Karmaveer Bhaurao Patil University,

Satara

Syllabus for

M. Sc. I (Botany)

Under

Faculty of Science and Technology

(As per NEP 2020)

With effect from Academic Year 2024-2025

TITLE: Botany

YEAR OF IMPLEMENTATION: 2024-25

PREAMBLE:

The M. Sc. Botany course under autonomy as per NEP 2020 has been prepared keeping in view the unique requirements of M. Sc. Botany students. The emphasis of the contents is to provide students the latest information along with due weightage to the concepts of classical botany so that they are able to understand and appreciate the current interdisciplinary approaches in the study of plant sciences and its role in societal development. The course content also lists new practical exercises so the students gets a hands on experience of the latest techniques that are currently in use. Project curriculum spanning over the two years of the course is designed in a way to give the students first hand research experience as it consists of writing of synopsis, literature review along with actual table work. The course will also inspire students to pursue higher studies and research in botany, for becoming an entrepreneur and enable students to get employed in plant based industries.

PROGRAM OUTCOMES:

After completing the Master of Science in Botany students will be able to

i. Expertise in the subject

ii. Qualified to continue Ph.D. in his subject

iii . Eligible to research scholar abroad

iv. Qualified to appear for the examinations for jobs in government organizations, private industries, research laboratories, etc

v. Eligible to appear for jobs with minimum eligibility as science post graduate

PROGRAM SPECIFIC OBJECTIVES OF THE COURSE:

i. To impart the knowledge of plant science is the basic objective of the course.

ii. To understand scientific terms, concepts, facts, phenomenon and their relationships.

iii. To develop skill in practical work, experiments and laboratory materials.

iv. To develop scientific attitude among the students and to make the students open minded, critical and curious so that they enter research field with a positive approach.

v. To make the students skilled to get employment in the plant based industries or to start their own plant based entrepreneurial ventures.

vi. To make the students aware of environment sustainable goals.

vii. To enable the students to acquire knowledge of plants and related subjects so as to apply them for the benefit of human beings.

PROGRAM SPECIFIC OUTCOMES OF THE COURSE: The students will be able to:

i. Explain, describe and discuss the concepts of plant sciences.

ii. Perform and design experiments related to plant sciences

iii. Decide and Undertake a project based on plant sciences

iv. Attain skills needed in the plant based industries through an internship.

v. Improve the research based skills by entering into a research internship as well as in house project.

vi. Present their research findings in research conglomerations like conferences and in research journals in the form of publications.

vii. Critically analyze their role as an environment sustainability goals oriented citizen.

1.TITLE: Botany

2.YEAR OF IMPLEMENTATION: 2024-25

3.DURATION: 02 year

4.PATTERN: Semester

5.MEDIUM OF INSTRUCTION: English

6. **Evaluation Structure**

Theory

Assessment Category	**Internal Evaluation**					**ESE**	**Total marks**	**Credits**
Theory Paper of 4 Credits	**CCE-I**	**CCE-II**	**Mid Sem**	**Activity**	**Total**	**60**	**100**	**04**
	10	**10**	**10**	**10**	**40**			

Theory Paper of 2 Credits	**5**	**5**	**5**	**5**	**20**	**30**	**50**	**02**

Practical

Assessment Category	**Internal Evaluation**	**ESE**	**Total**	**Credits**
Practical Paper of 2 Credits	**Journal/ Viva/ Activity 20**	**30**	**50**	**02**

7.STRUCTURE OF COURSE: Course Structure as per NEP-2020

Course Structure for M. Sc. I as per NEP-2020 (2.0)

Level	**Sem**	**Major**				**RM**	**OJT**	**RP**	**Total**
		DSC Mandatory		**DSE Elective**					
		T	**P**	**T**	**P**				
6	I	12 (3 papers)	2	2 (1 paper out of 2)	2	4	---	---	22
	II	12 (3 papers)	2	2 (1 paper out of 2)	2	---	---	4	22
6.5	III	12 (3 papers)	2	2 (1 paper out of 2)	---	---	---	6	22
	IV	12 (3 papers)	2	2 (1 paper out of 2)	2	---	4	---	22
Total		48	8	8	6	4	4	10	**88**
		70				8		10	

2) Titles of courses of M. Sc. Part I Course

M. Sc. I Semester I

Nature of Course	Course Code	Name of Course
Theory	MBT 411	Tools and Techniques in Botany
	MBT 412	Biology and Diversity of Cryptogams (Fungi, Algae and Bryophytes)
	MBT 413	Plant Ecology
	MBT 414: E_1	Biology and Diversity of Trachaeophytes (Pteridophytes and Gymnosperms)
	MBT 414: E_2	Genetic Engineering
	MBT 415	Research Methodology
Practical	MBP 416	Practical Course I: Lab I (Based on MBT 411, 412 and 413)
	MBP 417	Practical Course II: Lab II (Based on MBT 414)

M. Sc. I Semester II

Nature of Course	Course Code	Name of Course
Theory	MBT 421	Cell and Molecular Biology
	MBT 422	Taxonomy of Angiosperms
	MBT 423	Plant Pathology
	MBT 424: E_1	Developmental and Reproductive Biology
	MBT 424: E_2	Bioinformatics
	MBT 425	Research Project
Practical	MBP 426	Practical Course III: Lab III (Based on MBT 421, 422 and 423)
	MBP 427	Practical Course IV: Lab IV (Based on MBT 424)

Master of Science (M. Sc.) Part - I: Botany

Semester I

Theory Course I (MBT 411) Tools and Techniques in Botany

Course Objectives: Students should be able to:

1. Understand and apply statistical methods for the design of life science research and analysis of data.
2. Learn about separation of biomolecules and biochemicals based on size, shape, charge and state by using basic techniques such as centrifugation, chromatography and electrophoresis.
3. Learn microscopy basics, different types of microscopes, and working of microscopes.
4. Develop understanding of techniques for tissue culture, cell culture and organ transplantation.

Credits=4	**SEMESTER-I** **Theory Course I (MBT 411) Tools and Techniques in Botany**	**No. of lectures per unit**
Unit I	**Unit I: General techniques**	
	Collection and preservation of plant material, Cryopreservation – introduction, steps involved and applications. **(03)** Biochemistry Laboratory: Laboratory disciplines, safety and care, experimental report, SI units, pH and Buffers. **(03)** Equipments: Laminar Air Flow, Autoclaves, Thermal Water Bath, Shaker, Stirrers, Oven, Incubators. **(02)** Culture Techniques: Principles, Types (Bacterial, Fungal, Plant), Media Preparation, Sterilization, Inoculation and Incubation. **(05)** Palaeobotanical Techniques: Peel technique, Palaeopalynological techniques. **(02)**	**(15)**
Unit II	**Microscopic and Spectroscopic Techniques**	

