Anekant Education Society's

Tuljaram Chaturchand College of Arts, Science and Commerce, Baramati

(Autonomous)

Four B. Sc. Degree Program in Botany

(Faculty of Science and Technology)

CBCS Syllabus

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

Program Outcomes (Pos) for B. Sc. Program

PO1	**Disciplinary Knowledge:** Demonstrate comprehensive knowledge of the disciplines that form a part of a graduate programme. Execute strong theoretical and practical understanding generated from the specific graduate programme in the area of work.
PO2	**Critical Thinking and Problem solving:** Exhibit the skills of analysis, inference, interpretation and problem-solving by observing the situation closely and design the solutions.
PO3	**Social competence:** Display the understanding, behavioural skills needed for successful social adaptation , work in groups, exhibit thoughts and ideas effectively in writing and orally
PO4	**Research-related skills and Scientific temper:** Develop the working knowledge and applications of instrumentation and laboratory techniques. Able to apply skills to design and conduct independent experiments, interpret, establish hypothesis and inquisitiveness towards research.
PO5	**Trans-disciplinary knowledge:** Integrate different disciplines to uplift the domains of cognitive abilities and transcend beyond discipline-specific approaches to address a common problem
PO6	**Personal and professional competence:** Performing dependently and also collaboratively as a part of a team to meet defined objectives and carry out work across interdisciplinary fields. Execute interpersonal relationships, self-motivation and adaptability skills and commit to professional ethics.
PO7	**Effective Citizenship and Ethics:** Demonstrate empathetic social concern and equity centred national development, and ability to act with an informed awareness of moral and ethical issues and commit to professional ethics and responsibility.
PO8	**Environment and Sustainability:** Understand the impact of the scientific solutions in societal and environmental contexts and demonstrate the knowledge of and need for sustainable development.
PO9	**Self-directed and Life-long learning:** Acquire the ability to engage in independent and life-long learning in the broadest context of socio-technological changes.

Anekant Education of Society's

Tuljaram Chaturchand College of Arts, Science and Commerce, Baramati
Autonomous

SYLLABUS (CBCS) FOR T. Y. B. Sc. BOTANY (w.e. from June, 2024)

Semester	Paper	Title of Paper	Credits
V	USBT351	Cryptogamic Botany (Algae, Fungi, Bryophytes and Pteridophytes)	03
	USBT352	Spermatophyta and Palaeobotany	03
	USBT353	Cell and Molecular Biology	03
	USBT354	Industrial Botany	03
	USBT355	Biostatistics	03
	USBT356	Research Methodology	03
	USBT357	Practical based on USBT351 and USBT353	02
	USBT358	Practical based on USBT 352	02
	USBT359	Practical based on USBT 354 to USBT356	02
VI	USBT361	Plant Physiology and Biochemistry	03
	USBT362	Plant Biotechnology	03
	USBT363	Genetics and Plant Breeding	03
	USBT364	Plant Pathology	03
	USBT365	Pharmacognosy	03
	USBT366	Botanical Techniques	03
	USBT367	Practical based on USBT361 to USBT363	02
	USBT368	Practical based on USBT364 to USBT366	02
	USBT369	Project	02

Class : **T. Y. B. Sc. (Semester - V)**
Paper Code : **USBT 351**
Paper **I**
Title of Paper : **Cryptogamic Botany (Algae, Fungi, Bryophytes and Pteridophytes)**
Credit **03**
No. of lectures **48**

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 **(24L)**

Unit – 1: Algae and Fungi:

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

1.2 Study of distinguishing characters of following divisions and life cycle pattern of algae with reference to taxonomic position, occurrence, thallus structure and reproduction: **10L**

a) Cyanophyta : *Oscillatora*
b) Rhodophyta : *Batrachospermum*
c) Chlorophyta *Volvox*
d) Xanthophyta : *Voucheria*
e) Phaeophyta : *Laminaria*

Fungi:

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

1.4 Study of distinguishing characters of following groups and life cycle pattern of fungi with reference to taxonomic position, occurrence, thallus structure and reproduction. **10L**

a) Myxomycota : *Stemonitis*
b) Mastigomycotina : *Pythium*

c) Zygomycotina : *Mucor*
d) Ascomycotina : *Unicinula*
e) Basidiomycotina : *Agaricus*
f) Deuteromycotina : *Alternaria*

