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 & Technology)

CBCS Syllabus

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

For Department of Botany NEP 2.0

Choice Based Credit System Syllabus (2024 Pattern)

(As Per NEP 2020)

To be implemented from Academic Year 2026-2027

Department of Botany

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

Course Structure for T. Y. B. Sc. Botany Sem. V and VI (2024 Pattern)

as per NEP-2020

Sem.	Course Type	Course Code	Course Title	Theory/ Practical	Credits
V (5.5)	Major Mandatory	BOT-301-MRM	Cryptogamic Botany	Theory	02
		BOT-302-MRM	Cell Biology	Theory	02
		BOT-303-MRM	Spermatophyta and Palaeobotany	Theory	02
		BOT-304-MRM	Molecular Biology	Theory	02
	Major Mandatory	BOT-305-MRM	Practical based on BOT-301-MRM and BOT-302-MRM	Practical	02
		BOT-306-MRM	Practical based on BOT-303-MRM and BOT-304-MRM	Practical	02
	Major Elective (MJE)	BOT-307-MJE(A)	Biostatistics and Research Methodology	Theory (Any One)	02
		BOT-307-MJE(B)	Plant Embryology		
	Major Elective (MJE)	BOT-308-MJE(A)	Practical based on Biostatistics and Research Methodology	Practical (Any One)	02
		BOT-308-MJE(B)	Practical based on Plant Embryology		
	On Job Training (OJT)	BOT-309-OJT	On Job Training	Practical	04
	Minor	BOT-310-MN	Economic Botany	Theory	02
	Total Credits Semester - V (T=12, P=10)				**22**
VI (5.5)	Major Mandatory	BOT-351-MRM	Plant Physiology	Theory	02
		BOT-352-MRM	Plant Biotechnology	Theory	02
		BOT-353-MRM	Plant Genetics	Theory	02
		BOT-354-MRM	Plant Pathology	Theory	02
	Major Mandatory	BOT-355-MRM	Practical based on BOT-351-MRM and BOT-352-MRM	Practical	02
		BOT-356-MRM	Practical based on BOT-353-MRM and BOT-354-MRM	Practical	02
	Major Elective (MJE)	BOT-357-MJE(A)	Botanical Techniques	Theory	02
		BOT-357-MJE(B)	Plant Breeding	Theory	02
	Major Elective (MJE)	BOT-358-MJE(A)	Practical based on Botanical Techniques	Practical	02
		BOT-358-MJE(B)	Practical based on Plant Breeding	Practical	02
	Vocational Skill Course (VSC)	BOT-359-VSC	Pharmacognosy	Theory	02
	Vocational Skill Course (VSC)	BOT-360-VSC	Practical based on Pharmacognosy	Practical	02
	Field Project	BOT-361-FP	Field Project	Practical	02
	Total Credits Semester - VI (T=12, P=10)				**22**

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-MRM**
Course Title	**:**	**Cryptogamic Botany**
No. of Credits	**:**	**02**
No. of Teaching Hours	**:**	**30**

A) Course 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) upto classes and economic importance. **2L**

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

a) *Oscillatora*
b) *Batrachospermum*
c) *Volvox*

Fungi:

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

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

a) *Stemonitis*
b) *Mucor*
c) *Puccinia*

Credit – II : Bryophytes and Pteridophytes (15L)

Unit – 2 : Bryophytes

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

2.2. Study of life cycle of following bryophytes with reference to 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 upto classes (K. R. Sporne, 1975) and economic importance. **2L**

3.2 Study of life cycle of following pteridophytes with reference to 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). Unravelling the algae: the past, present and future of algal systematics. CRC press, New York.
2. Bellinger E.G. and Sigee D. C. (2010). Freshwater algae: Identification and use as bioindicators, Willey-Blackwell, UK.
3. Cole K. M. and Sheath R. G. (1990). Biology of the red algae. Cambridge University Press. USA.
4. Desikachary T. V. (1959). Cyanophyta. ICAR, New Delhi.
5. Graham L. E. and Wilcox L. W. (2000). Algae. Penticce-Hall, Inc.
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.
8. Misra J. N. (1996). Phaeophyceae in India. ICAR, New Delhi.
9. 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.
10. Das, Datta and Gangulee.College Botany Vol I, Central Book Depot.
11. Vashista B. R, Sinha A. K and Singh V. P. (2005). Botany for degree students – Algae, S. Chand Publication.
12. Sharma O.P. (2018). Algae.M. C. Graw Hill Publication, USA.

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 Ed) Introductory Mycology. Willey, New York, Alford
3. R. A. Deacon J. W. (2006). Fungal Biology (4th Ed.) Blackwell Publishing, ISBN. 1405130660.
4. Kendrick B. (1994). The fifth kingdom (paperback), North America, New York Publisher: 3rd Ed., ISBN- 10: 1585100226.
5. Kirk *et al.,* (2001). Dictionary of fungi, 9th Ed, 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 Ed.) 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. Parihar N. S. (1980). Bryophytes: An Introduction to Embryophyta. Vol. I. Central Book Depot, Allahabad.
4. Prem Puri (1981). Bryophytes: Morphology, Growth and Differentiation. Atma Ram and Sons, New Delhi.
5. Watson E. V. (1971). Structure and Life of Bryophytes. 3rd Ed. Hutchinson University Library, London.
6. Vashista B. R., Sinha A. K. and 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 Pteridophytes. Mac Millan India Ltd. Delhi.
3. Sporne K. R. (1986). The morphology of Pteridophytes. Hutchinson University Press. London.
4. Sundara Rajan S. (1999). Introduction to Pteridophyta. New Age International Publishers, New Delhi.
5. Parihar, N. S. (1976). Biology and morphology of the Pteridophytes. Central Book Depot.
6. Trivedi, A. N. (2002). Advances in Pteridology. Pointer Publisher, Jaipur.
7. Rashid A. (1978). An introduction of Pteridophytes. Vikas Publishing House, New Delhi.
8. Sporne, K. R. (2025). Morphology of Pteridophytes. United Book Prints, Abu Dhabi.
9. Vashishta, B.R. (1996). Botany for degree students – Pteridophytes.

Choice Based Credit System Syllabus (2024 Pattern)
Mapping of Program Outcomes with Course Outcomes

Class : T.Y. B. Sc. (Sem. V) Subject : Botany
Course : Cryptogamic Botany Course Code : BOT-301- MRM
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 Course.
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.

