Sant Gadge Baba Amravati University

Part A **Faculty – Science and Technology**

Programme- M. Sc. (Botany) CBCS

2023

Sant Gadge Baba Amravati University
Part A
Faculty – Science and Technology
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POs

1. To equip students with strong fundamentals in subject domain knowledge.
2. To attract students in all the areas of plant science with unique combination of core, elective papers.
3. Students can explore the cutting-edge technologies and skills currently used in plant sciences.
4. They are made aware of social, environmental issues and plant significance in natural interest.
5. To create interest in nature conservation and save the natural resources.
6. Focus is equally given on labour work as well as field work.
7. To worth together as a team along with other branches of life sciences without any complex.
8. To develop scientific temperament and research attitude and much for society.

PSOs 1

1. To equip the students with the fundamental concepts of plant sciences
2. To understand the basics of structure and functions of cells
3. To learn the process of growth and development of plants
4. To study the evolutionary process from lower to higher plants

2

1. To study the concepts of genetics, plant breeding and their applicability
2. To understand and correlate the various biochemical and physiological processes in plants
3. To study the evolutionary process in Bryophytes and Pteridophytes
4. To study the bioactive principles in plants and their defense mechanisms

Employability Potential:

Joseph Paxton Famous Botanist said that 'Botany the science of vegetable kingdom is one of the most attractive, useful and extensive department of human knowledge, the science of beauty. Any human activity without plant involvement is baseless. Botany is the scientific study of plants. Sant Gadge Baba Amravati University offers M.Sc. Botany a master's Program which deals with study of plants, their characteristics, classification and various related aspects in detail. The main aims and objectives of M.Sc. program are:

- To prepare students for a carrier as scientists, who can deal with current research lines in botany using modern techniques.
- To help them represent the discipline both in basic and applied research area.
- To encourage multidisciplinary collaboration.

- To equip and helpful students in all aspects of plant sciences with a view that they can take up teaching at different levels, researches in institute/university, doctoral work, EIA, Biodiversity studies entrepreneurship, Scientific writing in relevant topics have been included in curriculum.

The duration of this program is two years. There are 30 seats and admission on merit basis. Candidates who wish to opt M.Sc. Botany should have Botany as one subject at graduate level and deep interest in plants and their life cycle.

The Syllabi of Botany is designed as per CBSC pattern and is very rich so that along with Botany students can opt for their choices and interest in allied field. The major focus is upon ability and skills other than core course subjects. The whole post-graduate program is of 4 semesters, where students are imparted deep knowledge about plant kingdom, Physiology, Genetics, Molecular Biology, Biotechnology, Genetics Engineering, Pharmacognosy, Ecology, Microbiology, Biosystematics, Tissue Culture, Bioprospecting etc. Botany also deals with various aspects related to Agriculture, Environment, Pharmacy, Forestry, Horticulture and Floriculture. Nursery, farms, Environmental consultancies Pharmaceuticals companies Forest sciences with job profile as Ecologist, Plant Taxonomist, Plant Biochemist, Researcher, Environmental Consultant, forest ranger, Botanists. Nursery or green house manager, Farming consultant, geneticist, Biotechnologists, Microbiologist etc. It would also provide highly skilled human resource for incubation centres and start-ups in the field of plant related industrial units as well as Research and Development sectors.

Study of plants is fundamental and vital as life is dependent on plant for well being of all living organism as plants produce energy, O2, C, Water etc. Comparing with other forms of life, plants life can be studied at different levels molecular, genetical and biochemical through various cells, tissues, organ, individuals, plants population and communities. Botanists are concerned with identification classification, structure, function of plant life. Botany also covers the Protista group which include fungi, Lichens, bacteria, viruses and single cell algae. A good understanding of plants is essential to the future generation because

- Produce food for expanding population
- Understand fundamental life processes
- Produce medicine and materials to treat disease

Education is not only to gain knowledge and understand the things but it must be able to enhance one's ability and skills for better employability. Employability skills are those which help one to stand separately than others for the same jobs. These skills are vital in order to secure a role where employability, skill matches with your job profile. These skills come naturally or can be acquired through work experience, practice or education.

The employability means, teaching botany at various levels. Employability skills are transferable that students can use this at workplace. Teachers seek all these set of diverse skills in students in addition to academic qualification, in order to stay relevant and improve their efficiency. Teacher should focus on building the employability skills. Various skills can be developed after completion of this program. These are as follows.