Credit - II **(12 L)**

Unit – 2: Bryophytes and Pteridophytes

2.1 General characters, classification up to classes (G.M. Smith, 1955) and economic importance. **3L**

2.2. Study of distinguishing characters of following classes and life cycle pattern of bryophytes wrt. Taxonomic position, occurrence, thallus structure (morphology and anatomy), reproduction and sporophyte structure. **9L**

a) Hepaticopsida : *Marchantia* and *Porella*
b) Anthocerotopsida : *Anthoceros* and *Notothylas*
c) Bryopsida : *Bryum* and *Polytrichum*

Credit - III **(12L)**

Unit – 3 : Pteridophytes

3.1 General characters, classification up to classes (K. R. Sporne, 1975) and economic importance **4L**

3.2 Study of distinguishing characters of following classes and life cycle pattern of pteridophytes wrt. Taxonomic position, occurrence, morphology, anatomy, reproduction, gametophyte and sporophyte structure. **8L**

a) Psiloptopsida : *Psilotum*
b) Lycopsida : *Selaginella*
c) Sphenopsida : *Equisetum*
d) Pteropsida : *Salvinia*

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.

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Choice Based Credit System Syllabus (2022 Pattern)

Mapping of Program Outcomes with Course Outcomes

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

Course: Cryptogamic Botany **Course Code** : USBT 351

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

Justification for the mapping

PO1 Disciplinary Knowledge

CO2. Classify the algae, fungi, bryophytes and pteridophytes.

CO3. Understand external, internal structure and mode of nutrition in cryptogams

PO2 Critical Thinking and Problem solving

CO4. Understand life cycle of cryptogams.

PO4 Research-related skills and Scientific temper.

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 Trans-disciplinary knowledge.

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.

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.

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Class : **T. Y. B. Sc. (Semester - V)**
Paper Code : **USBT 352**
Paper **II**
Title of Paper : **Spermatophyta and Palaeobotany**
Credit **03**
No. of lectures **48**

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 **(16L)**
Unit-1: Gymnosperms

1.1. Introduction, general characters, and outline of classification of Gymnosperm according to Chamberlain (1934) Raizda and Sahani (1960) and economic importance. **4L**
1.2 Study of life cycle of *Pinus* and *Gnetum* with reference to distribution, morphology, anatomy, reproduction, gametophyte, sporophyte, seed structure and life cycle. (Developmental stages of sex organs are not expected). **12L**

Credit-II **(22L)**
Unit-2: Angiosperms

2.1. **Origin of angiosperms:** Origin with reference to time, place and ancestry-Pteridosperms theory, Bennettitalean theory and Gnetalean theory. **4L**
2.2. **Classification of angiosperms:** Review of artificial, natural and phylogenetic systems (general account). Hutchinson's system with reference to outline and assumptions, merits and limitations. **4L**
2.3 **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, Capparidaceae, Fabaceae, Asteraceae, Acanthaceae,

Lamiaceae, Nyctaginaceae, Orchidaceae, Cannaceae and Poaceae. **12L**

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

Credit-III **(10L)**

Unit-3: Palaeobotany

3.1 Geological time scale. **1L**

3.2 **Fossil:** Definition, process of fossil formation, types of fossils -Impression, Compression, Petrifaction, Coal ball. **3L**

3.3 Study of following fossil groups. **6L**

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.

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Choice Based Credit System Syllabus (2022 Pattern)

Mapping of Program Outcomes with Course Outcomes

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

Course: Spermatophyta and Palaeobotany **Course Code** : USBT351

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
CO 1	2								
CO 2					3				
CO 3				3					
CO 4						2			
CO 5		2							
CO 6			2	3					
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.