	Microscopy- Introduction, Principles, Working and Applications of Light Microscope, Compound Microscope, Con-focal Microscope, Stereomicroscope, Phase Contrast Microscope, Transmission Electron Microscope, Scanning Electron Microscope **(07)** Spectroscopy- Introduction, Principles and Applications of X-Ray Diffraction, UV-Vis, Fluorescence, AAS, Infrared and Raman Spectroscopy and NMR **(08)**	**(15)**
Unit III	**Separation Techniques**	
	Centrifugation: Basic principles of centrifugation, types, care and safety aspects of centrifuges, Density gradient centrifugation **(05)** Chromatography: Principles, working and applications of Course, Thin Layer Chromatography (TLC), Column, High Performance Liquid Chromatography (HPLC), High Performance Thin Layer Chromatography (HPTLC) and Gas Chromatography (GC) **(05)** Electrophoresis: General principle, Support Media, Electrophoresis of proteins and nucleic acids, Capillary Electrophoresis, Microchip Electrophoresis. **(05)**	**(15)**
Unit IV	**Computational Techniques**	
	Biostatistics: Introduction, Collection and Preparation of Data **(02)** Measures of central tendency – Introduction, Mean, Mode and Median **(03)** Measures of dispersion – Introduction, Mean Deviation, Standard Deviation, Variability, Variance, Coefficient of Variation; Tests of Significance – T-test, Chi-square Test **(04)** Presentation of data: Tabular, Graphical and Diagrammatic Presentations **(03)** Computers in Biology: Excel and SPSS **(03)**	**(15)**

Course Outcomes: The students will be able to:

1. Explain different techniques used in plant sciences.
2. Define the principles and method to be utilized for respective botanical technique.
3. Write answers and brief notes about all the techniques studied.
4. Present the data using different tools in computer.

References:

1. SK Jain and RR Rao, Handbook of field and herbarium techniques (Today and Tomorrow Publishers, 1978)
2. Wilson and Walker, Practical Biochemistry: Principles and Techniques. (Ed. E. Cambridge Publ., 2000)
3. HN Andrews Studies in Paleobotany, 1961
4. MJ Purvis and DC Collier and D Wallis, Laboratory techniques in Botany
5. KR Aneja, Text Book of Experimental Biology
6. Verma and Agarwal, Text book of Biotechnology (S. Chand Publication)
7. Verma and Agarwal, Text book of Microbiology (S. Chand Publication)
8. MJ Purvis and DC Collier and D Wallis, Laboratory techniques in Botany
9. Horst Piller-Microscope photometry
10. MJ Purvis and DC Collier and D Wallis, Laboratory techniques in Botany
11. Verma and Agarwal, Text book of Biotechnology (S. Chand Publication)
12. Verma and Agarwal, Text book of Microbiology (S. Chand Publication)
13. GA Meek and HY Elder, Analytical and quantitative methods in microscopy
14. Horst Piller Microscope photometry
15. A Engstrom and JB Finean, Biological Ultrastructure
16. Ruthmann August, Methods in Cell Research
17. Brain and Ten Cate, Techniques in Photomicrography
18. 10. Roger P. Loveland, Photomicrography: A comprehensive treatise
19. Schwer and Zeclinskin, Methods in plant molecular biology (Academic Press New York, 1989)
20. Jensen, Plant histochemistry
21. Coombs, Hall, Long and Sourlock, Techniques in Bioproductivity and photosynthesis (Pergamon press Oxford, 1985)
22. Colowick and Kaplan, Methods in enzymology (Academic Press)

23. Wilson and Walker, Practical Biochemistry: Principles and Techniques. (Ed. Cambridge Publication, 2000)
24. Goswami HK and R. Goswami, Practical cytology, applied genetics and Bio-statistics (Himalayan Publication House, Bombay, 1993)
25. Text Book of Biostatistics (S. Chand Publication)
26. Biostatistics: Basic Concepts and Methodology for the Health Sciences, Isv 9th Edition
27. Bernard Rosner, Fundamentals of Biostatistics

Master of Science (M. Sc.) Part - I: Botany

Semester I

Theory course II: (MBT 412) Biology and Diversity of Cryptogams (Fungi, Algae and Bryophytes)

Course Objectives: Students should be able to:

1. Know about plants of lower groups and their uses in the wellbeing of mankind
2. Create awareness of plant conservation in society.
3. Identify different plants from cryptogams
4. Culture different plants from cryptogams

Credits=4	**SEMESTER-I** **Theory Course II (MBT 412) Biology and Diversity of Cryptogams** **(Fungi, Algae and Bryophytes)**	**No. of lectures per unit**
Unit I	**Algae**	
	General Characters of Algae **(1)** Diversity and Distribution of Algae - Habitat diversity (Freshwater, Marine, Edaphic, Epiphytes, Endophytes, Parasites, Algal Blooms) **(3)** Classification of Algae: Classical Systems of Algal Classification by Smith and Fritsch, Recent developments in algal classification with special emphasis on emerging trends in molecular phylogeny and their relationships **(4)** Thallus Organization and Reproduction, Phylogeny and interrelationship of following classes: Cyanophyceae, Chlorophyceae, Xanthophyceae, Bacillariophyceae, Phaeophyceae, Rhodophyceae **(6)** Contribution of any two Phycologists **(1)**	**(15)**
Unit II	**Fungi**	
	General characters of Fungi **(1)** Classification of Fungi by Ainsworth, et al 1971, Alexopoulus, Mims and Blackwell (1993) **(2)** Thallus organization, Reproduction and Life cycle pattern in Myxomycetes – Types of plasmodia and fruit bodies;	**(15)**

	Chytridiomycetes – Chytridiales; Zygomycetes – Mucorales; Ascomycetes – Types of fruit bodies and study of life cycle pattern of Saccharomycetales, Erysiphales, Xylariales, Pezizales; Basidiomycetes – Types of basidia and basidiocarp and study of life cycle pattern in Uredinales, Ustilaginales, Agaricales, Aphyllophorales, Lycoperdales; Deuteromycetes – Types of conidia and conidiomata, Conidiogenesis **(11)** Contribution of any two Indian and any two foreign Mycologists **(1)**	
Unit III	**Bryophytes**	
	General characters of Bryophytes **(1)** Classification of Bryophytes - old and modern systems of classification of bryophytes **(2)** Distribution, Habit, Morphology, Reproduction, Phylogeny, and Inter-relationship of following orders: Sphaerocarpales, Takakiales, Calobryales, Jungermanniales, Anthocerotales, Sphagnales, Polytrichales **(8)** Origin of Bryophytes **(2)** Contributions of any two Bryologists **(2)**	**(15)**
Unit IV	**Applied aspects of Algae, Fungi and Bryophytes**	
	Cultural Techniques in Algae, Fungi and Bryophytes **(5)** Economic importance of Algae, Fungi and Bryophytes (**5)** Use of algae and fungi in bioremediation **(3)** Bryophytes as indicators of pollution, Conservation of Bryophytes: need and importance **(2)**	**(15)**

Course outcomes: The students will be able to:

1. Explain the role of Algae, Fungi and Bryophytes in human welfare.
2. Define concepts regarding industrial applications of Algae, Fungi and Bryophytes.
3. Write answers and brief notes about the role of Algae, Fungi and Bryophytes in economic development society.
4. Conserve different plants from cryptogams

References:

1. V.J. Chapman, and D. J. Chapman The Algae, (1965)
2. T.V Desikachary,. Taxonomy and Biology of Blue -green algae, (1972)
3. F. E. Fritsch, Structure and Reproduction of Algae (1965)
4. H.D Kumar,. and H. N. Singh Text book of Algae (1971)
5. B. P. Pandey, Text book of Botany – Algae (1994)
6. O.P. Sharma, Text book of Algae (1986)
7. B. R. Vashista, Botany for degree students-Algae (1995)
8. Venkataraman et al. Algae-Form and Function (1974)
9. G. C. Ainsworth, and A.S. Sussman : The Fungi Vols. I, II, III, IV- A and IV-B
10. , C.J Alexopoulos. and C. W. Mims, Introductory Mycology (1979) :
11. C. J. Alexopoulus, Introductory Mycology (1960)
12. Alexopoulus, Mims and Blackwell, Introductory Mycology (1993)
13. B. R. Vashistha and A. K. Sinha Botany for degree students- Fungi
14. E. A. Bessey,: Morphology and Taxonomy of Fungi (1967)
15. Dayal, Aquatic Fungi of India (1995)
16. H.C. Gangulee, and A. K. Kar, College Botany Vol. I (1992)
17. H C Dube, An Introduction to Fungi
18. Mehrotra and Aneja, An Introduction to Mycology
19. Mundkur B.B. and M.J.Trimukchar, Ustilaginales of India (1952)
20. O.P. Sharma, Textbook of Fungi (1989)
21. Sparrdo F.K., Aquatic phycomycetes (1960)
22. Subramanan, C. V., Hyphomycetes (1971)
23. Thind K. S., The Myxomycetes of India (1977)
24. R. N. Chopra and P. K. Kumra, Biology of Bryophytes. (1988)
25. S. R Kashyap,. Liverworts of Western Himalayas and the Punjab Plains Part I (1929)
26. N. S. Parihar, An introduction to Embryophyta. Bol. I –Bryophyta (1959)
27. Ram Udar, Bryology in India (1976) :
28. G. M. Smith, Cryptogamic Botany Bol. II (1955)
29. B. R. Vashista, Botany for degree students –Bryophyta (1996)
30. E. V, Watson, British Mosses and Liverworts (1963)

31. E. V, Watson, The Structure and life of Bryopytes (1964)
32. B. R. Vashista, Botany for degree students-Algae (1995)
33. B. P. Pandey, Textbook of Botany – Algae (1994)
34. O.P Sharma, Textbook of Algae (1986)
35. B. R. Vashistha and A. K. Sinha Botany for degree students- fungi
36. H.C. Gangulee, and A. K. Kar, College Botany Vol. III (1992)
37. H.C. Gangulee, and A. K. Kar, College Botany Vol. I (1992)
38. Mehrotra and Aneja An Introduction to Mycology
39. O.O. Sharma, Textbook of Fungi (1989)
40. B.R. Vashista, Botany for degree students –Bryophyta (1996)
41. G. M. Smith, Cryptogamic Botany Bol. II (1955)

Master of Science (M. Sc.) Part - I: Botany

Semester I

Theory course III: (MBT 413) Plant Ecology

Course objectives: The students should be able to:

1. Understand and recognize types of ecosystems, concept of population and community.
2. Identify the environmental issues
3. Understand basic concepts of plant ecology
4. Understand different processes of ecological succession

Credits=4	SEMESTER-I Theory Course III (MBT 413) Plant Ecology	No. of lectures per unit
Unit I	**Major ecosystems of the world**	
	Biomes: Concept, biomes of world, biome distribution Biomes of North America: Tundra, Boreal coniferous forest, Temperate deciduous forest Grassland, Eastern pine-oak biome Sub-tropical biome, Broad-sclerophyll biome Tropical biomes: Tropical rain forest, Tropical savannah, Temperate deciduous forest Some important biomes in India Aquatic Ecosystems: Fresh water ecosystems: Lotic and Lentic ecosystems Marine Ecosystems: Oceans, seas, estuaries and wetlands	**(15)**
Unit II	**Population Ecology**	
	Properties of Population: Population density, biomass, trophic relationship, methods of estimating population density, natality, mortality, survivorship curves, population age distribution. **(02)** Basic concepts of Rate: Birth rate, percentage growth rate, instantaneous rate. Intrinsic rate of natural increase: Specific	**(15)**

	growth rate, biotic potential **(02)** Concepts of carrying capacity: J-shaped growth form, S-shaped growth form, Maximum carrying capacity **(01)** Population fluctuations and cyclic oscillations: Seasonal changes, annual fluctuations, various examples of population cycles, extrinsic theories, intrinsic theories **(02)** Density independent and density dependent mechanisms of population regulation **(01)** Patterns of Dispersion: Basic patterns of dispersion of individuals within a population, The Allee Principle of Aggregation and Refuging **(03)** Meta population Dynamics: Concept, Meta population distribution **(01)** Energy partitioning and Optimization: r & k selection, A general model for r & k selection **(01)** Population genetics: Gene frequency, genotypes. Life History Traits and Tactics: Four life history traits and predictive theories **(02)**	
Unit III	**Community Ecology**	
	Types of interaction between two species- Co-evolution, Co-operation- Mycoheterotrophs, Competition- Inter and intra specific competition and Co-existence **(04)** Positive interactions: Commensalism, mutualism **(03)** Negative interactions: Predation, Herbivory, Parasitism **(02)** Ammensalism and Allelopathy **(01)** Concept of Habitat: Ecological niche, Guild, Biodiversity & stability, Biodiversity & productivity **(04)** Synecology and Autecology **(01)**	**(15)**
Unit IV	**Succession and Environmental Awareness**	
	Succession: Allogenic, Autogenic, Climatic climax, Regulation of	**(15)**

	Communities and Role of species diversity, Role of predators, Models of succession, Temporal and Spatial aspects **(07)** Environmental Education Programmes: Role of GO's and NGO's, Institute involved in various ecological activities like UNESCO, MAB, UNEP, WWF, MOEFCC, NBA etc. **(08)**	

Course outcomes: The students should be able to:

1. Explain ecological features.
2. Define ecological concepts with respect to plants.
3. Write answers and brief notes about ecological scenarios in present times with respect to plants.
4. Undertake excursion tours to various ecological habitats.

References:

1. RS Ambasht, Plant Ecology (1990)
2. CJ Krens, Horper and Row, Ecology: The experimental analysis of distribution and abundance (1978)
3. H.F.W. Lieth, Patterns of primary production in the biosphere (1978)
4. SK Agarwal, Fundamentals of Ecology (1992)
5. IK Bradbury, The Biosphere (1990)
6. SM Das, Handbook of Limnology and water pollution with practical methodology (1989)
7. JR Etherington, Environment and Plant Ecology (1975)
8. HI Freedman, Deterministic mathematical models in population ecology (1980)
9. Greig Smith P, Quantitative Plant Ecology (1983)
10. JP Grisms et al., Comparative Plant Ecology (1988)
11. KS Kershaw, Quantitative and dynamic ecology (1964)
12. EJ Kormondy Concept of ecology (1966)
13. CJ Krebs, Ecology (1978)
14. KC Misra, Manual of plant Ecology (1989)
15. R Misra and RR Das, Proceedings of the school of plant ecology (1971)
16. EP Odum, Ecology, (1971)
17. EP Odum, Fundamentals of Ecology (3^{rd} ed.) (1996)

18. EP Odum and G W Barrett, Fundamentals of Ecology (6^{th} ed.) (2010)
19. SC Pandeya et al., Principles of Environment Sciences (1963)
20. PD Sharma, Ecology and Environment (2007)

Master of Science (M. Sc.) Part - I: Botany

Semester I

Elective Course I (MBT 414: E1) Biology and Diversity of Trachaeophytes (Pteridophytes and Gymnosperms)