1. **Communication Skills:** It is one of the important personality traits which is sought after employment. It generally consists of five elements sender, receiver, message, medium and feedback. It can be verbal, nonverbal, visual or written. Good communication skills help any institution/organisation to avoid unnecessary misunderstanding, waste of time and increase the output. To be an effective communicator one has to understand colleagues through ideas and thoughts to achieve the goal. Practices like positive expression, body language, careful listening, think before you speak, debate, group discussion, elocution completion, seminars etc. can improve the skills.
2. **Leadership Skills:** Flourishing of any organisation requires good leaders with excellent leadership skills. They look for such persons. Good leaders can manage people/ team well, convince them, motivate them and train them so as to improve the workplaces practices as per the set objectives. Students are given various responsibilities of organising and conduction of event, arrangements and coordination of various activities in team to develop these qualities.
3. **Problem Solving Skills:** This quality helps to remove the obstacles by resolving complex issues. They are asset to any organisation for increasing the efficiency. It is an act to determine the issue, identify the cause, select best possible solution and implement it. Complex problem can be broken into smaller parts and then the issue can be addressed. In other way it can be solved by research, analyses and then decision can be made. Undertaking research projects, Assignments, brain storming sessions, solving puzzle etc. can enhance this skill.
4. **Team Work Skills:** To know role in team and work amicably with teammates. Healthy, cordial relationship with colleagues and better work environment increases job satisfaction. It has direct impact on organisation stability, innovation and output. In practical's, group of 4-5 students are made and they perform the experiment efficiently, group assignments, group activities etc. develop these skills.
5. **Reliability Skills:** This is very important employability skill to build trust with the employer. Consistency is the key of reliability. Meetings, daily task, respond to queries, acknowledge mistakes and take lessons from it are the thing to develop reliability. Mentor –mentee meet often, counselling etc.
6. **Self Management Skills:** It is the ability to organise and manage own works without guide. It saves time and enhances efficiency. Students project work, Botanical Excursions and tours management, preparations for exams, perform experiments in 3hrs etc.
7. **Learning Skills:** It enables to improve the knowledge about the subject. Tend to change to adapt new concepts and methods. Such persons can acquire challenging positions and save time. It ensures quick implementations of new system, process and technology. Students are asked to refer good books of the subject, seminars on recent topics are given, standard protocols are used in practicals etc.

8. **Technology skills:** In present scenario it is must to know and how to use the updated technology. It is one of the leading skills for any institution. Helps to stay relevant and ahead of the competition. These skilled are valued as one can grasp the technology-based concept and learn how to use them effectively. Students are using this technology for learning and research purpose.
9. **Planning and Organisation skills:** Important to achieve goals, manage time, money and effort and increase efficiency. Should be resourceful, manage priorities, timely and take decisions.
10. **Technical and Analytical skills:** Make them skilled in practicals, laboratory equipments and interpret the data on biological material.

The course is designed in such a way that after completion it is expected that they develop and nurture these employability skills for employment or entrepreneurship development

Scheme of Teaching, Learning & Examination leading to the Degree in Master of Science in the Programme Botany
(Two year- Four Semester Degree Programme- C.B.C.S.)
(M.Sc. Part II) Semester III

S. No.	Subject	Subject Code	Teaching & Learning Scheme							Duration of Exam Hours	Examination & Evaluation Scheme						
			Teaching Periods Per Week				Credits				Theory		Practical		Total Marks	Minimum Passing	
			L	T	P	Total	L/T	Practical	Total		Theory+ MCQ External	Theory Internal	Internal	External		Marks	Grade
1	DSC-IX Systematics and Taxonomy of Angiosperms	BOT 301	4	-	-	4	4	-	4	4	80	20	-	-	100	40	P
2	DSC-X Paleobotany, Evolution and Diversity of Gymnosperms.	BOT 302	4	-	-	4	4	-	4	3	80	20	-	-	100	40	P
3	**DSE- I** 1. Angiosperm Taxonomy, Phytochemistry and Pharmacognosy 2. Molecular Systematics of Plants 3. Plant Tissue Culture 4. Advanced Plant Physiology 5. Basic and Applied Mycology 6. Molecular Biology, Biotechnology &Plant Breeding	BOTE-I 301 to 308	4	-	-	4	4	-	4	3	80	20	-	-	100	40	P
4	**DSE -II** 1. Angiosperm Taxonomy, Phytochemistry and Pharmacognosy 2. Molecular Systematics of Plants 3. Plant Tissue Culture 4. Advanced Plant Physiology 5. Plant Pathology 6. Molecular Biology, Biotechnology & Plant Breeding	BOTE-II 301 to 308	4	-	-	4	4	-	4	3	80	20	-	-	100	40	P
5	Lab- 5 Practical Based on DSC IX & X		-	-	6	6	-	3	3	*	-	-	-	100	100	50	P
6	Lab- 6 Practical Based on DSE I & DSE- II		-	-	6	6	-	3	3	*	-	-	-	100	100	50	P
7	# Internship/ Field Work/ Work Experience @																
8	**Open elective/ GIC/ Open skill/ MOOC* Landscape Design and management**	OEC I 303	4	-	-	4	4	-	4	3	80	20	-	-	100	40	P
Total						28			26						600		

L: Lecture, T: Tutorial, P: Practical

Student may complete their Internship/ Field Work/ Work experience in First or Second or Third semester of Master of Science in the Programme, according to their convenience; @ denotes Non-Examination credits.

Note: Internship/ Apprenticeship/ Field Work Experience (during vacations of semester I to III. This will carry 2 credits for learning of 60 hours or 3 Credits for learning of 90 hours. Its credits and grades will be reflected in final semester IV credit grade report.