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Class	**:**	**T. Y. B. Sc. (Semester - V)**
Paper Code	**:**	**USBT 353**
Paper	**:**	**III**
Title of Paper	**:**	**Cell and Molecular Biology**
Credit	**:**	**03**
No. of lectures	**:**	**48**

A) Learning Objectives:

1. To acquaint students with some cytological techniques.
2. Expertise students for genetic library of plants.
3. Acquaint the students with synthesis of nucleic acids and PCR technique.
4. Expertise students with some cytological techniques.
5. Understand current findings in cell biology.
6. Demonstrate and explain different phases of cell cycle.
7. Acquaint students with different types of cell communication.

B) Learning Outcome:

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

CO1. Acquaint knowledge of some cytological techniques.
CO2. Expert in genetic library of plants.
CO3. Learn the synthesis of nucleic acids and PCR technique.
CO4. Expert in some cytological techniques.
CO5. Knowledge of current findings in cell biology.
CO6. Explain different phases of cell cycle.
CO7. Know different types of cell communication.

Credit - I **(20L)**

Unit - I

1.1 Cell Biology: An Introduction **2L**

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 - Cytoplasmic Constituents **14L**

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

1.3 Plant Cell - Nucleus and Chromosomes **4L**

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

Credit - II **(12L)**

Unit - II

2.1 Molecular Biology - Introduction **2L**

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

2.2 Nature of Genetic Material **4L**

Characteristics of genetic material, Watson and Cricks Model of DNA, Forms of DNA - A, B and Z, RNA as genetic material -TMV.

2.3 DNA Replication **3L**

Introduction and types.

2.4 DNA Damage and Repair **3L**

Introduction, Causes and types, DNA repair system - Photo reactivation, Dark excision repair

Credit - III **(16L)**

Unit – III

3.1 Gene Organization **2L**

Promoter-structure and function in prokaryotes and eukaryotes.

3.2 Transcription **4L**

Structure and role of m-RNA, r-RNA, t-RNA, Transcription apparatus.

3.3 Genetic Code and Translation **8L**

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

3.4 Gene Action and Regulation **2L**

Relation of Gene and Enzymes - One gene one enzyme hypothesis,

References:

1. Cell and Molecular Biology, S. C. Rastogi
2. Cytology, T. S. Verma and V. K. Agarwal
3. Cell Biology, C. B. Pawar
4. Cell and Molecular Biology, P. K. Gupta
5. Fundamentals of Molecular Biology, Veer Bala Rastogi
6. Fundamentals of Molecular Biology, G. K. Pal and Ghaskadabi
7. Cell and Molecular Biology, Robertis and DeRobertis
8. Molecular Biology of Gene, Watson J. D.
9. Biochemistry and Molecular Biology of Plants, Buchanan B. B.

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Choice Based Credit System Syllabus (2022 Pattern)

Mapping of Program Outcomes with Course Outcomes

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

Course: Cell and Molecular Biology **Course Code** : USBT 353

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

Justification for the mapping

PO1: Disciplinary Knowledge

CO5. Understand current findings in cell biology.

CO6. Demonstrate and explain different phases of cell cycle.
CO7. Get knowledge of different types of cell communication.

PO 3: Social competence

CO2. Experts required in future for genetic library of plants.

PO 4: Research-related skills and Scientific temper

CO1. The main outcome of this course is to acquaint students with some cytological Techniques.
CO3. Acquaint the students with synthesis of nucleic acids and PCR technique.

PO6: Personal and Professional Competence

CO4. Expert with some cytological techniques.

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Class : **T. Y. B. Sc. (Semester –V)**
Paper Code : **USBT354**
Paper **IV**
Title of paper : **Industrial Botany**
Credit **03**
No. of Lectures **48**

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: (Students will be)

CO1. Prepare different garden at personal level and to encourage people
CO2. Expert in hydroponic techniques.
CO3. Start their 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)**
Unit - I
1.1 Hydroponics

1. History and origin of soil less Culture, its advantages and disadvantages, Nutrient Film Technique (NFT) **1L**
2. Vertical Gardening: Introduction, Types and Benefits of Vertical gardening. **2L**
3. Aeroponics, Passive sub-irrigation, Ebb and flow or flood and drain irrigation, Run to waste, Deep water culture, Bubbleponics. **4L**
4. Media used for Hydroponics: Ex-clay, Rock wool, Coir, Perlite, Pumice, Vermiculite, Sand, Gravel, Brick shards, Polystyrene packing peanuts, wood fibre. 4**L**
5. Cultivation of Fruit Vegetable e.g. Tomato and Leaf Vegetable e.g. Spinach using hydroponic Technique. **2L**
6. Introduction to Aquaponics, Different Trends in Aquaculture, components of aquaponics. **3L**