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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-MRM**
Course Title	**:**	**Cell Biology**
No. of Credits	**:**	**02**
No. of Teaching Hours	**:**	**30**

A) Course 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) Course 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 - 1

1.1 Cell Biology: An Introduction **5L**

a) Definition and brief history.
b) Units of measurement of cell.
c) Difference in Prokaryotic and Eukaryotic Cell.
d) Physical nature of cytoplasmic matrix.
e) Chemical organization- organic and inorganic compounds of cytoplasmic matrix.

1.2 A) Plant Cell - Cytoplasmic Constituents **10L**

Morphology, Ultrastructure, Chemical composition and Functions of Cell wall, Plasma membrane, Endoplasmic Reticulum, Golgi apparatus and Mitochondria.

Credit - II **(15L)**

Unit - 2

2.1 B) Plant Cell - Cytoplasmic Constituents **10L**

Morphology, Ultrastructure, Chemical composition and Functions of Chloroplast, Lysosome, Vacuoles, Ribosomes, Peroxisomes and Glyoxysomes.

2.2 C) **Plant Cell - Nucleus and Chromosomes** **5L**

Nucleus - Morphology, Ultrastructure, Nucleoplasm, Nucleolus and functions.

Chromosome - Morphology and structure, Karyotype and ideogram.

References:

1. Arumugam, N. (2014). Cell biology. Saras Publication.
2. Cooper, G. M., & Hausman, R. E. (2013). The cell: A molecular approach (6th Ed.). Sinauer Associates.
3. Gupta, P. K. (2014). Cell and molecular biology (4th Ed.). Rastogi Publications.
4. Lodish, H., Berk, A., Kaiser, C. A., Krieger, M., Scott, M. P., Bretscher, A., Ploegh, H., & Matsudaira, P. (2016). Molecular cell biology (8th Ed.). W. H. Freeman.
5. Pollard, T. D., Earnshaw, W. C., Lippincott-Schwartz, J., & Johnson, G. T. (2017). *Cell biology* (3rd Ed.). Elsevier.
6. Powar, C. B. (2010). Cell biology. Himalaya Publishing House.
7. Rastogi, V. B. (2019). Cell biology. Kedarnath Ram Nath Publishers.
8. Roy, S. C., & De, K. K. (2005). Cell biology. New Central Book Agency.
9. Verma, P. S., & Agarwal, V. K. (2013). Cell biology, genetics, molecular biology, evolution and ecology. S. Chand Publishing.

Choice Based Credit System Syllabus (2024 Pattern)
Mapping of Program Outcomes with Course Outcomes

Class : T.Y.B. Sc. (Sem. V) **Subject** : Botany
Course: Cell Biology **Course Code :** BOT-302-MRM

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. Course 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.

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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- MRM**
Course Title	**:**	**Spermatophyta and Palaeobotany**
No. of Credits	**:**	**02**
No. of Teaching Hours	**:**	**30**

A) Course 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-1: Gymnosperms and Angiosperms **(15L)**

1.1 Introduction, general characters, classification Chamberlin 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 Theories related to origin of angiosperms 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 Use of flora, Preparation of artificial keys: Indented and bracketed keys, Plant authentication, Use of QR Code. 2L

Credit II

Unit-2: Palaeobotany (15L)

2.1 Geological time scale: Definition, Outline and brief account of Eras. 1L

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

2.3 Study of following fossil orders 10L

a) Psilophytales: External and internal characters of *Rhynia*.

b) Lepidodendrales: External and internal characters of *Lepidodendron*.

c) Calamitales: External and internal characters of *Calamites*.

d) Pentoxylales: External and internal characters of *Pentoxylon*.

References:

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Choice Based Credit System Syllabus (2024 Pattern)
Mapping of Program Outcomes with Course Outcomes

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

Course: Spermatophyta and Palaeobotany Course Code : BOT-303-MRM

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. Course 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.
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.

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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-MRM**
Course Title	**:**	**Molecular Biology**
No. of Credits	**:**	**02**
No. of Teaching Hours	**:**	**30**

A) Course 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) Course Outcome:

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

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 – 1 **(15L)**

1.1 Molecular Biology 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- 2 **(15 L)**

2.1 Gene Organization 3L

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

2.2 Transcription 5L

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

2.3 Genetic Code and Translation 7L

Definition, Concept, Properties of Genetic code Translation - Definition, Mechanism of translation - Initiation, Elongation and Termination

References

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2. Avers, C. J. (1986). Cell biology. Addison-Wesley.
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5. Loewy, A. G., & Siekevitz, P. (1991). Cell structure and function (3rd Ed.). Saunders College Publishing.
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9. Weaver, R. F. (2011). Molecular biology (5th Ed.). McGraw-Hill Science.
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Choice Based Credit System Syllabus (2024 Pattern)
Mapping of Program Outcomes with Course Outcomes

Class: T.Y.B. Sc. (Sem. V) Subject: Botany
Course: Molecular Biology Course Code: BOT-304-MRM
Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation

	Programme Outcomes (POs)												
Course Outcomes	PO1	PO2	PO 3	PO 4	PO 5	PO 6	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: Course 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.

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Name of the Programme	**:**	**B.Sc. Botany**
Program Code	**:**	**USBT**
Class	**:**	**T. Y. B. Sc.**
Semester	**:**	**V**
Course Type	**:**	**Major Mandatory**
Course Code	**:**	**BOT-305-MRM**
Course Title	**:**	**Practical based on BOT-301-MRM and BOT-302-MRM**
No. of Credits	**:**	**02**
No. of Teaching Hours	**:**	**60**

A) Course 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-MRM and BOT-302 MRM

1. Study of *Oscillatoria* with respect to systematic position, thallus structure and reproduction. 1P
2. Study of *Batrachospermum* with respect to systematic position, thallus structure and reproduction. 1P
3. Study of *Mucor* with respect to systematic position, thallus structure and reproduction. 1P
4. Study of *Puccinia* with respect to systematic position, thallus structure and reproduction. 1P
5. Study of *Anthoceros* with respect to systematic position, thallus structure and reproduction. 1P
6. Study of *Polytrichum* with respect to systematic position, thallus structure and reproduction. 1P
7. Study of *Psilotum* with respect to systematic position, sporophyte morphology and anatomy and reproductive structures. 1P

8. Study of *Selaginella* with respect to systematic position, sporophyte morphology and anatomy and reproductive structures. 1P
9. Study of cytological techniques- preparation of fixatives, preparation of stains. 1P
10. Study of various stages of mitosis. 1P
11. Study of various stages of meiosis. 1P
12. Plant genomic nucleic acids isolation. 1P
13. Extraction and estimation of plant DNA by DPA method. 1P
14. Extraction and estimation of plant RNA by orcinol method. 1P
15. Excursion tour to study cryptogams is compulsory. 1P

Choice Based Credit System Syllabus (2024 Pattern)
Mapping of Program Outcomes with Course Outcomes

Class: T.Y.B. Sc. (Sem. V) Subject: Botany
Course: Botany Practical I Course Code: BOT-305-MRM
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: Course 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.