-OEC (Optional) can be studied during semester I to IV

Part B

Syllabus Prescribed for 2023 Year **PG. Programme**

Programme **M.Sc. Botany**

Semester III

Code of the Course Subject	**Title of the Couse/ Subject**	**No. of periods/ week**
DSC IX	**Systematics and Taxonomy of Angiosperms**	**04**

Cos:

1. The ultimate aim of taxonomy is to understand the evolution at work. Angiosperms being the dominant as well as most evolved plant group, the sources of characters for taxonomy are also varied.
2. Itis also being practiced at various levels, from morphology to phylogenomic. This course aims to give comprehensive understanding in angiosperm taxonomy as well as its practice and applications.

Unit-I	**Taxonomic Nomenclature, Tools, Floristics** Aims, principles and practices in taxonomy. Botanical Nomenclature: Brief history, Scientific names, ICN, Principles, typification, Principle of priority, effective and valid publication, rank of taxa. ICBN an historical review and silent features of Shenzhen code 2018. Tools of taxonomy: Floras, monographs, revisions, websites. Herbarium and botanical gardens, their role in teaching, research and conservation, important herbaria and botanic gardens of the World. Botanical Survey of India. Floristics: Need and significance. History of botanical exploration in India and Botanical Survey of India. Morphological features used in identification. Artificial dichotomous keys.
Unit-II	**Classification** Importance and need for classification, hierarchical classification. Criteria used for classification; phases of plant classification. Overview on pre- and post-Darwinian systems of classification. Artificial systems of classification - Herbalists, Theophrastus, Linnaeus. Natural system of classification - Bentham and Hooker Phylogenetic systems of classification - Cronquist, Takhtajan APG system of classification, contributors, APweb.
Unit-III	**Evolution of Angiosperms** General characteristics; Evolutionary history; Evolutionary trends in Angiosperms, Basal angiosperms and Magnoliids; Basal monocots; Petaloid monocots; Commelinids; Basal eudicots and Caryophyllids; Rosids; Asterids. Molecular evolution – Neutral theory, molecular clock.Cladistics (Phylogeny) – Phylogeny and Classification of Angiosperms: Fossil angiosperms and their ecology. APG IV system of classification of angiosperms; characteristics and phylogeny of clades: Orders – Amborellales, Nymphaeales, Austrobaileyales, Chloranthales; Clades (Magnoliids), (Monocots (Commelenids)), Order Ceratophyllales, (eudicots, superrosids (Rosids (malvids, fabids))) (Superasterids (asterids (campanulids, lamids))))).
Unit-IV	**Plant Systematics** Evolutionary trends in Angiosperms with special reference to vegetative floral anatomical and chemical characters. Systematic studies of following families with emphasis on origin, floral structure, evolution and interrelationship.

	4.3 Magnoliaceae, Ranunculaceae; Papaveraceae; Capparidaceae; Meliaceae; Leguminoceae, Myrtaceae; Cucurbitaceae; Cactaceae.
Unit-V	**Plant Systematics** Gentianaceae; Rubiaceae; Asteraceae; Apocynaceae; Asclepiadaceae; Convolvulaceae, Boraginaceae. Scrophulariaceae, Acanthaceae, Lamiaceae, Polygonaceae; Nyctaginaceae; Caryophyllaceae; Loranthaceae Podostemonaceae; Poaceae; Cyperaceae Cannaceae; Orchidaceae, Arecaceae.

Suggested Reading:

1. Bhatnagar, S.P. and Moitra, A., 1996, Gymnosperm. New AgeInternational Pvt.Ltd.New Delhi.
2. Cole,A.J., 1969, Numerical Taxonomy, Academic Press, London.
3. Davis P.H. and Heywood, V.H. 1973, Principles of AngiospermsTaxonomy, Robert, E.Kreiger, Publishing Company, New York.
4. Grant,V. 1971. Plant Speciation, Columbia University Press, NewYork.
5. Grant,W.F., 1984, Plant Biosystematics, Academic Press, London.Balfour Austin (2016). Plant Taxonomy. Syrawood Publishing House
6. Chapman, J.L. and Reiss, M.J. (1998). Ecology: Principles and applications.Cambridge, University Press.
7. Chopra G.L. (1984). Angiosperms: Systematics and Life-Cycle., Pradeep Publications
8. Cooke, Theodore (1903-8). The Flora of the Presidency of the Bombay Vol. I, II, III(Repr. ed), Botanical Survey of India.
9. Cronquist, A. (1968). The Evolution and Classification of Flowering Plants. ThomasNel and Sons Ltd. London.
10. Datta S.C. (1988). Systematic Botany. New Age Publ.
11. Davis P.H and V.H Heywood (1963). Principles of Angiosperm Taxonomy. Oliverand Boyd, London.
12. Heywood V.H. (1967). Plant Taxonomy, Hodder & Stoughton Educational, London.
13. Judd Walter S., Campbell, C. S., Kellogg, E. A., Stevens, P.F. and M. J. Donoghue.(2008). Plant Systematics- A Phylogenetic Approach. Sinauer Associates, INCPublishers.Sunderland, Massachusetts, USA.
14. Kormondy Edward (1995). Concepts of Ecology, Pearson Publ.
15. Lawrence G.H.M. (1955). An Introduction to Plant Taxonomy. McMillan, New York.
16. Lawrence, G.H.M. (1951). Taxonomy of Vascular Plants. McMillan, New York.
17. Michael P. (1984). Ecological Methods for field and Laboratory investigations TMHCo. ltd.Bombay.
18. Mondol A.K. (2016) Advanced Plant Taxonomy, New Central Book Agency (NCBA)
19. Naik V.N. (1988) Taxonomy of Angiosperms. Oxford and IBH
20. Odum E.P., (2004). Fundamentals of Ecology, Publ. Cengage Learning, Australia
21. Pande B.P. (1997). Taxonomy of Angiosperms. S. Chand.
22. Pande B.P. (2001) Taxonomy of Angiosperms. S. Chand.
23. Radford A.E. 1986. Fundamentals of Plant Systematics, Harper and Row N Y.
24. Santapau H. (1953). The Flora of Khandala on the Western Ghats of India. BSI
25. Sharma O.P. (2011), Plant Taxonomy, Tata Mc grow Hill
26. Shivrajan V.V. & N.K.P. Robson (1991). Introduction to Principles of PlantTaxonomy. Cambridge Univ. Press
27. Shukla Priti and Shital Mishra (1982). An introduction to Taxonomy of angiosperms.Vikas Publ.
28. Simpson, M.G. (2010). Plant Systematics. Elsevier, Amsterdam.
29. Singh Gurucharan (2005). Systematics: Theory and Practice. Oxford IBH.
30. Singh J.S., S.P. Singh, and S.R. Gupta (2006). Ecology, Environment and ResourceConservation. Anamaya Publ. New Delhi.
31. Singh N.P. (2001) Flora of Maharashtra Volume-II BSI, Kolkatta
32. Singh N.P. (2003) Flora of Maharashtra Volume-III BSI, Kolkatta
33. Singh N.P., S. Karthikeyan (1996) Flora of Maharashtra Volume-I, BSI, Kolkatta
34. Singh V. and D.K. Jain, (1981). Taxonomy of Angiosperms. Rastogi Publication,Meerut.
35. Singh, Gurcharan. (2012). Plant Systematics: Theory and Practice. Completelyrevised and enlarged 3rd edition. Oxford & IBH, New Delhi.

36. Stuessy, Tod F. (2009). Plant Taxonomy: The Systematic Evaluation of ComparativeData, second edition. Columbia University Press.
37. Swingle D.B. (1946). A Text book of Systematic Botany. McGraw Hill Book Co.New York.
38. Takhtajan A. (1969). Flowering Plants: Origin and Disposal.
39. Coble, A. J. 1969. Numerical Taxonomy. Academic Press, London
40. Davis, P. .& Heywood, V. H. 1973. Principles of angiosperms Taxonomy. Robert E. Kreugeer Pub. Co., New York
41. Eames, A. J. I 1961. Morphology of the Angiosperms. McMgraw- Hill, Neew York.
42. Harrison, H. J. 1971. New concepts in Flowering Plant Taxonomy. Heiman, London
43. Heywood, V. H. & Moore, D. M 1984. Current Concepts in Plant Taxonomy Academic Press, London. Global
44. Heywood, V. 1995. Global Biodiversity Assessment Cambridge Univ., Cambridge.
45. Radford, A. E. 1986 Fundamentals of Plant Systematics- Harper & Row, USA
46. Stace, C. A. 1989. Plant Taxonomy and Biosystematics. Edward Arnold, London
47. Takhtajan, A. L. 1997. Diversity and Classification of Flowering Plants Columbia University Press, New York.
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56. Jain, S.K. and R.R. Rao. 1977. A handbook of Field and Herbarium methods. Today and Tomorrow Printers and Publishers, New Delhi.
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61. Michael George Simpson, 2010. Plant systematic (2nd Edition). Academic Press.
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69. Singh, G. 2010. Plant systematics: an integrated approach(Third Edition). CRC Press.
70. Sivarajan, V.V. 1991. (2nd ed.). Introduction to the Principles of Plant Taxonomy (Ed. N S K Robson). Oxford& IBH publishing Co. Pvt. Ltd.
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72. Walter S. Judd, Christopher S. Campbell, Elizabeth A. Kellogg, Peter F. Stevens, Michael J. Donoghue, 2015.Plant Systematics: A Phylogenetic Approach, Fourth Edition. Sinauer Associates, Inc., Publishers, Sunderland, USA (Now Oxford University Press).

Learning Outcome:

Students would be able to

1. Apply principles of general taxonomy and they can use nomenclature rules plants.
2. Understand historical development of taxonomy.
3. Explain concept of species.
4. Order sub and super categories of species according to Linne hierarchy.
5. Apply nomenclature rules in Botany.
6. Description of a plant specimen.
7. Study of at least 20 locally available families of flowering plants.
8. Identification of genus and species of locally available wild plants.
9. Preparation of botanical keys at generic level by locating key characters.
10. Knowledge of at least 10 medicinal plant species.
11. Knowledge of plant phylogeny and cladistics and its use in taxonomy

Part B

Syllabus Prescribed for 2023 Year **PG. Programme**

Programme **M.Sc. Botany**

Semester III

Code of the Course Subject **Title of the Couse/ Subject** **No. of periods/ week**

