Hand book of horticulture, ICAR, New Delhi.
11. Floriculture in India, Randhawa and Mukho paddhay.

Mapping of Program Outcomes with Course Outcome

Class : T.Y. B.Sc. (Sem. V) **Subject** : Botany

Course : Industrial Botany **Course Code**: BOT-311-MN

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

	Programme Outcomes (POs)												
Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO 7	PO 8	PO9	PO10	PO11	PO12	PO13
CO 1		3	3							3	3	3	3
CO 2		3				3		2					
CO 3						2							
CO 4	3			3					2				
CO 5	3				3				1				
CO 6	3								2				
CO 7							2						

Justification for the mapping

PO1: Comprehensive Knowledge and Understanding
CO4. Develop plant tissue culture industry.
CO5. Get expertise to develop agro based industries.
CO6. Get expertise in field of Industrial Botany.
PO2: Practical, Professional, and Procedural Knowledge
CO1. Prepare different garden at personal level and to encourage people.
CO2. Expert in hydroponic techniques.
PO3: Entrepreneurial Mindset and Knowledge
CO1. Prepare different garden at personal level and to encourage people.
PO4: Specialized Skills and Competencies
CO5. Get expertise to develop agro based industries.
PO5: Capacity for Application, Problem-Solving, and Analytical Reasoning
CO5.Get expertise to develop agro based industries.
PO6: Communication Skills and Collaboration
CO2. Expert in hydroponic techniques.
PO7: Research-related Skills
CO7.Understand basics of plant resource based industries.
PO8: Learning How to Learn Skills
CO2. Expert in hydroponic techniques.
PO9: Digital and Technological Skills
CO4. Develop plant tissue culture industry.
CO5. Get expertise to develop agro based industries.
CO6. Get expertise in field of Industrial Botany.
PO10: Multicultural Competence, Inclusive Spirit and Empathy
CO1. Prepare different garden at personal level and to encourage people.
CO2. Expert in hydroponic techniques.
PO11: Value Inculcation and Environmental Awareness
CO3. Start the own business in cold storage, packing of flowers and fruits.
PO12: Autonomy, Responsibility and Accountability
CO3. Start the own business in cold storage, packing of flowers and fruits.
PO13: Community Engagement and Service
CO3. Start the own business in cold storage, packing of flowers and fruits.

Name of the Programme : B. Sc. Botany
Programme Code : USBT
Class : T. Y. B. Sc.
Semester : V
Course Type : Minor (Practical)
Course Code : BOT-312-MN
Course Title : Practical Based on Industrial Botany
No. of Credits : 02
No. of Teaching Hours : 60

A) Learning Objectives

1. Understand Hydroponic Systems and Media
2. Familiarization with Nursery Tools and Gardening Techniques.
3. Develop Skills in Kokedama and Bonsai Preparation.
4. Learn the Principles of Fruit Processing.
5. Practical Experience in Making Jam, Jelly, Squash, and Pickles.
6. Techniques of Ketchup Preparation.
7. Extraction and use of Scented Oils

B) Course Outcome:

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

CO1. Understand the types of hydroponic media, their properties, and their role.
CO2. Explore various hydroponic systems and nutrient solutions.
CO3. Learn about different nursery tools.
CO4. Gain hands-on experience in plant artistry, Kokedama and Bonsai techniques.
CO5. Learn the principles of fruit processing and preservation methods.
CO6. Acquire skills in making jam, squash and pickles.
CO7. Explore methods of extracting scented oils.

Practical based on Industrial Botany

1. Hydroponic technology.
2. Media Required for Hydroponics.
3. Nursery tools.
4. Bottle garden.
5. Preparation of Kokedama.
6. Bonsai Techniques.
7. Demonstration of fruits processing methods.
8. Preparation of Jam.
9. Preparation of Squash.
10. Preparation of Pickles.
11. Preparation of Ketchup.
12. Extraction of Aromatic oils.
13. Herbal skin care products.
14. Plant-based hair care products.
15. Nursery / Food / Herbal cosmetic Industry visit. (Submission of visit report is compulsory in semester end examination).

Mapping of Program Outcomes with Course Outcomes

Class : T.Y. B.Sc. (Sem. V) **Subject** : Botany
Course : MN Practical **Course Code**: BOT-312-MN

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

	Programme Outcomes (POs)												
Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO 7	PO 8	PO9	PO10	PO11	PO12	PO13
CO 1	3				2			3		3	3	3	3
CO 2		3		3				3	2	2			
CO 3						3			2		2		
CO 4		2	2			3	2		3			2	
CO 5			1						3				2
CO 6	3								3				
CO 7	3			3	2				3				

Justification of Mapping:

PO1: Comprehensive Knowledge and Understanding
CO1. Understand the types of hydroponic media, their properties, and their role.
CO6. Acquire skills in making jam, squash and pickles.
CO7. Explore methods of extracting scented oils.
PO2: Practical, Professional, and Procedural Knowledge
CO2. Explore various hydroponic systems and nutrient solutions
CO4. Gain hands-on experience in plant artistry, Kokedama and Bonsai techniques.
PO3: Entrepreneurial Mindset and Knowledge
CO4. Gain hands-on experience in plant artistry, Kokedama and Bonsai techniques.
CO5. Learn the principles of fruit processing and preservation methods.
PO4: Specialized Skills and Competencies
CO2. Explore various hydroponic systems and nutrient solutions.
CO7. Explore methods of extracting scented oils
PO5: Capacity for Application, Problem-Solving, and Analytical Reasoning
CO1. Understand the types of hydroponic media, their properties, and their role
CO7. Explore methods of extracting scented oils.
PO6: Communication Skills and Collaboration
CO3. Learn about different nursery tools.
CO4. Gain hands-on experience in plant artistry, Kokedama and Bonsai techniques.
PO7: Research-related Skills
CO4. Gain hands-on experience in plant artistry, Kokedama and Bonsai techniques.

PO9: Digital and Technological Skills
CO1. Understand the types of hydroponic media, their properties, and their role.
CO2. Explore various hydroponic systems and nutrient solutions.
PO10: Multicultural Competence, Inclusive Spirit and Empathy
CO1. Understand the types of hydroponic media, their properties, and their role.
CO2. Explore various hydroponic systems and nutrient solutions.
PO11: Value Inculcation and Environmental Awareness
CO1. Understand the types of hydroponic media, their properties, and their role.
CO2. Explore various hydroponic systems and nutrient solutions.
PO12: Autonomy, Responsibility and Accountability
CO1. Understand the types of hydroponic media, their properties, and their role.
CO2. Explore various hydroponic systems and nutrient solutions.
PO13: Community Engagement and Service
CO1. Understand the types of hydroponic media, their properties, and their role.
CO2. Explore various hydroponic systems and nutrient solutions.

Name of the Programme : B.Sc. Botany
Program Code : USBT
Class : T. Y. B. Sc.
Semester : V
Course Type : Vocational Skill Course (Practical)
Course Code : BOT-321-VSC
Course Title : Practical based on Organic Farming
No. of Credits : 02
No. of Teaching Hours : 60

A) Course Objective:

1. To study quality analysis of compost and Vermi compost.
2. To make students expert in preparation of organic biofertilizers.
3. To give knowledge of cultivation of Azolla and Blue Green Algae (BGA.
4. To give knowledge about Vermi compost and Vermi wash.
5. To expert in preparation of Panchagavya.
6. To make students expert in preparation of different organic Bio- pesticides.
7. To create awareness about organic farming.

B) Course Outcome:

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

CO1. Analyzed quality of compost and Vermi compost.
CO2. Expert in preparation of organic biofertilizers.
CO3. Expert in cultivation of *Azolla* and Blue Green Algae (BGA.
CO4. Expert in preparation of Vermi compost and Vermi wash.
CO5. Understand the preparation and uses of Panchagavya.
CO6. Expert in preparation of organic Bio- pesticides.
CO7. Creating awareness about organic farming.

Practicals

1.	Study of *Azolla* cultivation.	1P
2.	Study of Blue Green Algae (BGA) cultivation.	1P
3.	Study of methods of compost preparation in organic farming.	2P
4.	Study of Vermi compost.	1P
5.	Study of Vermi wash.	1P
6.	Preparation of Panchagavya.	1p
7.	Study of different Green manures.	1P
8.	Study of different biofertilizers treatments with seed and seedling.	1P
9.	Weed management practices in Organic farming.	1P
10.	Study of quality analysis of compost and Vermi compost.	2P
11.	Preparation of Bio-pesticide - Dashparni ark and Bramhastra.	2P

Note: Visit to organic farming field and submission of report.

Mapping of Program Outcomes with Course Outcomes

Class: T.Y.B. Sc. (Sem. V) **Subject**: Botany

Course: VSC - Practical **Course Code**: BOT-321-VSC

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

	Programme Outcomes (POs)												
Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13
CO 1	3	3	2	2	3	2	2	2	2	1	3	2	2
CO 2	3	3	2	2	3	2	2	2	2	1	3	2	2
CO 3	3	3	2	2	3	2	2	3	2	1	3	2	2
CO 4	3	3	2	2	3	2	2	3	2	1	3	2	2
CO 5	3	3	3	2	3	3	2	3	2	1	3	2	3
CO 6	3	3	3	2	3	2	2	3	2	2	3	2	2
CO 7	3	3	3	2	3	2	2	3	3	1	3	2	3

Justification for the mapping

PO1. Comprehensive Knowledge and Understanding
CO1. Analyzed quality of compost and Vermi compost.
CO2. Expert in preparation of organic biofertilizers.
CO3. Expert in cultivation of *Azolla* and Blue Green Algae (BGA).
CO4. Expert in preparation of Vermi compost and Vermi wash.
CO5. Understand the preparation and uses of Panchagavya.
CO6. Expert in preparation of organic Bio- pesticides.
CO7. Creating awareness about organic farming.