Credit – II **(16L)**
Unit – II
2.1 Gardening

1. Definition, Principles, objectives and scope of garden designing **2L**
2. Different types of gardening – roof / terrace / vertical/ guerrilla/ rock garden/ water gardens and sunken garden/ bottle / circular garden. **7L**
3. Indoor gardening: Bonsai, Terrarium, dish, Kokedama, Hugelkultur. **5L**
4. Aesthetic value of Gardens, Famous gardens of India. **2L**

Credit - III **(16L)**

Unit- III

3.1 Post-Harvest Technology

1. Introduction to post harvest technology of agricultural produce; Status of Production, Losses, Need, Scope and Importance. **3L**
2. Introduction to various post-harvest operations such as Primary Processing Operation Vs. Secondary Operation, Operations like Harvesting, Handling cleaning, grading, sorting, drying, storage, milling, size reduction, expelling, extraction, blending, heat treatment, separation, material handling (transportation, conveying, elevating),washing; their functions and use in the post-harvest processing. **8L**
3. Post-harvest treatment to increase shelf life i.e. freezing, chilling, dehydration, canning, thermal processing **3L**
4. Introduction to Packaging of fruits and vegetables and types of packaging. Concept of modified atmosphere packaging. **2L**

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, Woodhead 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, ShrutiSethai, ShrutiSethi, Indus Publishing.
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11. Floriculture in India, Randhawa and Mukhopaddhay.
12. Gardening in India, Bose and Mukherjee, Oxford.
13. Introductory ornamental horticulture, Arora, Kalyani publishers
14. Forest Management in India, Vasant Desai, Himalaya Publications
15. Forest and Forestry, K P. Sagreiya, National Book Trust
16. Gardening in India, Bose T. K. & Mukherjee, D., 1972, Oxford & IBH Publishing Co., New Delhi.

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Choice Based Credit System Syllabus (2022 Pattern)

Mapping of Program Outcomes with Course Outcomes

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

Course : Industrial Botany **Course Code** : USBT 354

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
CO1		3	3						
CO2		3				3		2	
CO3						2			
CO4	3			3					2
CO5	3				3				1
CO6	3								2
CO7							2		

Justification for the mapping

PO1: Disciplinary Knowledge

CO4. Develop plant tissue culture industry.

CO5. Get expertise to develop agro based industries.

CO6. Get expertise in field of Industrial Botany.

PO2: Critical Thinking and Problem solving:

CO1. Prepare different garden at personal level and to encourage people.

CO2. Expert in hydroponic techniques.

PO 3: Social competence

CO1. Prepare different garden at personal level and to encourage people.

PO4: Research-related skills and Scientific temper

CO5. Get expertise to develop agro based industries.

PO5: Trans-disciplinary knowledge

CO5. Get expertise to develop agro based industries.

PO6: Personal and Professional Competence

CO2. Expert in hydroponic techniques.

CO3. Start their own business in cold storage, packing of flowers and fruits.

PO7: Effective Citizenship and Ethics:

CO7. Understand basics of plant resource based industries.

PO8: Environment and Sustainability:

CO2. Expert in hydroponic techniques.

PO 9: Self-directed and Life-long Learning

CO4. Develop plant tissue culture industry.

CO5. Get expertise to develop agro based industries.

CO6. Get expertise in field of Industrial Botany.

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Class : **T. Y. B. Sc. (Semester –V)**
Paper Code : **USBT354**
Paper **V**
Title of paper : **Biostatistics and computational Botany**
Credit **03**
No. of Lectures **48**

A) Learning Objectives:

1) To study the computer Techniques.
2) To study the various statistical techniques.
3) To understand basic concepts of computer and statistics useful for botany.
4) To understand various sampling methods.
5) To solve biological problems.
6) To understand knowledge about different branches of biology.
7) To study about techniques of seed testing and plant growth indices.