Course Objectives: The students should be able to:

1. Understand the knowledge of Trachaeophytes and Paleoenvironment.
2. Understand the knowledge of importance of study of palaeofossils in Coal and Oil exploration.
3. Identify different pteridophytes from local area
4. Identify different gymnosperms from local area

Credits=2	**SEMESTER-I** **Elective Course I (MBT 414: E1) Biology and Diversity of Trachaeophytes (Pteridophytes and Gymnosperms)**	**No. of lectures per unit**
Unit I	**Pteridophytes – General and fossil types**	
	Distinguishing characters, origin of Pteridophytes, apospory, apogamy, telome theory, stelar evolution, contribution of any two pteridologists (**03)** Economic Importance **(01)** Homospory, Heterospory and seed habit **(01)** Fossil Pteridophytes – *Rhynia*, *Lepidodendron*, *Lepidophyllum*, *Lepidostrobus*, *Lepidocarpon*, **(02)**	**(07)**
Unit II	**Pteridophytes – Living**	
	Psilopsida – Distinguishing characters, External and Internal morphology and reproduction of *Psilotum* **(02)** Lycopsida – Distinguishing characters, external and Internal morphology and reproduction of Lycopodiales, Selaginellales, **(02)** Sphenopsida – Distinguishing characters, external and Internal morphology and reproduction of Equisitales **(02)**	**(08)**

	Pteropsida – Distinguishing characters, external and Internal morphology and reproduction of Marsileales, Salviniales **(02)**	
Unit III	**Gymnosperms (General Aspects)**	
	Introduction, Distinguishing characters **(01)** Gymnosperms – Classification as per Sahni (1920), **(01)** Fossil gymnosperms - Pteridospermales – Important characters of *Lyginopteris*, *Glossopteris* **(02)** Cycadeoidales – Important characters, *Williamsonia* **(01)** Pentoxylales – Important characters of *Pentoxylon*, *Sahnia*, **(02)** Cordaitales –*Callioxylon* **(01)**	**(08)**
Unit IV	**Gymnosperms – Living Cycads and Conifers**	
	Cycadales – distribution, morphology and reproduction**. (01)** Gingkoales – external and internal morphology and reproduction. **(01)** Coniferales – Morphology, sporophyte and gametophyte in Pinaceae, Cupressaceae, Araucariaceae and their interrelationships. **(03)** Welwitschiales - Interelationship, Morphology of sporophyte, gametophyte **(01)** Economic Importance **(01)**	**(07)**

Course outcomes: The students will be able to:

1. Explain the concepts of fossil and living Trachaeophytes.
2. Define the characteristic features of fossil and living Trachaeophytes.
3. Write answers and brief notes on morphology and diversity of extinct and extant Trachaeophytes and their importance in present global economic scenario.
4. Conserve plants of tracheophyte from local area

References:

1. N.S. Parihar, An Introduction to Pteridophyta (1959)
2. A.Rashid, An introduction of Peridophytes (1978)
3. K.R. Sporne, Morphology of Pteridophytes (1966)

4. K. R. Surange, Indian Fossil Pteridophytes (1968)
5. B.R. Vashishta, Botany for degree students – Pteridophytes (1996)
6. F. O. Bower, The Ferns, (1963)
7. H.N. Andrews, Studies in Paleobotany (1961)
8. B. A. Arnold, An Introduction to Paleobotany (1972)
9. C.A. Arnold, An introduction to Paleobotany (1972)
10. S.P. Bhatnagar and Moitra Alok, The Gymnosperms (1975)
11. S.P. Bhatnagar, and Moitra Alok, The Gymnosperms (1996)
12. Coulter and Chamberlain, J. M. - Morphology of Gymnosperms
13. W. C. Darroh, Principles of Paleobotany (1960)
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18. B. J. Chamberlain, Gymnosperms, Structure and Evolution (1966)
19. Coulter and J. M. Chamberlain, Morphology of Gymnosperms
20. W. C. Darroh, Principles of Paleobotany (1960)
21. W. C. Darroh, Principles of Paleobotany (1968)
22. G. K. Ramanujan, Indian Gymnosperms in Time and Space (1979)
23. K. R. Spome, Morphology of Gymosperms (1967)
24. W. N. Stewart, Paleobotany and the evolution of plants, Cambridge U.S (1983)
25. P.C. Vashistha, The Gymnosperms (1976)

Master of Science (M. Sc.) Part - I: Botany

Semester I

Elective Course I (MBT 414: E2) Genetic engineering

Course Objectives: The students should be able to:

1. Understand different aspects of Biotechnology and tissue culture.
2. get introduced to different methods in biotechnology and genetic engineering.
3. understand the advanced techniques in molecular biology used in study of plants.
4. understand the basics of the 'omics' in plant sciences.

Credits=2	**Semester-I** **Elective Course I (MBT 414: E2) Genetic engineering**	**No. of lectures per unit**
Unit I	**Introduction to RDT and Genetic Engineering**	
	Overview of major steps involved in genetic engineering Tools for RDT: **Enzymes:** Restriction endonucleases: Types, Nomenclature, Recognition sequences, cleavage pattern **Other enzymes:** A brief account of alkaline phosphatase, Polynucleotide kinase, Exonuclease III, DNase I, Klenow fragment, Terminal nucleotidyl transferase, RNA dependent DNA polymerase and S1 endonuclease. **Vectors:** Properties of an ideal vector, i) Prokaryotic vectors: Plasmids- pBR 322; pUC 18; Bacteriophages- Lambda phage, Cosmids. ii) Eukaryotic vectors: YAC vectors; Shuttle vectors- Yeast and E. coli. iii) For higher plants: Integrative DNA transfer- Agrobacterium vectors-Ti plasmid	**(07)**
Unit II	**Isolation, construction and transfer of genes**	
	Isolation and construction of a desired genes**:** mRNA isolation, cDNA library, Genomic library Gene transfer methods: *Agrobacterium* mediated gene transfer, Direct gene transfer methods: Chemical method-Calcium phosphate method and DEAE -(Diethylaminoethyl) Dextran mediated DNA transfer: Lipofection, Electroporation, Microinjection, Gene gun method	**(08)**
Unit III	**Selection and screening of recombinants**	
	Identification and selection of transformed cells: Direct methods-	**(07)**

	Insertional inactivation, Visual screening method, Plaque formation, Complementation of mutation /nutrition Indirect methods- Colony hybridization, Immunochemical detection Use of selectable and scorable genes: a) Selectable genes: Plants- npt; Animals-TK b) Scorable genes: Plants-Gus; Animals-lux	
Unit IV	**Technique and applications of RDT**	
	Gel electrophoresis: AGE and SDS-PAGE, PCR - Principle and applications, Hybridization: Southern; Northern; Western; Autoradiography – Principle and applications, DNA foot prints, DNA microarray and DNA chips, CRISPR-Cas9: Gene editing and beyond **Applications:** Transgenic animals: Methodology to create transgenic animals (mouse). Applications of Transgenic Knock-out Mouse, Sheep, Fish, Cow, Transgenic Plants: Resistance to diseases (Pathogen resistance to viral, fungal and bacterial); insects (Bt gene transfer). Fertilizer management – organization of nif gene in Rhizobium.	**(08)**

Course outcomes: The students will be able to:

1) explain the use of biotechnology in botany.
2) describe the various branches of biotechnology in plant science.
3) discuss the recent molecular technology in study of plants.
4) discuss the application of genes, proteins and secondary metabolites in plant science.