DSC X **Paleobotany, Evolution and Diversity of Gymnosperms.** **04**

Cos:

1. To understand the phylogenetic significance of Gymnosperms
2. To illustrate the diversity of past vegetation
3. To know the distribution and economic potential of gymnosperms
4. To contribute to the ancestry of present day dominant vegetation: Angiosperms
5. To understand the significance of past vegetation in the formation of fossil fuel

Unit-I	**Evolutionary concept and Antiquity of Gymnosperms** Geological Time Scale and Plant life through the ages Process of fossilization ; types of preservation and techniques of fossil study, formation of fossil fuel Nomenclature and reconstruction of form genera Contributions of Indian paleo botanists like Professors Birbal Sahni, D.D.Pant and K.R.Surange
Unit-II	**General account of Gymnosperms** Distinguishing characters of gymnosperms. Geographic distribution and economic importance of gymnosperms Development of Seed through male and female gametophyte with evolutionary trends Classification of Gymnosperms: D.D.Pant and S.V. Meyen Progymnospermopsida

Unit-III	**Morphology, anatomy, reproduction and evolutionary trends** Pteridospermales, Glossopteridales, Caytoniales Bennittitales and Cycadales Pentoxylales, Czekanowskiales Cordaitales
Unit-IV	**Morphology, anatomy, reproduction and affinities** Ginkgoales Coniferales: Araucariaceae, Podocarpaceae, Taxodiaceae, Cupressaceae, Cephalotaxaceae Taxales with taxonomic status *In-vitro* studies in gymnosperms
Unit-V	**Gnetopsida as ancestors of Angiosperms** Ephedrales Gnetales Welwitschiales Phylogenetic reflection of Gnetopsida

Suggested Reading:

1. Stewart W.N. qne Rothwell G.W.(1993): Palaeobotany and the Evolution of Plants, Cambridge University Press
2. Foster A.S. and Gifford F.M. (1967): Comparative Morphology of Vascular Plants, Freeman Publishers, San Fransisco
3. Arnold C.A. (1947): Introduction to Palaeobotany, Mc-Graw Hill Book Co.Inc.New York and London
4. Kubitzki K. (1990): The families and genera of vascular plants-Pteridophytes and Gymnosperms, Springer Verlag, New York
5. Agashe S.N. (1995): Palaeobotany, Oxford and IBH, New Delhi
6. Coulter J.M. and Chamberlain C.J. (1978): Morphology of Gymnosperms, Allahabad
7. Biswas C. and Johri B.N. (2004): The Gymnosperms, Narosa Publishing House, New Delhi
8. Bierhorst D.W. (1971): Morphology of Vascular Plants, McMillan, New York
9. Bharnagar S.P. and Moitra A. (1966): Gymnosperms, New Age International Pvt. Ltd., New Delhi
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11. Maheshwari P and Singh H. (1960): Economic importance of Conifers, J.Univ, Gauhati 11(Sci): 1-28
12. Maheshwari P. and Singh H. (1967): The female gametophyte of Gymnosperms, Biol. Rev.42: 88-130
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26. Steward W.N., Palaeobotany and evolution of plant. Cambridge University Press, New York.405 p.(1)
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28. 10. Wilson N Stewart and Gar W. Rothwell - 1993. Palaeobotany and the evolution of plants. Cambridge university press.
29. 11. Edith L. Taylor, Thomas N. Taylor, Michael Krings – 2009. Palaeobotany: The Biology and Evolution of Fossil Plants. Academic Press.

Learning Outcome:

Students would be able to

1. Illustrate the phylogenetic significance of past vegetation
2. Help in understanding the diversity and economic potential of the gymnosperms
3. Contribute to how past vegetation formed the fossil fuel
4. Substantiate the evolutionary trends and dominance of present day angiosperms

Semester III Code of the Course/Subject	**Title of the Course/Subject** (Laboratory/Practical/practicum/hands-on/Activity)	**(No. of Periods/Week)**
Practical – V	Practical based on Paper IX and X	**06**

Course Objective:

To learn plant taxonomy through dissection of flowers, use of Floras and field study and develop skills to handle plant identification and floristic work independently and at the same time able to handle molecular data for interpreting phylogeny.

List of Practical's Based on Paper IX

1. Writing of technical descriptions.
2. Construction of keys.
3. Identification of local species using Floras, keys and campus field trips.
4. Construction of phylogenetic tree based on gene sequences available at NCBI database (each student may be given different gene sequences/taxa).
5. Technical description of plant species available locally and identification up to family.
6. Study of species belonging to single genus and preparation of key at genus level.
7. Preparation of herbarium specimens following standard techniques.
   At least 100 specimens should be presented collectively by the class of locally abundant species. Frequent field trips should be arranged to get acquainted with local flora. One tour within state and one outside the state should be arranged to study the biodiversity of Angiosperms. Field tour reports should be supported by exhaustive field notes and photographic representations of plant species

Suggested Readings:

1. Barry G. Hall. 2007. Phylogenetic Trees Made Easy: A How-To Manual, Third Edition. Sinauer Associates, Inc., Publishers, Sunderland, USA.
2. Jain, S.K. and R.R. Rao. 1977. A handbook of Field and Herbarium methods. Today and Tomorrow Printers and Publishers, New Delhi.
3. Lawrence, G.H.M. 1951. Taxonomy of Vascular. Plants. Oxford & IBH Publishing Co.
4. Singh, G. 2009. Plant systematics: an integrated approach. Science Pub Inc.
5. Utteridge, T. and G. Bramley. 2014. Tropical Plant Families Identification Handbook. Kew Publishing.
6. Walter S. Judd, Christopher S. Campbell, Elizabeth A. Kellogg, Peter F. Stevens and Michael J. Donoghue.2007. Plant Systematics: A Phylogenetic

Approach, Third Edition. Sinauer Associates, Inc., Publishers, Sunderland, USA.