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Name of the Programme	**:**	**B.Sc. Botany**
Program Code	**:**	**USBT**
Class	**:**	**T. Y. B. Sc.**
Semester	**:**	**V**
Course Type	**:**	**Major Mandatory (Practical)**
Course Code	**:**	**BOT-306-MRM**
Course Title	**:**	**Practical based on BOT-303-MRM and BOT-304-MRM**
No. of Credits	**:**	**02**
No. of Teaching Hours	**:**	**60**

A) Course Objectives:

8. To give knowledge of identification of higher plants and classify them.
9. To make students expert in slide preparation.
10. To give knowledge of advanced techniques in angiosperm taxonomy.
11. To make students expert in preparation of artificial keys.
12. To give knowledge of fossil plant groups.
13. To study methodology of extraction of DNA and RNA from plant material.
7. To aware the students about conservation of higher plants.

B) Course Outcome:

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

CO1. Get expertise in identification and classification of higher plants.
CO2. Get expertise in slide preparation.
CO3. Learnt advanced techniques in angiosperm taxonomy.
CO4. Get expertise in preparation of artificial keys.
CO5. Get knowledge of fossil plant groups.
CO6. Get expertise in extraction of DNA and RNA from plant material.
CO7. Get knowledge of conservation of higher plants.

Practical based on BOT-303-MRM and BOT-304-MRM

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. 2P
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. 2P
3. Study of at least any eight families as per theory course. 4P
4. Identification of plants with the help of regional/local/suitable flora. 1P
5. Preparation of an artificial key based on multiple characters - Androecium/Gynoecium/vegetative characters. 1P
6. Plant identification with the help of QR Code system. 1P
   Study of the fossil specimens with the help of slides and or specimens: 1P
   i) Impression ii) Compression iii) Petrifaction and iv) Coal ball.
7. Study of the fossil specimens with the help of slides and or specimens : 1P
   i) *Rhynia* ii) *Pentoxylon* iii) *Nipaniophyllum* and iv) *Lepidodendron*.
9. Plant Genomic DNA extraction from Cauliflower. 1P

10. Extraction and estimation of RNA by Orcinol Method. 1P

Note: Excursion tour to study Spermatophytes is compulsory.

Choice Based Credit System Syllabus (2024 Pattern)
Mapping of Program Outcomes with Course Outcomes

Class: T.Y.B. Sc. (Sem. V) Subject: Botany
Course: Practical based on BOT-303 & 304-MRM Course Code: BOT-306-MRM

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

Justification for the mapping

PO1. Comprehensive Knowledge and Understanding
CO1. Get expertise in identification and classification of higher plants.
CO2. Get expertise in slide preparation.
CO3. Learnt advanced techniques in angiosperm taxonomy.
CO4. Get expertise in preparation of artificial keys.
CO5. Get knowledge of fossil plant groups.
CO6. Get expertise in 3extraction of DNA and RNA from plant material.
CO7. Get knowledge of conservation of higher plants.

PO2. Practical, Professional, and Procedural Knowledge
CO1. Get expertise in identification and classification of higher plants.
CO2. Get expertise in slide preparation.
CO3. Learnt advanced techniques in angiosperm taxonomy.
CO4. Get expertise in preparation of artificial keys.
CO5. Get knowledge of fossil plant groups.
CO6. Get expertise in extraction of DNA and RNA from plant material.
CO7. Get knowledge of conservation of higher plants.

PO3. Entrepreneurial Mind-set and Knowledge
CO1. Get expertise in identification and classification of higher plants.
CO2. Get expertise in slide preparation.
CO3. Learnt advanced techniques in angiosperm taxonomy.
CO4. Get expertise in preparation of artificial keys.

P04. Specialized Skills and Competencies

CO1. Get expertise in identification and classification of higher plants.
CO2. Get expertise in slide preparation.
CO3. Learnt advanced techniques in angiosperm taxonomy.
CO4. Get expertise in preparation of artificial keys.

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

CO5. Get knowledge of fossil plant groups.
CO6. Get expertise in extraction of DNA and RNA from plant material.
CO7. Get knowledge of conservation of higher plants.

PO7. Research-related Skills

CO1. Get expertise in identification and classification of higher plants.
CO2. Get expertise in slide preparation.
CO3. Learnt advanced techniques in angiosperm taxonomy.
CO4. Get expertise in preparation of artificial keys.
CO5. Get knowledge of fossil plant groups.
CO6. Get expertise in extraction of DNA and RNA from plant material.
CO7. Get knowledge of conservation of higher plants.

P08. Course How to Learn Skills

CO1. Get expertise in identification and classification of higher plants.
CO2. Get expertise in slide preparation.
CO3. Learnt advanced techniques in angiosperm taxonomy.
CO4. Get expertise in preparation of artificial keys.

PO11. Value Inculcation and Environmental Awareness

CO7. Get knowledge of conservation of higher plants.

PO13. Community Engagement and Service

CO1. Get expertise in identification and classification of higher plants.
CO2. Get expertise in slide preparation.
CO3. Learnt advanced techniques in angiosperm taxonomy.
CO4. Get expertise in preparation of artificial keys.
CO5. Get knowledge of fossil plant groups.
CO6. Get expertise in extraction of DNA and RNA from plant material.
CO7. Get knowledge of conservation of higher plants.

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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-307-MJE (A)**
Course Title	**:**	**Biostatistics and Research Methodology**
No. of Credits	**:**	**02**
No. of Teaching Hours	**:**	**30**

A) Course Objectives:

1. To understand the meaning, objectives, types and significance of research in biological sciences.
2. To learn the process of identification and formulation of a research problem.
3. To understand the characteristics and basis of a good hypothesis in scientific research.
4. To study the systematic preparation of a project report including all essential components.
5. To understand the basic concepts and terminology used in biostatistics.
6. To learn the scope, applications and limitations of biostatistics in biological research.
7. To develop skills in tabular and graphical representation of statistical data.