References:

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10. Gupta, P. K. 2010. Plant Biotechnology. Rastogi Publications, Meerut.
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16. Reinhert, J. and Bajaj, Y. P. S. 1977. Applied and fundamental aspects of plant cell, tissue and organ culture, Springer Verlag, Berlin.
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Master of Science (M. Sc.) Part - I: Botany

Semester I

MBT 415 Research Methodology

Course objectives: The students should be able to:

1. Understand skills of basics of research
2. Define research problems
3. Gather data from experiments, presented and analyzed
4. Propose hypotheses and learn the tools to test them

Credits=4	SEMESTER-I MBT 415 Research Methodology	No. of lectures per unit
Unit I	**Introduction**	
	Meaning of Research, Objectives of Research, Types of Research, Research Approaches, Significance of Research, Research Methods vs Methodology, Research and Scientific Method Defining the Research Problem: What is a Research Problem? ii. Selecting the Problem, iii. Necessity of Defining the Problem, iv. Technique Involved in Defining a Problem	**(15)**
Unit II	**Research Design**	
	Meaning of Research Design, Need for Research Design, Features of a Good Design, Important Concepts Relating to Research Design, Basic Principles of Experimental Designs Sampling Design i. Census and Sample Survey, ii. Implications of a Sample Design, iii. Steps in Sampling Design, iv. Criteria of Selecting a Sampling Procedure, v. Characteristics of a Good Sample Design, vi. Different Types of Sample Designs, vii. How to Select a Random Sample, Random Sample from an Infinite Universe	**(15)**
Unit III	**Methods of Data Collection and analysis**	
	Methods of Data Collection: Collection of Primary Data; Observation Method; Interview Method; Collection of Data through	**(15)**

	Questionnaires; Collection of Data through Schedules; Difference between Questionnaires and Schedules; Some Other Methods of Data Collection; Collection of Secondary Data Processing and Analysis of Data: Processing Operations; Some Problems in Processing; Elements/Types of Analysis; Statistics in Research; Measures of Central Tendency; Measures of Dispersion; Measures of Asymmetry (Skewness); Measures of Relationship; Simple Regression Analysis; Multiple Correlation and Regression; Partial Correlation; Association in Case of Attributes; Other Measures Comparison of means: chi square test, students t test, ANOVA with interpretation of data, statistical tables and their use - significance test and fixing levels of significance - use of statistical software like COSTAT, STATISTICA, SPSS	
Unit IV	**Interpretation and the art of scientific writing**	
	Interpretation: Interpretation and Report Writing; Meaning of Interpretation; Why Interpretation? Technique of Interpretation: Precaution in Interpretation The art of scientific writing: Significance of Report Writing; Different Steps in Writing Report; Layout of the Research Report; Types of Reports; Oral Presentation; Mechanics of Writing a Research Report; Precautions for Writing Research Reports; Conclusions; Plagiarism: Introduction to copyright, academic misconduct/plagiarism The Computer: Its Role in Research: Introduction; The Computer and Computer Technology; The Computer System; Important Characteristics; The Binary Number System; Computer Applications; Computers and Researcher	**(15)**

Course Outcomes: Students will be able to:

1. Perform basics of research work
2. Understand and define research problems
3. Collect, present and analyze data from experiments
4. Propose hypotheses and use the tools to test them

References:

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7. Kothari, C. R. “Research Methodology: Methods & Techniques”. New Delhi: New Age
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14. Satyanarayana, L., Indrayan, A. “Biostatistics for Medical, Nursing and Pharmacy Students”.
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Master of Science (M. Sc.) Part - I: Botany

Semester I

Practical Course I (MBP 416) Practical Course I: Lab I (Based on MBT 411, MBT 412 and MBT 413)

Course Objectives: The student should be able to:

1. gain practical knowledge of different techniques and instruments used in plant sciences.
2. gain practical knowledge about the diversity of lower plants.

Practicals:

Credits=2	**Semester I** **Practical Course I (MBP 416)** **Practical Course I: Lab I (Based on MBT 411, MBT 412 and MBT 413)**	**No. of hours allotted:** **60 hours**
	1. ANOVA use of computer. 2. Determination of Correlation Coefficient. 3. Preparation of standard solutions: %, M, N, ppm, etc. 4. Verification of Beer and Lambert's law. 5. Density gradient centrifugation 6. Study of instruments / equipments- Photomicrography, Flame photometer, R.C., GC, HPLC, AAS, SEM. 7. Study of micrometry technique. 8-11. Study of Algae: Types mentioned against each class in theory course (available specimens / slides) Charophyceae (any one form); Chlorophyceae (3 forms), Cyanophyceae (3 forms), Bacillariophyceae (2 forms), Phaeophyceae (3 forms), Rhodophyceae (3 forms). 12-16. Detailed study of following types from each of the following orders: Myxomycetes (two forms), Chytridiomycetes (two forms), Oomycetes (two forms), Ascomycetes (six forms), Basidiomycetes (six forms),	

	Deuteromycetes (two forms). 17-20. Morphological, anatomical and reproductive studies of the following members (available specimens / slides) Hepaticopsida (four forms), Anthocerotopsida (two forms), Musci (three forms).	

Course outcomes: Students will be able to:

1. Perform statistical analyses on given data and use various equipments.
2. Identify and describe plants from cryptogams

Master of Science (M. Sc.) Part - I: Botany

Semester I

Practical Course II (MBP 417) Practical Course II: Lab II (Based on MBT 414)

Course Objectives: The student should be able to:

1. To give practical knowledge to students about ecology of plants.
2. To give the practical knowledge about morphological and anatomical variations in living and fossil Trachaeophytes.

Practicals:

Credits=2	**Semester I** **Practical Course I (MBP …….)** **Practical Course II: Lab II (Based on MBT 414)**	**No. of hours allotted:** **60 hours**
	1. Study of Phytoplanktons. 2-3. Evaluation of abiotic components of aquatic ecosystem (pH, Temperature and Transparency). 4. Study of Species diversity index. 5. Study of population dynamics. 6. Estimation of primary productivity of an aquatic ecosystem. 7. Determination of hardness of water. 8. Ecological reports based on tour and / analysis. 9-13. Morphological, Anatomical and Reproductive studies of the following members (available specimens / slides) (Extant) - Psilotales - *Tmesipteris*; Lycopodiales -*Lycopodium*; Isoetales - *Isoetes*; Filicales - *Microsorium*; Marattiales – *Angiopteris*; Salviniales - *Salvinia*. 14-20. Study of the Morphology and Anatomy of (Extant) the vegetative and reproductive parts of: *Araucaria*, *Cupressus*, *Podocarpus*, *Ginkgo*, *Taxus*, and *Ephedra* from available specimens / slides	

Course outcomes: Students will be able to:

1. Evaluate biotic and abiotic properties of water bodies
2. Identify and describe living and extinct members of tracheophytes

Master of Science (M. Sc.) Part - I: Botany

Semester II

Theory Course IV: (MBT 421) Cell and Molecular Biology

Course Objectives: The student should be able to:

1. Understand different aspects of cell biology
2. Know the modern techniques in cell Biology
3. Understand the basic structure of gene organization
4. Understand gene expression process

Syllabus:

Credits=4	SEMESTER-II Theory Course IV (MBT 421) Cell and Molecular Biology	No. of lectures per unit
Unit I	**The Cell**	
	Dynamic cell: Ultra structure of Plant cell and cell organelles, organization and their functions **(05)** Plasma membrane: Structure, models and functions, Channels and pumps, receptors: GPCR and RTK, transport: uniport, symport and antiport, Cell signalling: introduction, primary and secondary signallng molecules **(05)** Cell wall: Structure and its functions **(01)** Plasmodesmata and Gap junctions: Structure and role in intracellular transport of molecules **(04)**	**(15)**
Unit II	**Cell Motility and Multiplication**	
	Organellar Genomes: Organization and function of chloroplast and mitochondrial genome **(02)** Cell shape and motility: The cytoskeleton, organization and role of microtubules and microfilaments, motor movements, implications in flagellar and other movements **(05)** Cell division: Mitosis and Meiosis **(02)**	**(15)**

	Cell multiplication and turnover: Cell Cycle, Steps in cell cycle, control system, Cell cycle check points, Cyclin dependent kinases, and cyclines, Meiotic cell division and Dynamics of chromosome movement during cell division, proteolysis, apoptosis **(06)**	
Unit III	**Gene and Organization of Genetic Material**	
	Concept of gene and overview of chemistry of gene **(02)** DNA replication in prokaryotes and eukaryotes **(03)** DNA damage: spontaneous damage, damage due to physical and chemical mutagens **(02)** DNA repair systems: Direct repair, Excision repair (NER, BER), Mismatch repair and SOS repair **(04)** Packaging of DNA in prokaryotes and eukaryotes **(01)** DNA modifications **(01)** Repetitive and Unique DNA sequences **(01)** Split genes, Overlapping genes, Pseudo genes and Cryptic genes **(01)**	**(15)**
Unit IV	**Gene expression and Gene regulation in Prokaryotes and Eukaryotes**	
	Introduction, Central Dogma, Sense and antisense strand **(01)** Transcription: Concept and requirement of transcription, Transcription Unit, Transcription process in Prokaryotes and Eukaryotes, Reverse transcription **(04)** RNA processing and editing **(01)** Translation: Introduction, requirement, Genetic code and Translation Process in Prokaryotes and Eukaryotes **(03)** Post translational processing of proteins and protein transport **(01)** Regulation of Gene Expression: Introduction, regulation of gene	**(15)**

	expression in Prokaryotes and eukaryotes **(05)**	

Course Outcomes: The students will be able to

1. Explain the concepts of the cell.
2. Define the characteristic features of cell and gene.
3. Write answers and brief notes on the current findings in the field of cell and molecular biology.
4. Apply the gene expression knowledge in research

References:

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4. B Alberts et al, Molecular Biology of Cell; 6th edition (Garland Science, Taylor and Francis, New York, 2014)
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6. John PCL (Ed.), The Cell Cycle (Cambridge University Press, 1981)
7. EJ Dupraw, Cell and Molecular Biology, (Academic Press, London, 1970)
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11. Watson et al, Molecular Biology of the Gene (V) (Pearses Educatias, Inc India, 2004)
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Master of Science (M. Sc.) Part - I: Botany

Semester II

Theory Course V: (MBT 422) Taxonomy of Angiosperms

Course Objectives: The students should be able to:

1. Know the basic rules of classification of angiosperms.
2. Know about the recent systems of classification in angiosperms.
3. Identify the plants around them.
4. Classify the plants around them

Credits=4	SEMESTER-II Theory Course V (MBT 422) Taxonomy of Angiosperms	No. of lectures per unit
Unit I	**General Aspects and History of Classification**	
	Principles, aims and basic components of taxonomy, Principles, aims and basic components of taxonomy **(03)** History of classification, Units of classification **(02)** Outline of current systems of classification and their merits and demerits: Cronquist, Dahlgren, Thorne, Wettstein (up to subclass level) and APG III (2009) and APG IV (2018) **(06)** Origin of Angiosperms, the Cradle and Ancestors of angiosperms: Coniferales-Amentiferae Theory, Ephedrales Theory, Gnetales-Angiosperms Theory, Durion Theory and Gigantopteridalean **(04)**	**(15)**
Unit II	**Nomenclatural Aspects of Classification**	
	History and principles of ICN **(03)** Importance and major codes of nomenclature **(03)** Names of taxa, the type method, author citation, effective and valid publications, retention and choice of names, rejection and conservation of names **(03)**	**(15)**

	Literature in taxonomy – Floras, Manuals, Monographs, Icones, Journals and Checklists **(02)** Taxonomic keys – Indented and Bracketed **(04)**	
Unit III	**Modern Trends of Classification**	
	Modern trends in taxonomy – Embryology, Palynology, Chemotaxonomy, Numerical Taxonomy, Molecular systematics and Computerized systematics **(11)** Taxonomic tools – Herbarium techniques, Importance of herbaria in Botanical research, purpose of digital herbarium. **(02)** Botanical gardens of India and their role in teaching, research and conservation **(02)**	**(15)**
Unit IV	**Taxonomic Aspects of Classification**	
	Study of selected families of angiosperms as per classification of APG IV (2018) with reference to diversity in Morphological characters, distinguishing characters, affinities and economic importance **(15)** MAGNOLIIDS: Magnoliaceae, Annonaceae; MONOCOTS: Araceae, Liliaceae; Arecaceae, Cannaceae, Zingiberaceae; Orchidaceae EUDICOTS: Papaveraceae, Ranunculaceae; Super Asterids: Caryophyllaceae; ROSIDS: Myrtaceae; Rosaceae, FABIDS- Cucurbitaceae COM clade; Placement uncertain- Oxalidaceae; Malvids: Malvaceae, Brassicaceae ASTERIDS: Sapotaceae, Lamiaceae, Gentianaceae, Apiaceae, Acanthaceae	**(15)**

Course Outcomes: The students will be able to:

1. Explain the concepts of angiosperm classification.
2. Define the characteristic features classification systems.
3. Write answers and brief notes on the current trends in the field of angiosperm systematics.
4. Undertake short tour to different floristic regions.