B) Course Outcome:

CO1. Students will be expert in use of computer to solve biological problems.
CO2. Students can be master in solving biological problems with the help of statistics.
CO3. Students will apply their knowledge in various branches of biology.
CO4. Students will be expert in use of sampling methods 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 biology.
CO7. Students' expertise in seed testing techniques.

Credit - I **(16L)**
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

i. Merits and limitations of graphic representation ii.Diagrammatic representation of data
- Line diagram
- Bar diagram
- Pie diagram

1.4 Measures of central tendency of grouped and ungrouped data **4L**

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

Credit – II **(16 L)**

Unit- 2

2.1 Measures of dispersion **4L**

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
   a. Definition and types of regression
   b. Linear regression
f) Similarities and dissimilarities of correlation and regression

2.3 Probability and types of theoretical probability distribution **4L**

a) Concept of probability
b) Binomial distribution
c) Poisson distribution

d) Normal distribution
e) Normal distribution curve
f) Relationship between normal curve area and standard deviation
g) Properties of normal distribution curve.

2. Tests of significance of mean **4L**

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

Credit – III **(16L)**

Unit - I

3. Computation of seed testing and plant growth indices **10L**

a. 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
   i. Promptness index (PI)
   ii. Germination stress tolerance index (GSI),
   iii. Plant height stress tolerance index (PHSI)
   iv. Root length stress tolerance index (RLSI)
   v. Dry matter stress tolerance index (DMSI)
c. Plant growth indices
   i. Absolute Growth Rate (AGR)
   ii. Crop Growth Rate (CGR)
   iii. Relative Growth Rate (RGR)
   iv. Leaf Area Index (LAI)

4. Analysis of data on vegetation studies **6L**

a. Computation of crop/vegetation biomass using satellite data
   i. Simple Ratio (SR) or Ratio Vegetation Index (RVI)
   ii. Difference Vegetation Index (DVI),
   iii. Normalised Difference Vegetation index (NDVI) or greenness index

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.

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Choice Based Credit System Syllabus (2022 Pattern)

Mapping of Program Outcomes with Course Outcomes

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

Course: Biostatistics and Computational botany **Course Code**: USBT355

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

Justification for the mapping

PO1: Disciplinary Knowledge

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

CO6. Students will apply their knowledge in various branches of biology.

PO2: Critical Thinking and Problem Solving

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

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

PO 4: Research-related skills and Scientific temper

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

PO5: Trans-disciplinary Knowledge

CO7. Students' expertise in microscopic techniques.

PO6: Personal and Professional Competence

CO4. Students will be expert in use of computer to solve biological problems.

PO 9: Self-directed and Life-long Learning

CO5. Students can be master in solving biological problems with the help of statistics.

Class : **T. Y. B. Sc. (Semester - V)**
Paper Code : **USBT 356**
Paper : **Practical-VI**
Title of Paper : **Research Methodology**
Credit **03**
No. of Teaching Hours **48**

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:

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 **(16L)**

Unit- I

1.1 Introduction to Research Methodology: Meaning of Research, Objectives of Research, Motivations in Research, types of Research, Research Approaches, Significance of Research, Criteria of Good Research. **8L**

1.2 Defining the Research Problem: Concept and need, Identification of Research problem, defining and delimiting Research problem. **6L**

1.3 Characteristics of research: Qualitative and Quantitative **2L**

Credit – II **(16L)**

Unit- II

2.1 Research Questions and Hypothesis: Variables and their linkages, characteristics of good Hypothesis. Basis for hypotheses, formulation of hypotheses- directional and non-directional hypotheses. **8L**

2.2 Research design: Meaning, Need, Features of Good Design, Concepts, Types, Basic principles of Experimental Design, various methods of Research: Survey, Philosophical, Historical, Experimental, Case Studies. **8L**

Credit - III **(16L)**
Unit- III

3.1 Data Collection: Methods of Data Collections : Observation, Experimental and questionnaire, Primary Data, Secondary Data, Selection of appropriate method for data collection, Case Study, Reliability and validity of Research tools. **8L**

3.2 Preparation of Project Report: Data Analysis and Consolidation of Photographs, Illustration, Table and Graphs, Title, Introduction, Review of Literature, Materials and Methods, Results, Discussions, Summary, References, Acknowledgment, Bibliography: Method of Citing And Arrangement of References. **8L**

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.