Learning Outcomes:

1. Able to write technical description of plants and construct and use keys for identification.
2. Able to identify common plant families based on the morphological features.
3. Able to recognize common plants.
4. Able to construct phylogenetic tree based on molecular sequences.

List of Practical's Based on Paper X

A. Comparative Study of vegetative and reproductive parts of – Cycas, Zamia, Cedrus, Abies, Pinus, Cupressus, Cryptomeria, Taxodium, Podocarpus, Agathis, Thuja, Gnetum, Ephedra, Juniperus, Cephalotaxus, Taxus, Permanent micro preparations to be submitted by the students.

C. Ginkgo: Morphology to be studied from Museum specimens & and anatomy from permanent slides.

D. Study of important fossil gymnosperms from available material and permanent slides.

E. Visit to palaeobotanical Institutes, localities and collection of specimens.

F. Field visits to ecologically different localities to study living gymnosperms

PRACTICAL–V: PTERIDOPHYTA, GYMNOSPERMS AND TAXONOMYOFANGIOSPERMS. PRACTICALSCHEDULE

Time : 6 Hrs. Max. Marks: 40

Identify and describe the given pteridophytic material 06 Marks

Identify, describe and make a double stained permanent micropreparation of gymnosperm material 07 Marks

Systematic description of a given angiospermic two plant species.

14 Marks

Spotting: 08 Marks

i) Pteridophyte- 2
ii) Gymnosperm- 2
iii) Fossil Specimen- 2
iv) Angiosperm- 2

Viva-voce 05 Marks

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI
PRACTICAL EXAMINATION
M.Sc. II Botany, Semester- III (CBCS)

PRACTICAL V: - (Systematics and Taxonomy of Angiosperms and Paleobotany, Evolution and Diversity of Gymnosperms)

TIME: -6 Hrs. **Maximum Marks: -80 + 20 = 100**

	Systematic description of a given Angiospermic two plant species.	**15**
	To Prepare of botanical keys at generic level by locating key characters.	**10**
	Identify the fossil gymnosperms from permanent slides.	**05**
	Identify and comment on its medicinal utility any two medicinal plant species	**10**
	Identify, describe and make a double stained permanent micro preparation of gymnosperm material.	**15**
	To study Morphology of Museum specimens & and anatomy from permanent slides.	**10**
	Perform study of vegetative and reproductive parts of given gymnosperm material	
	Spotting	**05**
Q.8	**Internal marks :** Practical Record (10); Viva voce (05); Student overall performance and Activity – Field visit report (Agriculture University, Nursery, Research Institute) / Monograph and Attendance (05)	**20**

Part B
Syllabus Prescribed for 2023 Year **PG. Programme**
Programme **M.Sc. Botany**
Semester III

Code of the Course Subject	**Title of the Couse/ Subject**	**No. of periods/ week**
BOEC III	**Landscape Design and management**	**04**

Cos :

1. To make them understand the concept and its use**.**
2. To know the aesthetic value and commercialization.
3. To apply this knowledge for country economic development.

Unit-I	• Concepts in Landscape, definition, classification and Planning. • Design Basic Elements of Landscape.
Unit-II	• Landscape Design, Goals and guidelines, Processes. • Analytical Methods Climate and other Environmental factors in Landscape Design.
Unit-III	• Landscape Evaluation Techniques, Types, Economics. • Techniques Site Selection and Site Planning Principles and factors for Site Selection
Unit-IV	• The Site Plan: scale, circulation, building lines, plot coverage and drainage. • Landscape Construction Materials and Elements Typology of humanized landscape (housing) Landscape design Techniques
Unit-V	• Management of Landscape and their Environmental Impacts

Suggested Reading:

1. Abello, R.P., Bernaldez, F.G. and Galiano, E.F. (1986) Consensus and contrast components in landscape preference. Environment and Behaviour, 18, 155-176.
2. Amir, S. and Gidalizon, E. (1990) Expert based Method for the Evaluation of Visual Absorption Capacity of the Landscape. Journal of Environmental Management, 30, 251-163.
3. Anderson, L.M., Mulligan, B.E., Goodman, L.S. and Regen, H.Z. (1983) Effects of sounds on preferences for outdoor settings. Environment and Behaviour, 15, 539-566.
4. Arthur, L.M., Daniel, T.C. and Boster, R.S. (1977) Scenic assessment: an overview. Landscape Planning, 4, 109-129.
5. Bishop, I.D and Hulse, D.W. (1994) Prediction of scenic beauty using mapped data and geographic information systems. Landscape and Urban Planning, 30, 59-70.
6. Brabyn, L. (1996) Landscape Classification using GIS and National Digital Databases. Landscape Research, 27, 277-300.
7. Briggs, D.J. and France, J. (1980) Landscape Evaluation: A comparative study. Journal of Environmental Management, 10, 263-275.
8. Bürgi, M., 1999. A case study of forest change in the Swiss lowlands. Landscape Ecology 14, 567–575.
9. Burton, A. (1974). How Lagos Became a Colony: Nigeria the Land and its Arts and its People. An Anthology (Ed.) Lunney, F. Studio Vista, London.
10. Carls, E.G. (1974) The effects of people and man-induced conditions on preferences for outdoor recreational landscapes. Journal of Leisure Research, 6, 113-124. Conservation Study Institute website – visit www.nps.gov/archive/csi/about/about.htm. Accessed March 2008.
11. Cooper, A and Murray, R. (1992) A structured method of landscape assessment and countryside management. Applied Geography, 12, 319-338.
12. Crofts, R.S. (1975) The landscape component approach to landscape evaluation. Transactions of the Institute of British Geographers, no 66, 124-129.

13. Crofts, R.S. and Cooke, R.U. (1974) Landscape Evaluation: A comparison of techniques. Occasional Papers, no 25, Department of Geography, University College London.
14. Crowe, S. (1956). Tomorrow's Landscape: Architectural Press, London
15. Dearden, P. (1985) Philosophy, theory, and method in landscape evaluation. Canadian Geographer, 29, 263-265.
16. Dunn, M.C. (1976) Landscape with photographs: testing the preference approach to landscape evaluation. Journal of Environmental Management, 4, 15-26.
17. Eckbo, G. (1969). The Landscape We See. McGraw-Hill Book Co. New York Eckbo,
18. G. (1964). Urban Landscape Design. McGraw-Hill Book Co. NewYork
19. Falade, J.B. and Oduwaye, A.O.(1998). Essentials of Landscape and Site Planning. Omega Hi- Tech Information and Planning System Ltd.
20. Ikeja, Lagos, Nigeria. Falade, J.B. (1987). Rural Landscape and Design. A Commissioned Paper presented at the 18th Annual General Conference of NIOB at Minna,
21. Nigeria Fischer, J., Lindenmayer, D.B. & Fazey, I. (2004). Appreciating ecological complexity: habitat contours as a conceptual landscape model. Conserv. Biol., 18, 1245–1253.
22. Forman, R.T.T. (1995). Land Mosaics: The Ecology of Landscapes and Regions. Cambridge University Press, New York.
23. Fowler, PJ 2003, World Heritage cultural landscapes 1992–2002, UNESCO World Heritage Centre, Paris.
24. Geist, H.J., McConnell, W.J., Lambin, E.F., Moran, E., Alvers, D., Rudel, T., 2006. Causes and trajectories of land-use/cover change. In: Lambin, E.F., Geist, H.J. (Eds.), Land-Use and Land Cover Change. Springer, Berlin, pp. 41–70. READING LIST: http://www.unaab.edu.ng
25. Gosden C and Head L 1994, 'Landscape – a usefully ambiguous concept', Archaeology in Oceania, 29, pp 113–116.
26. Grubler, A (1994) Technology. In Changes in Land Use and Land Cover: A Global Perspective. pp. 287–328. Cambridge University Press, Cambridge.
27. Haines-Young, R., Barr, C.J., Firbank, L.G., Furse, M., Howard, D.C., McGowan, G., Petit, S., Smart, S.M., Watkins, J.W., 2003. Changing landscapes, habitats and vegetation diversity across Great Britain. Journal of Environmental Management 67, 267–281.
28. Harrison R 2004, Shared landscapes: archaeologies of attachment and the pastoral industry in New South Wales, Department of Environment and Conservation, Sydney, and University of New South Wales Press, Sydney.
29. Jacques, D.L. (1980) Landscape Appraisal: The Case for a Subjective Theory. Journal of Environmental Management, 10, 107-113.
30. Johnston R 1998, 'Approaches to the perception of landscape: philosophy, theory, methodology', Archaeological Dialogues, 5, pp 54–68. Koeppel, H.-D., Schmitt, H.-M., Leiser, F., 1991.
31. Landschaft unter Druck. Zahlen und Zusammenhange über Veränderungen in der Landschaft Schweiz. Buwal, Bern, 154pp.
32. Lennon J and Mathews S 1996, 'Cultural landscape management: guidelines for identifying, assessing and managing cultural landscapes in the Australian Alps national parks', unpublished report for the Cultural Heritage Working Group, Australian Alps Liaison Committee.
33. Ludwig, J., Tongway, D., Freudenberger, D., Noble, J. & Hodgkinson, K.C. (1997). Landscape Ecology, Function and Management: Principles from Australia_s Rangelands. CSIRO Publishing, Melbourne.
34. Marcucci, D.J., 2000. Landscape history as a planning tool. Landsc. Urban Plan. 49, 67–81.
35. Marsh, W.M. Landscape Planning: Environmental Applications. Fourth Edition. John Wiley and Sons, Inc Meinig D W 1979, The interpretation of ordinary landscapes: geographical essays, Oxford University Press, New York, USA.
36. Melnick RZ 1984, Cultural landscapes: rural historic districts in the national park system, US Department of the Interior, National Park Service, Washington DC.
37. Murtagh, B., et al. Authenticity and stakeholder planning in the segregated city. Progress in Planning (2008), doi:10.1016/j.progress.2007.11.001