References:

1. A Cronquist An Integrated System of Classification of Flowering Plants (Columbia University Press, New York, 1981)
2. A Cronquist, The Evolution and Classification of Flowering Plants (2nd ed.) (Allen Press, USA 1988)
3. PH Davis, VH Heywood, Principles of Angiosperm Taxonomy (Today and Tomorrow Publications, New Delhi., 1991)
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5. VN Naik, Taxonomy of Angiosperms (Tata McGraw-Hill Publication Com. Ltd. New Delhi 1984)
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7. Gurucharan Singh, Plant Systematics, Science Publishers US, 2004)
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10. Gurucharan Singh, Plant Systematics (Science Publishers US, 2004)
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14. DV Taylor, LJ Hickey, Flowering Plants: Origin, Evolution and Phylogeny (CBS Publishers & Distributers, New Delhi, 1997)
15. R. N. Sutaria, Textbook of Systematic Botany (Publ. Ramniklal P. Kothari, 1998)

Master of Science (M. Sc.) Part - I: Botany

Semester II

Theory Course VI: (MBT 423) Plant Pathology

Course Objectives: The students should be able to:

1. Understand knowledge of Plant pathogens, diseases and management.
2. Understand knowledge of applications and significance of plant pathology.
3. Identify the plant diseases
4. Control the plant diseases

Syllabus:

Credits=4	**SEMESTER-II** **Theory Course VI (MBT 423) Plant Pathology**	**No. of lectures per unit**
Unit I	**General Aspects**	
	Introduction, definition, importance and scope of plant pathology **(02)** History of plant pathology; Socio economic importance of plant diseases **(02)** Discovery and role of fungi, bacteria, viruses, nematodes and MLO's as plant pathogens; Development in chemical control of plant diseases **(02)** Discovery of Bordeaux mixture, Confirmation of Prevost's work, Koch's postulates **(01)** Contribution of Anton de Bary, Brefeld, Woronin, J. G. Horsefall, E J Butler, E C Stakman, K C Mehta, B B Mundkar, M J Thirumalachar **(03)** Plant diseases and classification of plant diseases **(01)** Symptoms of plant diseases- necrotic, hypertrophic and hypoplasic **(02)** Causes of plant diseases- animate and inanimate causes, plant disease Clinic **(02)**	**(15)**

Unit II	**Pathogenesis**	
	Dispersal of plant pathogens: Methods of autonomous and passive dispersal of plant pathogens, diseases and epidemiology (03) Stages in development of disease cycle- Inoculation, Prepenetration, penetration, infection, invasion, colonization of host (04) Pathogenesis- Penetration and infection by plant pathogen (03) Enzymes and toxins in Plant diseases: Pectic enzymes, macerating enzymes, cellulolytic enzymes, ligninolytic enzymes, proteolytic enzymes, lipolytic enzymes, toxins and plant diseases, classification of toxins (05)	**(15)**
Unit III	**Physiological Plant Pathology**	
	Alteration in plant physiological functions due to disease- Permeability, Translocation, photosynthesis, respiration, nitrogen metabolism, protein metabolism, growth regulators in plant diseases **(05)** Plant defense mechanism- Morphological and structural defense, biochemical defense, Defense through induced synthesis of proteins, enzymes, detoxification of pathotoxins, hypersensitive defense reaction, phytoncides **(05)** Effect of environmental factors and nutrition on disease development—temperature, humidity, moisture, soil, pH, soil texture, light, nutrients **(05)**	**(15)**
Unit IV	**Study of Important Diseases w.r.t causal organism, symptoms, control measures**	
	Rots and Downy Mildews - Late blight of potato, Fruit rot of cucurbit, Downy mildew of grapes, White rust of crucifers **(02)** Powdery mildew- Powdery mildew of peas, grapes, roses and	**(15)**

	cucurbits **(02)** Smuts - Loose smut of wheat, Bunt of wheat, Grain smut of jowar, Whip smut of sugarcane **(02)** Rusts - Wheat rust, Rust of pea and beans, Rusts of gram and groundnut, Rust of jowar and bajra **(03)** Wilt and leaf spots - Wilt of cotton, wilt of *Cajanus*, Panama disease of banana, Leaf spot of turmeric, Early blight of potato, Blast of rice, Tikka of groundnut, Red rot of sugarcane, Fruit rot of chillies **(03)** Bacterial diseases – Angular leaf spot of cotton, Brown rot of potato **(01)** Viruses, MLO's and nematodal diseases – Mosaic of Tomato, Viral disease of Papaya, Yellow Vein Mosaic of Bhindi, Bunchy top of Bananas, Root knot of vegetables, Grassy shoot of Sugarcane **(02)**	

Course Outcomes: The students will be able to:

1. Explain the concepts of plant diseases, pathogens and plant disease clinic.
2. Define the symptoms of plant diseases.
3. Write answers and brief notes on symptoms and control measures of plant diseases.
4. Undertake pathology based institute/ agricultural fields, College/ University visits.

References:

1. G. N. Agrios, Plant Pathology, 5th Edition (2006)
   A. Agarwal and R. S. Mehrotra, Plant Pathology (2012)
2. J. Kuijit, The Biology of parasitic flowering plants (1969)
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8. R. Heitefuß, Paul Williams, (Eds.) Physiological Plant Pathology (1976)

A. Mahadevan, and R. Shridhar, Methods in Physiological Plant Pathology (1982)

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A. A. Cooke, Diseases of Tropical and Subtropical field, Fiber and oil plants (1981)

11. Nyvall RF, Field Crop Diseases Handbook (1979)

12. Paul Khurama, Pathological Problems of Economic crop plants and their management (1998)

13. G. Rangaswami, Diseases of Crop Plants in India (1979)

14. R. S. Singh, Plant Diseases, 9th Edition (2009)

Master of Science (M. Sc.) Part - I: Botany

Semester II

Elective Course II : (MBT 424: E1) Developmental and Reproductive Biology

Course Objectives: The students should be able to:

1. Understand various developmental processes in embryology
2. Understand various techniques used in embryological studies
3. Identify the peculiarities in pollens of different plants
4. Recognize the importance of palynology

Credits=2	**SEMESTER-II** **Elective Course II (MBT 424: E1) Developmental and Reproductive Biology**	**No. of lectures per unit**
Unit I	**Anatomy**	
	Shoots development: Organization of Shoot Apical Meristem (SAM) Cytological and Molecular aspects of SAM **(02)** Root development: Organization of Root Apical Meristem (RAM) **(02)** Nodal Anatomy: Unilacunar, Trilacunar, and Multilacunar nodes, Root stem transition **(04)**	**(08)**
Unit II	**Embryology**	
	Male gametophyte: Pollen development; Pollen tube growth and guidance; Pollen storage; Pollen embryos. **(02)** Female gametophyte: Structure and Types of embryo sac. **(04)** Seed development and Fruit growth: Endosperm development during early Maturation **(01)**	**(07)**
Unit III	**Pollen Studies**	
	Pollen: Structure of stigma and style **(01)** Types of Apomixis: Diplospory, Apospory. Causes, consequences and Significances of Apomixis. **(03)** General account of pollen morphology: Polarity, size shape, Symmetry, apertures (NPC Classification included), Exine, Stratification,	**(08)**

	dimorphism and hybrid seed production **(04)**	
Unit IV	**Applications of Palynology**	
	Palynology: Scope and branches. **(01)** Palyno-taxonomy: Pollen morphology and plant taxonomy with reference to Gymnosperms and Angiosperms. **(02)** Aeropalynology: General account of aerobiology and its application in human respiratory allergy and immunology, Allergic properties of pollen, Pollen calendar and its importance **(02)** Melittopalynology: Bee colony, Foraging behavior of bees **(01)** Agropalynology: Pollen viability, Pollen Storage and their significance **(01)**	**(07)**

Course Outcomes: The students will be able to:

1. Explain the concepts of developmental and reproductive biology of plants.
2. Define the concepts of plant developmental and reproductive biology.
3. Write answers and brief notes on developmental and reproductive aspects of plant biology.
4. Explain importance of palynology

References:

1. M A. Barnova, Historical developments of the present classification of morphological types of stomata (Bot.Res., 1987) 53:53-79.
2. E G Cutter, Plant Anatomy. (1971)
3. E J. Eames, and M C Danials, An introduction to plant anatomy (1947)
4. K. Easau, Plant anatomy –anatomy of seed plants (1962)
5. A Fahn, Secretary Tissue system (1969)
6. A S Foster, Practical plant anatomy (1942)
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9. B M. Johari, Experimental embryology of vascular plants. (1963)
10. P. Maheshwari, An introduction to the embryology of Angiosperm. (1950)
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19. K. R. Shivanna, and B M Johari, The Angiosperm pollen structure (1989)
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Master of Science (M. Sc.) Part - I: Botany

Semester II

Elective Course II: (MBT 424: E2) Bioinformatics

Course Objectives: The students should be able to:

1. Understand basics of bioinformatics
2. Understand use of different biological databases
3. Understand sequences, alignments and dynamic programming
4. Perform gene expression analysis

Credits=2	SEMESTER-II Elective Course II (MBT 424: E2) Bioinformatics	No. of lectures per unit
Unit I	**Basics of Bioinformatics**	
	What is Bioinformatics and its relation with molecular biology databases (GENBANK, Pubmed, PDB) Data generation; Generation of large scale molecular biology data. (Through Genome sequencing, Protein sequencing, Gel electrophoresis, NMR Spectroscopy, X-Ray Diffraction, and microarray). Applications of Bioinformatics.	**(08)**
Unit II	**Biological Database and its Types**	
	Introduction to data types and Source. Population and sample, Classification and Presentation of Data. Quality of data, private and public data sources. Introduction of Biological Databases: Nucleic acid databases (NCBI, DDBJ, and EMBL). Protein databases (Primary, Composite, and Secondary). Specialized Genome databases: (SGD and TIGR). Structure databases (CATH, SCOP, and PDBsum).	**(07)**

Unit III	**Sequence Alignments and Visualization**	
	Introduction to Sequences, alignments and Dynamic Programming; Local alignment and Global alignment (algorithm and example), Pairwise alignment (BLAST and FASTA Algorithm)	**(07)**
Unit IV	**Phylogenetic analysis and Gene expression analysis**	
	Phylogenetic analysis: Definition and description of phylogenetic trees, a primer on computational phylogenetic analysis. Computational gene prediction methods, analysis of codon usage bias, computational prediction and analysis of regulatory sites (MEGA 11) Introduction, Basic steps for gene expression. Transcriptome and Proteome- General Account Introduction to Regular Expression, Hierarchies, and Graphical models (including Marcov chain and Bayes notes). DNA microarray: understanding of microarray data and correlation of gene expression data to biological processes and computational analysis tools	**(08)**

Course Outcomes: The students will be able to:

1. Understand different applications of bioinformatics
2. Use of different biological databases
3. Perform gene sequence analysis
4. Perform gene expression analysis

References:

1. Noor Ahamad Shaikh, Khalid Rehaman Hakeem, Essentials of Bioinformatics, Volume II (2019)

2. T W Tan, Eric Lee, Beginners Guide to Bioinformatics for High Throughput Sequencing (2018)
3. Eric Lee, Beginners Guide To Bioinformatics For High Throughput Sequencing (2018)
4. R. Amjesh, S.S. Vinodchandra, Bioinformatics for beginners (2019)
5. Maxwell James, Bioinformatics for beginners (2021)

Master of Science (M. Sc.) Part - I: Botany

Semester II

Practical III: (MBP 426) Practical Course III: Lab III (Based on MBT 421, 422, 423)

Course objectives: The students should be able to:

1. Perform experiments related to study of cell and molecular biology along with latest techniques.
2. Identify the plants using classical and modern system of classification.

Practicals:

Credits=2	**Semester II** **Practical Course III (MBP 426)** **Practical Course III: Lab III (Based on MBT 421, 422, 423)**	**No. of hours allotted:** **60 hours**
	Section I 1. Isolation of chloroplasts. 2-3. Isolation and estimation of DNA from dividing root tip cells of *Allium cepa.* 4-5. Preparation of carmine stained chromosome in root tip cells. 6-7. Effect of colchicine on chromosome movements during mitosis. 8. Demonstration of Nitrate reductase (Substrate inducible enzyme). 9. Estimation of protein from germinating and developing seeds 10-16. Study of families of angiosperms as per theory. i. Data base on morphology ii. Determination of family iii. Diagnostic features of series, order and family iv. Complete classification by Bentham and Hookers System of classification v. Floral formula vi. Floral diagram. 17-18. Identification of genus and species of locally available wild plants using Floras (minimum 10 plants).	

	19. Preparation of botanical keys. 20. Field trips within and around the Institute campus, compilation of field notes and preparation of herbarium sheets of such plants.	

Course Outcomes: The student will be able to:

1.Perform isolation technique for organelles and biomolecules.

2. Perform practicals related to plant taxonomy.

Master of Science (M. Sc.) Part - I: Botany

Semester II

Practical IV: (MBP 427) Practical Course IV: Lab IV (Based on MBT 424)

Course objectives: The students should be able to:

1. Perform experiments related to study of cell and molecular biology along with latest techniques.
2. Identify the plants using classical and modern system of classification.

Practicals:

Credits=2	**Semester II** **Practical Course IV (MBP 427)** **Practical Course IV: Lab IV (Based on MBT 424)**	**No. of hours allotted:** **60 hours**
	Section I 1-6. Study of Fungal diseases as per theory: Club root, Damping off, White rust of crucifers, Early and late Blight of potato, Downy mildew of grapes, Powdery mildew of cucurbits, Smut of jowar, Rust of wheat, Bunt of rice, Blast of rice, leaf spot (Tikka), Anthracnose of bean, Black rot of onion and Wilt of pomegranate. 7. Study of Bacterial Diseases as per theory: Bacterial Blight of Pomegranate and Leaf Spot. 8. Study of Mycoplasmal Diseases as per theory: Grassy shoot disease of sugarcane and Little leaf of chilli/brinjal. 9. Study of Viral Diseases as per theory: TMV, PMV and YVMV. 10. Phanerogamic plant Diseases: Total and Partial root and stem parasites. 11. Estimation of chlorophylls, proteins, enzymes and polyphenols from healthy and infected leaves 12. Study of cyto-histological zonation in the Shoot Apical Meristem (SAM) in sectioned and doubled stained permanent	

	slides of suitable plant such as *Coleus*, *Kalanchoe*, Tobacco. Examine of shoot apices in a monocotyledons in both T.S. and L.S. to show the origin and arrangement of leaf primordia. 13. Examine of L.S. of root from a permanent preparation to understand the organization of Root Apical Meristem and its derivatives (use maize, aerial roots of banyan, *Pistia* etc.), origin of lateral roots. 14. Study of leguminous roots with different types of nodules. 15. Study of leaf anatomy – structure, stomata, trichomes, types of stomata. 16. Study of ultrastructure of male and female gametophyte with the help of slides and microphotographs. 17. Culture of any one organ: anther / ovary / endosperm / nucellus / embryo. 18. Study of apomicts and polyembryonic seeds with the help of any suitable material. 19. Study of Acetolysis, pollen morphotypes and pollen fertility. 20. Study of aerospora in the vicinity of allergic plants by Tilak Air Sampler and Gravity slide method.	

Course Outcomes: The student will be able to:

1. Identify Plant diseases.
2. Distinguish shoot apical meristem and shoot apical meristem