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Choice Based Credit System Syllabus (2022 Pattern)

Mapping of Program Outcomes with Course Outcomes

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

Course : Research Methodology **Course Code :** USBT 356

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
CO1	3								
CO2				3					
CO3				2					
CO4				3					
CO5					2				
CO6						3			
CO7				2					

Map Co with PO as weightage 3= strongly Related 2= Moderately Related 1= Partially Related in one line justification

Justification for the mapping

PO1: Disciplinary Knowledge:

CO1. Comprehensive knowledge in research areas

PO4: Research-related skills and Scientific temper

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: **Trans-disciplinary knowledge**

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

PO6: Personal and professional competence

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

Class : T. Y. B. Sc. (Semester - V)
Paper Code : USBT 357
Paper : Practical-I
Title of Paper : Practical based on USBT351 and USBT353
Credit 02
No. of Practicals 12

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 USBT 351- Cryptogamic Botany (08 Prac.)

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

   Excursion tour to study cryptogams is compulsory.

Practical based on USBT 353 - Cell and 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.

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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 Course I **Course Code**: USBT 357

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
CO 1	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: Disciplinary Knowledge

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)

PO 4: Research-related skills and Scientific tempe.

CO3. Expert in slide preparation and permanent slide also.

PO5: Trans-disciplinary Knowledge

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

PO6: Personal and Professional Competence

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

PO 7: Effective Citizenship and Ethics

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

PO 8: Environment and Sustainability

CO4. Use various cytological techniques in cell biology.

Class : **T. Y. B. Sc. Practical - II (Sem. - V)**
Paper Code : **USBT 358**
Paper : **Practical - II**
Course Title : **Practical based on USBT 352**
Credit : **2**
No. of Practicals **12**

A) Learning Objectives:

1. To aware the students about higher plants diversity.
2. To make expert the students in identification of plants.
3. To make expert the students in advanced techniques in angiosperm taxonomy.
4. It will help to conserve the biodiversity of higher plants.
5. Students can expert in evolutionary and advanced characters of plants.
6. Students will get the job in the field of plant taxonomy and allied sciences.
7. Students get knowledge of fossil specimens.

B) Learning Outcome :

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

CO1. Know diversity of higher plants.
CO2. Students can expert in identification of plants.
CO3. Students learn advanced techniques in angiosperm taxonomy.
CO4. Know about the conservation of the biodiversity of higher plants.
CO5. Expertise in evolutionary and advanced characters of plants.
CO6. Get employment in the field of plant taxonomy and allied sciences.
CO7. Acquaint knowledge of fossil specimens.

Practical based on USBT 352 - Spermatophyta and Palaeobotany (12 Prac.)

1. Study of *Pinus* with the help of permanent slides and plant material- i) External morphology, ii) T. S. of stem (Temporary double stained preparation), iii) T. S. of needle (Temporary double stained preparation), iv) Morphology of male cone – T. S. & L. S. Permanent slide, mounting of pollen grains. v) Morphology of female cone – T. S. & L. S. Permanent slide, vi) Mounting of pollen grains. vii) V. S. of mature ovule (Permanent slide) (2 P)
2. Study of *Gnetum* with the help of permanent slides and plant material. i) External morphology, ii) T. S. of stem iii) T. S. of leaf (permanent slide), iv) Morphology of male cone vi) Morphology of female cone vii) V. S. of mature ovule. (2 P)
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. (1 P)
5. Preparation of an artificial key based on multiple characters - Androecium / Gynoecium/vegetative characters (at least two keys) (1P)
6. Plant identification with the help of QR Code system (1 P)
7. Study of the following with the help of slides and / or specimens. (1P) i) Impression ii) Compression iii) Petrifaction iv) Coal ball v) *Rhynia* vi) *Pentoxylon* vii) *Nipaniophyllum* vii) *Lepidodendron*

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Choice Based Credit System Syllabus (2022 Pattern)

Mapping of Program Outcomes with Course Outcomes

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

Course: Practical Course II **Course Code** : USBT 358

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

Justification for the mapping

PO1: Disciplinary Knowledge

CO6. Get employment in the field of plant taxonomy and allied sciences

CO7. Acquaint knowledge of fossil specimens.