B) Course Outcome:

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

CO1: Explain the definition, objectives, types, and significance of research in life sciences.
CO2: Identify and formulate research problems and construct scientifically valid hypotheses.
CO3: Prepare a well-structured project report including introduction, review of literature, methodology, results, discussion, and bibliography.
CO4: Define and interpret fundamental statistical terms such as population, sample, qualitative and quantitative data, statistical error, and frequency distribution.
CO5: Describe the scope, applications, and limitations of biostatistics in biological studies.
CO6: Present statistical data effectively using tabular methods and graphical techniques such as histogram, frequency polygon, frequency curve, and scatter diagram.
CO7: Analyze and interpret biological data using appropriate diagrammatic representations such as line diagram, bar diagram, and pie diagram.

Credit-I **(15L)**

Unit-1

1.1 Introduction to Biostatistics:

a) Definition: 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
b) Scope, applications, limitations and uses of biostatistics 6L

1.2 Analysis of data for vegetation studies: Data obtained from quadrates methods: mean, mode median, standard deviation, frequency, percent frequency, relative frequency, density, relative density, abundance, dominance and ANOVA. 4L

1.3 Computation of seed germination and plant growth indices: 5L

a) Seed germination and early seedling growth.
b) Germination percentage
c) Mean germination time (MGT)

d) Germination index (GI)
e) Germination speed (GS)
f) Vigor index (VI).

Credit-II **(15L)**

Unit-2 Research Methodology

2.1 Definition, objectives of research, types of research, significance of research. 1L
2.2 Identification and defining the research problem. 2L
2.3 Characteristics of research: qualitative and quantitative. 2L
2.4 Research questions and hypothesis: characteristics of good hypothesis. Basis for hypotheses, formulation of hypothesis- directional and non-directional hypothesis. 2L

2.5 Methods of data collections: Observation, experimental and questionnaire, primary data, secondary data, selection of appropriate method for data collection. 1L
2.2 Research design: concepts, need, features of good design. 1L
2.3 Methods of research: survey, philosophical, historical, experimental, case studies. 2L
2.4 Preparation of project report: Title, introduction, review of literature, material and methods, table and graphs, result and discussions, summary and conclusion, bibliography. 4L

References:

1. Creswell, J. W. (2014). Research design: Qualitative, quantitative, and mixed methods approaches (4th Ed.). SAGE Publications.
2. Daniel, W. W. (2000). Biostatistics: A foundation for analysis in the health sciences (7th Ed.). John Wiley & Sons.
3. Gomez, K. A., & Gomez, A. A. (1984). Statistical procedures for agricultural research (2nd Ed.). John Wiley & Sons.
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Choice Based Credit System Syllabus (2024 Pattern)
Mapping of Program Outcomes with Course Outcomes

Class: T.Y.B. Sc. (Sem. V) Subject : Botany
Course: Practical based on BOT-303-MRM and BOT-304-MRM
Course Code: BOT-306-MRM
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	1	2			1	2					1
CO 2	2	1	2	2			1	2					2
CO 3	2	2	3	3			2	3					3
CO 4	3	1	2	3			3	2					3
CO 5	3	2			3		2						2
CO 6	3	3			2		3						2
CO 7	3	3			2		3				3		1

Justification for the mapping

PO1: Comprehensive Knowledge and Understanding
CO1 provides foundational knowledge about the definition, objectives, types, and significance of research, which strengthens students' conceptual clarity in life sciences.
CO4 enhances understanding of fundamental statistical terms essential for interpreting scientific data.
CO5 broadens students' knowledge regarding the scope and applications of biostatistics in biological studies.
Together, these outcomes ensure comprehensive theoretical understanding aligned with PO1.**PO2: Practical, Professional, and Procedural Knowledge**
CO3 develops procedural knowledge by training students in preparing structured project reports following scientific standards.
CO6 enhances practical competence in presenting statistical data using appropriate graphical tools.
CO7 strengthens professional skills in analyzing and interpreting biological data through diagrams.
These competencies directly support practical and professional knowledge as stated in PO2.
PO3: Entrepreneurial Mindset and Knowledge
CO5 introduces students to the real-world applications and limitations of biostatistics in biological fields. Understanding practical applications in agriculture, biotechnology, healthcare, and environmental sciences fosters innovative thinking and entrepreneurial awareness.
PO4: Specialized Skills and Competencies
CO2 develops specialized skills in identifying research problems and constructing valid hypotheses.
CO6 and CO7 build technical competence in statistical data presentation and interpretation.
These skills are essential for professional specialization in research and scientific practice.
PO5: Capacity for Application, Problem-Solving, and Analytical Reasoning
CO2 enhances analytical reasoning through hypothesis formulation.
CO4 develops interpretative ability of statistical concepts.
CO6 and CO7 improve data analysis and problem-solving skills through graphical and diagrammatic representations.
PO5.6: Communication Skills and Collaboration

Preparation of a structured project report (CO3) enhances scientific writing, documentation, and presentation skills. These are critical components of effective communication and collaboration in research environments.

PO7: Research-related Skills

CO1 builds research awareness and understanding of scientific methodology.

CO2 strengthens research design skills through problem identification and hypothesis formulation.

CO3 develops competence in documentation and presentation of research findings.

Together, these outcomes align strongly with PO7.

PO8: Course How to Learn Skills

CO1 encourages students to explore research methodologies independently.

CO5 promotes understanding of statistical applications, motivating continuous Course and skill enhancement in biostatistics.

PO9: Digital and Technological CO6 and CO7 require the use of statistical tools, graphical techniques, and possibly software for data representation. This enhances students' digital literacy and technological competence.

PO10: Multicultural Competence, Inclusive Spirit, and Empathy

Understanding research methodologies exposes students to global research standards and diverse scientific perspectives, fostering inclusivity and cross-cultural scientific awareness.

PO11: Value Inculcation and Environmental Awareness

Applications of biostatistics in biological and environmental studies promote ethical data interpretation and awareness of sustainability and ecological responsibility.

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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-307-MJE (B)**
Course Title	**:**	**Plant Embryology**
No. of Credits	**:**	**02**
No. of Teaching Hours	**:**	**30**

A) Course 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.

Credit - I **(18L)**

Unit - 1

1.1 Plant Embryology Introduction **2L**

Definition and scope of plant embryology.

1.2 Microsporangium and male gametophyte **8L**

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

1.3 Megasporangium and female gametophyte **8L**

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.

Credit - II **(12L)**

Unit - 2

2.1 Fertilization **6L**

Mechanism of pollination - entomophily, anemophily, hydrophily, zoophily, germination of pollen grain, double fertilization (syngamy and triple fusion) and its significance.