PO2. Practical, Professional, and Procedural Knowledge
CO1. Analyzed quality of compost and Vermi compost.
CO2. Expert in preparation of organic biofertilizers.
CO3. Expert in cultivation of *Azolla* and Blue Green Algae (BGA).
CO4. Expert in preparation of Vermi compost and Vermi wash.
CO5. Understand the preparation and uses of Panchagavya.
CO6. Expert in preparation of organic Bio- pesticides.
CO7. Creating awareness about organic farming.

PO3. Entrepreneurial Mindset and Knowledge
CO2. Expert in preparation of organic biofertilizers.
CO3. Expert in cultivation of *Azolla* and Blue Green Algae (BGA).

PO4. Specialized Skills and Competencies
CO2. Expert in preparation of organic biofertilizers.

PO5. Capacity for Application, Problem-Solving, and Analytical Reasoning
CO3. Expert in cultivation of *Azolla* and Blue Green Algae (BGA).

PO6. Communication Skills and Collaboration
CO2. Expert in preparation of organic biofertilizers.
CO3. Expert in cultivation of *Azolla* and Blue Green Algae (BGA).
PO7. Research-related Skills
CO2. Expert in preparation of organic biofertilizers.
P08. Learning How to Learn Skills
CO2. Expert in preparation of organic biofertilizers.
CO3. Expert in cultivation of *Azolla* and Blue Green Algae (BGA).
PO9. Digital and Technological Skills
CO2. Expert in preparation of organic biofertilizers.
PO10 Multicultural Competence, Inclusive Spirit, and Empathy
CO1. Analyzed quality of compost and Vermi compost.
CO2. Expert in preparation of organic biofertilizers.
PO11. Value Inculcation and Environmental Awareness.
CO3. Expert in cultivation of *Azolla* and Blue Green Algae (BGA).
PO12 Autonomy, Responsibility, and Accountability
CO2. Expert in preparation of organic biofertilizers.
PO13. Community Engagement and Service
CO2. Expert in preparation of organic biofertilizers.
CO3. Expert in cultivation of *Azolla* and Blue Green Algae (BGA).

Name of the Programme : B.Sc. Botany
Program Code : USBT
Class : T. Y. B. Sc.
Semester : V
Course Type : Field Project (FP)
Course Code : BOT-335-FP
Course Title : Field Project
No. of Credits : 02
No. of Teaching Hours : 60

A) Course Objective:

1. To identify research problem.
2. To set objectives of the project.
3. To write review of literature.
4. To identify methodology of the project
5. To interpret results of the project.
6. To find out conclusions or outputs of the project.
7. To prepare project report.

B) Course Outcome:

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

CO1. Identify research problem.
CO2. Set objectives of the project.
CO3. Write review of literature.
CO4. Identify methodology of the project.
CO5. Interpret results of the project.
CO6. Find out conclusions or outputs of the project.
CO7. Prepare project report.

Project Work:

1 Survey, Analysis and Compilation of data.
2 Typing, binding and submission of project report.
3 Writing of research paper or review.
4 Power point presentation based on project work.

Step of Project	Individual students work in hours	Marks
Topic Selection/ Study Design	05	05
Survey preparation / Fieldwork	25	20
Analysis	10	05
Report writing	20	10
Oral Presentation		10
Total	60	50

Mapping of Program Outcomes with Course Outcomes

Class: T.Y.B. Sc. (Sem. V) **Subject**: Botany

Course: Field Project (FP) **Course Code:** BOT-335-FP

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

	Programme Outcomes (POs)												
Course Outcomes	PO1	PO2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO9	PO10	PO 11	PO 12	PO 13
CO 1	3											3	
CO 2	3												
CO 3	3												
CO 4	3												
CO 5		3						3	3				
CO 6		2							2				
CO 7							3						3

Justification for the mapping

PO1. Comprehensive Knowledge and Understanding:
CO1. Identify research problem.
CO2. Set objectives of the project.
CO3. Write review of literature.
CO4. Identify methodology of the project.
PO2.Practical, Professional, and Procedural Knowledge
CO5. Interpret results of the project.
CO6. Find out conclusions or outputs of the project.
PO7. Research-related Skills
CO7. Prepare project report.
PO9. Digital and Technological Skills:
CO5. Interpret results of the project
CO6. Find out conclusions or outputs of the project.
PO12. Autonomy, Responsibility, and Accountability
CO1. Identify research problem.
PO13. Community Engagement and Service
CO7. Prepare project report.