PO2: Critical Thinking and Problem Solving

CO2. Students can expert in evolutionary and advanced characters of plants.

PO 3: Social competence

CO4. It will help to conserve the biodiversity of lower plants.

PO6: Personal and Professional Competence

CO3. Students learn advanced techniques in angiosperm taxonomy

CO5. Expertise in evolutionary and advanced characters of plants.

PO 8: Environment and Sustainability

CO1. It will help to conserve the biodiversity of higher plants.

Class	**: T. Y. B. Sc. (Semester - V)**
Paper Code	**: USBT 359**
Paper	**: Practical-IX**
Title of Paper	**: Practical based on USBT 355, USBT 355 and USBT 356**
Credit	**03**
No. of Teaching Hours	**48**

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:

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

Practical based on USBT 354-Industrial Botany

1. Study of Media Required for Hydroponics
2. Study of Hydroponic technology for Chilli
3. Study of bottle and circular gardening
4. Study of Bonsai Preparation.

****Visits: Visit to any one Hydroponics Farming unit/Warehouses/ Packhouses /cold-storage/hydroponic farming unit**

Practical based on USBT 355–Biostatistics

1. Computation of mean, mode, median, variance and standard deviation from the plant sample.
2. StatisticalproblemsolvingbasedonStudent's't'testandChi-squaretest.
3. Germinationofvariousseedlotsandanalysisofdatawithvariousseed germinationindices.
4. Analysis of vegetation data obtained from list count quadrat method for frequency, Density, abundance, relative dominance and importance value index.

Practical based on USBT 3506–Research Methodology

1. Witting of introduction and review of literature of research project.
2. Setting of methodology for research project work.
3. Writing of results and discussion of research project.

4. Writing of summary and conclusion of research project.
5. Bibliography

Note: Projects will be allotted for fifth and sixth semester and students will submit project work at sixth semester practical examination

Choice Based Credit System Syllabus (2019 Pattern)

Mapping of Program Outcomes with Course Outcomes

Course: Practical **Course Code**: USBT 3509

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
CO1	3	3			2			2	2
CO2			3			2			
CO3					3		2	2	
CO4	3	3					2		
CO5									
CO6									
CO 7			3	3		3			2

Map Co with PO as weightage 3= strongly Related 2= Moderately Related 1= Partially Related in one line justification.

PO1: Disciplinary Knowledge:
CO1. Student can develop small scale hydroponic technology units.
CO2. Students will analyze the research data for biostatistical analysis.
PO2: Critical Thinking and Problem solving.
CO1. Student can develop small scale hydroponic technology units.
CO2. Students will analyze the research data for biostatistical analysis.
PO3: Research-related skills and Scientific temper
CO1. Students will be able to counseling for gardening ideas at home or corporate level.
CO2. Students will be able to write Manuscript, Review article and Project Report.
PO4: Research-related skills and Scientific temper
CO1. Students will be able to write Manuscript, Review article and Project Report.
PO5: Trans-disciplinary knowledge
CO1. Student can develop small scale hydroponic technology units.
CO2. Student will be able to prepare bonsai and can generate own business.
PO6: Personal and professional competence
CO1. Students will be able to counseling for gardening ideas at home or corporate level
CO2. Students will be able to write Manuscript, Review article and Project Report.
PO7: Effective Citizenship and Ethics
CO1. Student will be able to prepare bonsai and can generate own business.
CO2. Students will analyze the research data for biostatistical analysis.

PO8: Environment and Sustainability

CO1. Student can develop small scale hydroponic technology units.

CO2. Student will be able to prepare bonsai and can generate own business.

PO9:Self-directed and Life-long learning

CO1. Student can develop small scale hydroponic technology units.

CO2. Students will be able to write Manuscript, Review article and Project Report.

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