2.2 Endosperm and embryo **6L**

Endosperm: Types - nuclear, helobial and cellular.

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

Choice Based Credit System Syllabus (2024 Pattern)

Mapping of Program Outcomes with Course Outcomes

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

Course: Plant Embryology Course Code : BOT-307-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	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. Course 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.

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Name of the Programme	**:**	**B.Sc. Botany**
Program Code	**:**	**USBT**
Class	**:**	**T. Y. B. Sc.**
Semester	**:**	**V**
Course Type	**:**	**MJE Major Elective (Practical)**
Course Code	**:**	**BOT-308-MJE (A)**
Course Title	**:**	**Practicals based on Biostatistics and Research Methodology**
No. of Credits	**:**	**02**
No. of Teaching Hours	**:**	**60**

A) Course Objectives

1. To understand the basic concepts, objectives, types and significance of research in life sciences.
2. To develop the ability to identify and formulate research problems in biological studies.
3. To understand the characteristics and formulation of scientific hypotheses.
4. To learn the systematic preparation of research reports including all essential components.
5. To acquire knowledge of fundamental statistical terms and concepts used in biostatistics.
6. To understand the scope, applications, and limitations of biostatistics in biological research.
7. To develop skills in tabular, graphical, and diagrammatic representation of statistical data.

B) Course Outcomes (COs)

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

CO1: Explain the definition, objectives, types, and significance of research in life sciences.

CO2: Identify research problems and formulate clear, testable scientific hypotheses.

CO3: Prepare a structured research report including title, introduction and review of literature, methodology, results, discussion, and bibliography.

CO4: Define and interpret fundamental statistical terms such as population, sample, qualitative and quantitative data, and frequency distribution.

CO5: Describe the scope, applications, and limitations of biostatistics in biological sciences.

CO6: Present and analyze statistical data using appropriate tabular and graphical methods such as histograms, frequency polygons, and scatter diagrams.

CO7: Interpret biological data effectively using diagrammatic representations such as line diagrams, bar diagrams, and pie charts.

Practicals based BOT-307- MRM (A) on Biostatistics and Methodology
BOT-308-MJE (A)

1. Calculate the mean, median and mode from biological data. 1P
2. Calculate the standard deviation and standard error of given data. 1P
3. Perform linear regression analysis on biological data. 1P
4. Apply student's t-test to compare two sample means. 1P
5. Construct frequency distribution table and histogram. 1P
6. Represent biological data using bar diagram. 1P

7. Represent biological data using pie chart. 1P
8. Analysis of variance (ANOVA) for comparing multiple means. 1P
9. Identification and formulation a research problem in biological sciences. 1P
10. Preparation objectives and hypothesis for a research project. 2P
11. Preparation of a review of literature from scientific journals and books. 1P
12. Preparation of a complete project report (Title to Bibliography format). 2P
13. Studies on laboratory hazards and safety measures in biological laboratory. 1P

Choice Based Credit System Syllabus (2024 Pattern)
Mapping of Program Outcomes with Course Outcomes

Class : T.Y.B. Sc. (Sem. V) Subject : Botany
Course Code: BOT-308-MJE (A)
Course: Practicals based on Biostatistics and Research Methodology
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	–	2	2	1	2	2	–	1	–	1	–
CO 2	2	2	1	3	3	1	3	2	–	–	–	2	1
CO 3	2	3	1	3	2	3	3	2	2	1	–	2	1
CO 4	3	2	–	2	3	1	2	2	1	–	–	1	–
CO 5	3	2	1	2	3	1	2	2	1	–	1	1	2
CO 6	2	3	1	3	3	2	2	2	3	–	–	1	1
CO 7	2	3	1	3	3	2	2	2	3	–	1	1	1

Justification for the mapping

PO1: Comprehensive Knowledge and Understanding
PO1 focuses on developing strong conceptual foundations in the subject.
CO1 builds fundamental understanding of research definitions, objectives, types, and significance in life sciences. This strengthens theoretical clarity and scientific awareness.
CO4 enhances conceptual understanding of statistical terms such as population, sample, qualitative and quantitative data, and frequency distribution, which are essential for interpreting scientific studies.
CO5 broadens knowledge about the scope, applications, and limitations of biostatistics, helping students understand how statistical tools function within biological sciences.
Together, these outcomes ensure a deep and structured understanding of research and statistical foundations, justifying a strong mapping with PO1.
PO2: Practical, Professional, and Procedural Knowledge
PO2 emphasizes procedural competence and professional readiness.
CO3 trains students in preparing structured research reports, which is a professional skill required in academic and industrial research settings.

CO6 develops practical competence in constructing and analyzing graphs such as histograms and frequency polygons.
CO7 strengthens procedural ability in preparing line diagrams, bar diagrams, and pie charts for data interpretation.
PO3: Entrepreneurial Mindset and Knowledge
PO3 encourages innovation and application-based thinking.CO5 introduces students to real-world applications of biostatistics in agriculture, healthcare, biotechnology, and environmental sciences, which fosters innovative problem-solving ideas.
CO6 and CO7 equip students with data analysis and interpretation skills that are essential for evidence-based decision-making in entrepreneurial ventures.
PO4: Specialized Skills and Competencies
PO4 focuses on developing subject-specific expertise.
CO2 develops specialized skills in identifying research problems and constructing scientifically valid hypotheses
CO3 builds competence in scientific documentation and report preparation.
CO6 and CO7 enhance technical proficiency in statistical and diagrammatic data analysis.
PO5: Capacity for Application, Problem-Solving, and Analytical Reasoning
PO5 emphasizes logical reasoning and application.
CO2 involves hypothesis formulation, which requires analytical thinking.
CO4 develops interpretation skills of statistical concepts.
CO6 and CO7 strengthen analytical ability through graphical and diagrammatic data interpretation.
PO6: Communication Skills and Collaboration.
CO3 involves structured scientific writing, preparation of research reports, and presentation of results.
Scientific documentation improves clarity, organization, and professional communication.
Report writing and presentation skills are essential for teamwork, academic communication, and professional collaboration.
PO7: Research-related Skills **CO1** builds foundational knowledge of research methodology.
CO2 strengthens skills in research problem identification and hypothesis construction.
CO3 enhances competence in documentation and reporting of research findings.
PO8: Course How to Learn Skills
PO9: Digital and Technological Skills
CO6 and CO7 require preparation of statistical graphs and diagrams, often using digital tools such as spreadsheets or statistical software.
These activities enhance digital literacy and technological proficiency in handling biological data.
PO10: Multicultural Competence, Inclusive Spirit, and Empathy
CO1 introduces students to universal research methodologies and global scientific standards.
CO3 involves structured documentation aligned with international research formats.
PO11: Value Inculcation and Environmental Awareness
CO5 highlights applications of biostatistics in environmental and ecological studies, promoting responsible data interpretation.
CO7 enables analysis of biological data related to environmental trends and sustainability.
PO12: Autonomy, Responsibility, and Accountability
CO2 requires independent identification of research problems and hypothesis formulation.
CO3 develops responsibility in accurate documentation and reporting of research findings.

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Name of the Programme	**:**	**B.Sc. Botany**
Program Code	**:**	**USBT**
Class	**:**	**T. Y. B. Sc.**
Semester	**:**	**V**
Course Type	**:**	**MJE Major Elective (Practical)**
Course Code	**:**	**BOT-308-MJE (B)**
Course Title	**:**	**Practical based on Plant Embryology**
No. of Credits	**:**	**02**
No. of Teaching Hours	**:**	**60**

A) Course Objectives:

1. To understand the structure and development of male and female reproductive organs in angiosperms.
2. To study the process of microsporogenesis and megasporogenesis.
3. To examine the structure and development of male and female gametophytes.
4. To understand the process of pollination, fertilization, and double fertilization.
5. To identify permanent slides and reproductive stages under a microscope.
6. To develop practical skills in slide observation and diagrammatic representation.
7. To correlate theoretical knowledge with practical observations.

B) Course Outcome:

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

CO1. Describe the internal structure of anther and ovule.
CO2. Explain the stages of microsporogenesis and megasporogenesis.
CO3. Identify and draw labeled diagrams of pollen grain and embryo sac.
CO4. Explain the process of double fertilization in angiosperms.
CO5. Identify important embryological stages in permanent slides.
CO6. Develop skills in microscopic observation and scientific drawing.
CO7. Interpret developmental stages of seed formation.

Practical based on Plant Embryology

1. Study of T.S. of Anther
2. Study of Microsporogenesis
3. Study of Structure of Pollen Grain (Male Gametophyte)
4. Study of Pollen Germination (Temporary Mount)
5. Study of Types of Ovules
6. Study of T.S. of Ovule (Anatropous Ovule)
7. Study of Megasporogenesis
8. Study of Development of Embryo Sac (*Polygonum* Type)
9. Study of Structure of Mature Embryo Sac
10. Study of Fertilization and Double Fertilization
11. Study of Development of Dicot Embryo (*Capsella* type)
12. Study of Development of Monocot Embryo
13. Study of Structure of Dicot Seed
14. Study of Structure of Monocot Seed (Maize)
15. Identification of Permanent Slides/Spotting (Anther, Ovule, Embryo Sac, Endosperm, etc.)

Choice Based Credit System Syllabus (2024 Pattern)
Mapping of Program Outcomes with Course Outcomes

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

Course: Practical based on Plant Embryology Course Code: BOT-308-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	1	2			1								
CO 2	1	2			2								
CO 3	2	3			1								
CO 4	2	1			2								
CO 5	3	3	2	3	2			2					3
CO 6	2	2	2	3				3					3
CO 7	3	2		2				2	2				2

Justification for the mapping

PO1. Comprehensive Knowledge and Understanding

CO1. Describe the internal structure of anther and ovule.
CO2. Explain the stages of microsporogenesis and megasporogenesis.
CO3. Identify and draw labeled diagrams of pollen grain and embryo sac.
CO4. Explain the process of double fertilization in angiosperms.
CO5. Identify important embryological stages in permanent slides.
CO6. Develop skills in microscopic observation and scientific drawing.
CO7. Interpret developmental stages of seed formation.

PO2. Practical, Professional, and Procedural Knowledge

CO1. Describe the internal structure of anther and ovule.
CO2. Explain the stages of microsporogenesis and megasporogenesis.
CO3. Identify and draw labeled diagrams of pollen grain and embryo sac.
CO4. Explain the process of double fertilization in angiosperms.
CO5. Identify important embryological stages in permanent slides.
CO6. Develop skills in microscopic observation and scientific drawing.
CO7. Interpret developmental stages of seed formation.

PO3. Entrepreneurial Mindset and Knowledge

CO5. Identify important embryological stages in permanent slides.
CO6. Develop skills in microscopic observation and scientific drawing.

PO4. Specialized Skills and Competencies

CO5. Identify important embryological stages in permanent slides.
CO6. Develop skills in microscopic observation and scientific drawing.
CO7. Interpret developmental stages of seed formation.

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

CO1. Describe the internal structure of anther and ovule.
CO2. Explain the stages of microsporogenesis and megasporogenesis.

CO3. Identify and draw labeled diagrams of pollen grain and embryo sac.
CO4. Explain the process of double fertilization in angiosperms.
CO5. Identify important embryological stages in permanent slides.

P08. Course How to Learn Skills.

CO5. Identify important embryological stages in permanent slides.
CO6. Develop skills in microscopic observation and scientific drawing.
CO7. Interpret developmental stages of seed formation.

PO9. Digital and Technological Skills

CO7. Interpret developmental stages of seed formation.

PO13. Community Engagement and Service

CO5. Identify important embryological stages in permanent slides.
CO6. Develop skills in microscopic observation and scientific drawing.
CO7. Interpret developmental stages of seed formation.

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Name of the Programme	**:**	**B.Sc. Botany**
Program Code	**:**	**USBT**
Class	**:**	**T.Y.B.Sc.**
Semester	**:**	**V**
Course Type	**:**	**On Job Training - Practical**
Course Code	**:**	**BOT-309-OJT**
Course Title	**:**	**On Job Training**
No. of Credits	**:**	**04**
No. of Teaching Hours	**:**	**120 hrs.**

A) Course Objectives:

1. To bridge theory and practice in Botany.
2. To expose students to real world applications of Botanical science
3. To develop technical competencies in lab / field / industry relevant work.
4. To build soft skills: professional conduct, teamwork, communication
5. To help students understand operations in an industry / research institution / botanical garden / agricultural / forestry / biotech industry etc.
6. To enable students to undertake a meaningful project.
7. To develop entrepreneur skill in students.

B) Course Outcomes:

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

CO1.Apply theoretical botanical knowledge to practical, real-life lab and field situations.

CO2.Demonstrate awareness of how botanical science is used in various sectors such as agriculture, environment, and industry.

CO3.Operate laboratory and field instruments, follow standard protocols, and collect & analyse botanical data.

CO4.Display professional behaviour, work effectively in teams, and communicate scientific information clearly.

CO5.Describe and evaluate the organizational setup and workflows of botanical institutions and industries.

CO6.Plan, execute, and report a small-scale project with scientific temperament.

CO7.Identify and evaluate entrepreneurial opportunities in plant-based products, services, or processes.

Credit: I **(30L)**

Unit-1

Industry selection, Topic selection, Study design, Survey preparation, Field work, Analysis.

Credit: 2 **(30L)**

Unit-2

Report writing and Oral presentation based on Job Training (OJT) Project work.

Choice Based Credit System Syllabus (2024 Pattern)
Mapping of Program Outcomes with Course Outcomes

Class: T. Y. B. Sc. (Sem. VI) Subject: Botany
Course: Community Engagement Project-Practical Course Code: BOT-309-OJT
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	PO 11	PO 12	PO 13
CO1	03	02			02			02					
CO2	02			03							02		02
CO3		03		02	02				02				
CO4						03						02	03
CO5		02										03	02
CO6					02		02	03					
CO7			02	02	03							02	

Justification for the mapping

PO1. Comprehensive Knowledge and Understanding
CO1: Apply theoretical botanical knowledge to practical, real-life lab and field situations.
CO2: Demonstrate awareness of how botanical science is used in various sectors such as agriculture, environment, and industry.

PO2. Practical, Professional, and Procedural Knowledge
CO1: Apply theoretical botanical knowledge to practical, real-life lab and field situations.
CO3: Operate laboratory and field instruments, follow standard protocols, and collect & analyse botanical data.
CO5: Describe and evaluate the organizational setup and workflows of botanical institutions and industries.

PO3. Entrepreneurial Mind set and Knowledge
CO7: Identify and evaluate entrepreneurial opportunities in plant-based products, services, or processes.

PO4. Specialized Skills and Competencies
CO2: Demonstrate awareness of how botanical science is used in various sectors.
CO3: Operate laboratory and field instruments effectively.
CO7: Identify and evaluate entrepreneurial opportunities in the botanical domain.

PO5. Capacity for Application, Problem-Solving, and Analytical Reasoning
CO1: Apply theoretical botanical knowledge to real-world situations.
CO3: Analyse field and lab data critically.
CO6: Plan and execute a small-scale scientific project.
CO7: Evaluate plant-based entrepreneurial ideas using scientific reasoning.

PO6. Communication Skills and Collaboration
CO4: Display professional behavior, work in teams, and communicate effectively.

PO7. Research-related Skills
CO6: Plan, execute, and report a small-scale project or case study with scientific rigor.

PO8. Course How to Learn Skills
CO1: Apply theoretical knowledge independently in practical contexts.
CO6: Plan and manage independent Course through project execution.

PO9. Digital and Technological Skills
CO3: Operate lab/field instruments and use digital tools for botanical analysis.
PO11. Value Inculcation and Environmental Awareness
CO2: Demonstrate awareness of botany's applications in agriculture, ecology, and conservation.
PO12. Autonomy, Responsibility, and Accountability
CO4: Demonstrate professionalism and ethical behavior in teams.
CO5: Understand institutional responsibilities and work systems.
PO13. Community Engagement and Service
CO2: Demonstrate real-world relevance of botanical science.
CO4: Collaborate and communicate effectively in societal or field settings.
CO5: Understand how botanical institutions serve communities.

Anekant Education Society's
Tuljaram Chaturchand College, Baramati
Standard Operating Protocols for On Job Training
UG (Year-III Semester-VI)

1. Objective of On-Job Training (OJT)
   To provide hands-on exposure to real-world working environments, improve employability, and bridge the gap between academic Course and industry expectations.
2. Industry/Organization Engagement
   - Students must be placed in an industry, NGO, government organization, private enterprise, MSME, or other approved workplaces relevant to their field of study.
   - The organization should be identified by the department/placement cell/student (with departmental approval).
   - A formal letter (from department to organization) and consent letter (from organization to department) should be exchanged before OJT begins.
3. Faculty Guide and Departmental OJT Coordinator
   - One faculty member will be assigned as a Guide for 2-3 students or per student (based on department policy).
   - A departmental OJT Coordinator will oversee the implementation and record maintenance of all students.
4. Course Hours Requirement
   - A minimum of 30 hours per credit (i.e., 60 hours total) must be completed for the award of 2 credits.
5. Project Topic/Area Selection
   Students should identify a training domain/topic aligned with their academic course and job aspirations.

The Training Plan must include:
- Objective of training
- Expected outcomes
- Activities to be undertaken
- Organization details

6. Training Diary / Logbook Maintenance
- Students must maintain a Daily Training Diary **or** Logbook detailing:
- Date-wise tasks performed
- Skills learned

- Observations
- Reflections on practical exposure
- The diary should be signed weekly by the industry supervisor and submitted to the guide for review.

7. Evaluation Parameters & Hours Allocation

Step of Project	**Individual students work in hours**	**Marks**
Topic Selection/ Study Design	05	05
Hands-on Training	30	20
Weekly Logbook/Daily Diary	05	05
Final Report Writing	10	10
Oral Presentation		10
Total	**60**	**50**

8. OJT Report Format

- Typed and spiral-bound report with the following structure (minimum 25 pages):
- Title Page
- Certificate (by Organization & College)
- Acknowledgment
- Index
- Chapter 1: Introduction of Organization
- Chapter 2: Nature of Work Assigned
- Chapter 3: Skills and Knowledge Acquired
- Chapter 4: Observations and Course
- Chapter 5: Challenges and Solutions
- Chapter 6: Conclusion and Recommendations
- References
- Appendices (if any – photos, documents, certificates)

9. Submission Guidelines

- Submit the final OJT Report (2 copies) with signatures of the Guide and Industry Mentor to the Departmental OJT Coordinator**.**

10. Oral Presentation / Viva Voce

- All students must make a presentation of their training experience.
- Evaluation to be conducted by two examiners (internal/external) appointed by the HoD.

11. Passing Criteria

- This is a compulsory subject under the NEP curriculum.
- Students must successfully complete the OJT and pass all components to be eligible for their degree.

12. Important Notes

- Students are responsible for their own safety, conduct, and punctuality during the training.
- Attendance and behavior at the workplace will be monitored by both the industry and academic supervisors.
- Insurance coverage (if required) to be clarified in advance.

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Name of the Programme	**:**	**B.Sc. Botany**
Program Code	**:**	**USBT**
Class	**:**	**T.Y.B.Sc.**
Semester	**:**	**V**
Course Type	**:**	**Minor (Theory)**
Course Code	**:**	**BOT-310-MN**
Course Title	**:**	**Economic Botany**
No. of Credits	**:**	**02**
No. of Teaching Hours	**:**	**30**

A) Course Objectives:

1. To know plant biology.
2. To give knowledge about botanical aspects of economically important plants.
3. To impart and origins of important plats utilized as food, fiber, fodder, medicine, dye.
4. To demonstrate a deeper knowledge of a chosen medicinal plant.
5. To impart the career opportunities agriculture.
6. To evaluate the importance of plants and their different roles.
7. To study use of different plant structures.

B) Course Outcomes:

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

CO1.Apply theoretical botanical knowledge to practical, real-life lab and field situations.

CO2.Demonstrate awareness of how botanical science is used in various sectors such as agriculture, environment, and industry.

CO3.Operate laboratory and field instruments, follow standard protocols, and collect & analyse botanical data.

CO4.Display professional behaviour, work effectively in teams, and communicate scientific information clearly.

CO5.Describe and evaluate the organizational setup and workflows of botanical institutions and industries.

CO6.Plan, execute, and report a small-scale project with scientific temperament.

CO7.Identify and evaluate entrepreneurial opportunities in plant-based products, services, or processes.

Topics and Course

Study of the following plants with respect to Botanical name, family, method of cultivation, part used, economic importance of plants of each category.

Credit - I

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

1.1 Definition, Scope, Importance and applications of Economic Botany. 1L

1.2 Study of the following plants with respect to Botanical name, family, method of cultivation, part used, economic importance of at least three plants of each category.

a) Cereals: Rice, Wheat, Maize. 2L
b) Millets: Jowar, Ragi, Bajra. 2L
c) Pulses: Soyabean, Peanut, Chick-pea. 2L
d) Fiber plants: Cotton, Jute, Agave. 2L
e) Rubber and its products. 2L
f) Oil yielding plants: Coconut, Sunflower, Safflower. 2L

g) Timber: Indian Rosewood (Shisham), Teakwood and Mahogany. 2L

Credit - II

Unit-II: (15L)

2.1 Study of the following plants with respect to Botanical name, family, method of cultivation, part used, economic importance of plants of each category.

a) Spices: Clove, Cardamom, Cinnamon. 2L
b) Beverages: Coffee, Tea, Kokum. 2L
c) Aromatic plants: Rose, Geranium, Sandalwood. 2L
d) Fruits: Mango, Grapes, Dragon fruit. 2L
e) Medicinal plants: Amla, Adulsa, *Aloe vera*. 2L
f) Vegetables: Potato, Brinjal, Tomato. 2L
g) Nuts: Cashewnut, Walnut, Almond. 1L
h) Gum and Resin: Neem, Babul, *Pinus*. 2L

References:

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4. Pandey, B. P. (1992). *Economic botany*. S. Chand & Company.
5. Pandey, B. P. (2023). Botany for B.Sc. student's semester II: Economic botany and plant conservation. S. Chand Publishing.
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Choice Based Credit System Syllabus (2024 Pattern)
Mapping of Program Outcomes with Course Outcomes

Class : T. Y. B. Sc. (Sem. V) Subject : Botany
Course : Minor Course Code : BOT-310-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	PO7	PO8	PO9	PO10	PO 11	PO 12	PO 13
CO1	03	02			02			02					
CO2	02			03							02		02
CO3		03		02	02				02				
CO4						03						02	03
CO5		02										03	02
CO6					02		02	03					
CO7			02	02	03							02	

Justification for the mapping

PO1: Comprehensive Knowledge and Understanding:
CO2. Utilize knowledge about plants utilized in food, fibre, fodder, medicine, dye.
CO3. Use knowledge about different plants and their commercial products.
PO2: Practical, Professional, and Procedural Knowledge
CO2. Utilize knowledge about plants utilized in food, fibre, fodder, medicine, dye. CO3. Use knowledge about different plants and their commercial products.
PO3: Entrepreneurial Mind-set and Knowledge:
CO1. Understand basics of commercial source of plant part.
CO2. Utilize knowledge about plants utilized in food, fibre, fodder, medicine, dye.
CO3. Use knowledge about different plants and their commercial products.
PO4: Specialized Skills and Competencies:
CO2. Utilize knowledge about plants utilized in food, fibre, fodder, medicine, dye.
CO3. Use knowledge about different plants and their commercial products.
PO5: Capacity for Application, Problem-Solving, and Analytical Reasoning:
CO2. Utilize knowledge about plants utilized in food, fibre, fodder, medicine, dye.
CO3. Use knowledge about different plants and their commercial products.
PO6: Communication Skills and Collaboration:
CO1. Understand basics of commercial source of plant part.
CO2. Utilize knowledge about plants utilized in food, fibre, fodder, medicine, dye.
PO7: Research-related Skills:
CO1. Understand basics of commercial source of plant part.
CO2. Utilize knowledge about plants utilized in food, fibre, fodder, medicine, dye.
PO8: Course How to Learn Skills:
CO2. Utilize knowledge about plants utilized in food, fibre, fodder, medicine, dye.
CO3. Use knowledge about different plants and their commercial products.
PO9: Digital and Technological Skills:
CO1. Understand basics of commercial source of plant part.
CO2. Utilize knowledge about plants utilized in food, fibre, fodder, medicine, dye.
CO3. Use knowledge about different plants and their commercial products.
PO10: Multicultural Competence, Inclusive Spirit, and Empathy:
CO1. Understand basics of commercial source of plant part.
CO2. Utilize knowledge about plants utilized in food, fibre, fodder, medicine, dye.
PO11: Value Inculcation and Environmental Awareness:
CO2. Utilize knowledge about plants utilized in food, fibre, fodder, medicine, dye.
CO3. Use knowledge about different plants and their commercial products.
PO12: Autonomy, Responsibility, and Accountability:
CO2. Utilize knowledge about plants utilized in food, fibre, fodder, medicine, dye.
CO3. Use knowledge about different plants and their commercial products.
PO13: Community Engagement and Service:
CO1. Understand basics of commercial source of plant part.
CO2. Utilize knowledge about plants utilized in food, fibre, fodder, medicine, dye.
CO3. Use knowledge about different plants and their commercial products.

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