38. Oduwaye, A.O. (1996). Urban Landscape Planning in Nigeria Landscape and Urban Planning Journal. Elsevier Science Publisher, Amsterdam Onibokun,
39. A.G. (1984). The Nature of Urban and Regional Planning Policies. Chapt. 2. p15-23, In: Urban and Regional Planning Policy Formulation of Developing Countries.
40. (E.) Faniran, A., Onibokun, A.G., Abumere, S.I., University Press House, Ibadan.
41. Pearson M and Sullivan S 1995, Looking after heritage places: the basics of heritage planning for managers, landowners and administrators, Melbourne University Press, Victoria.
42. Penning-Rowsell, E.C. (1982) A public preference evaluation of landscape quality. Regional Studies, 16, 97-112.
43. Price, C. (1994) Appendix: Literature Review. Landscape Research, 19,38-42.
44. Robinson, D.G. et al. (eds) (1976) Landscape evaluation - the landscape evaluation research project 1970-1975. University of Manchester. Rockwell, R.C., 1994. Culture and cultural change. In: Meyer, W.B., Turner, B.L. (Eds.), Changes in land use and land cover: a Global Perspective. Cambridge University Press, Cambridge, pp. 357–382.
45. Sauer C 1925, 'The morphology of landscape', in Geography 2(2), pp 9–25, University of California Publications. Scazzosi L 2003, 'Landscape and cultural landscape: European Landscape Convention and UNESCO Policy', in UNESCO World Heritage Centre cultural landscapes: the http://www.unaab.edu.ng challenges of conservation. World Heritage papers 7, pp 55–59,
46. UNESCO World Heritage Centre, France. Schroeder, H. and Daniel, T.C. (1981) Progress in Predicting the Perceived Scenic Beauty of Forest Landscapes. Forest Science, 27, 71 - 80.
47. Shafer, E.L. and Tooby, M. (1973) Landscape preferences: an international replication. Journal of Leisure Research, 5, 60-65.
48. Shafer, E.L., Hamilton, J.F. and Schmidt, E.A. (1969) Natural landscape preferences: a predictive model. Journal of Leisure Research, 1, 1-19.
49. Shuttleworth, S. (1980b) The Evaluation of Landscape Quality. Landscape Research, 5, 14 - 20.
50. Tandy, C. (1971) Landscape evaluation technique. Working Paper, Croydon, Land Use Consultants. Site Planning Process Chesterfield County, Virginia Planning Department. Accessed 11 August 2011 Tips,
51. W.E.J. (1984) A Review of Landscape Evaluation in Belgium and Some Implications for Future Research. Journal of Environmental Management, 18, 57 - 71.
52. Unwin, K.I. (1975) The relationship of observer and landscape in landscape evaluation. In Transactions of the Institute of British Geographers, no.66, 130-133.
53. von Droste B, Plachter H and Rossler M (eds) 1995, Cultural landscapes of universal value – components of a global strategy,
54. Gustav Fischer Verlag, Jena. Wade, G. (1982) The relationship between landscape preference and looking time: a methodological investigation. Journal of Leisure Research, 14, 217-222.
55. Weedle, A.E. (1979). Landscape Technique. Institute of Landscape Architects. Heinemann Limited.
56. London Willis, K.G. and Garrod, G.D. (1993) Valuing Landscape: a Contingent Valuation Approach. Journal of Environmental Management, 37, 1-22.
57. Wood, R., Handley, J., 2001. Landscape dynamics and the management of change. Landsc. Res. 26, 45–54.

Learning Outcome:

i. The fundamental terms in landscaping.
ii. Convert any piece of barren land into beautification
iii. Select a proper site for landscape design.
iv. Design a urban /rural land and increase country's economic value

ELECTIVE OPTIONS UNDER CBCS

Part B

Syllabus Prescribed for 2023 Year **P.G.**

Programme

Programme : **M.Sc. Botany**

Semester: III

Code of the Course	Subject Title of the Couse/ Subjec	No. of periods/ week
DSE I	**Angiosperm Taxonomy, Phytochemistry and Pharmacognosy**	**04**

COs:

1) Study plant morphology, Description of a plant specimen, Study of locally available families of flowering plants, Identification of genus and species of locally available wild plants.
2) Appreciate the need to conserve floristic and cultural diversity of the region.
3) Preparation of botanical keys at generic level by locating key characters.
4) To develop laboratory skill like isolation, extraction & evaluation of phytochemicals from medicinal plants.
5) To develop knowledge of herbal drugs and new commercial plant products.
6) Rescue and document Ethnobotanicals for sustainable use of plant resources.

UNIT I:	Scope, Aims, Principles of Taxonomy, Historical Development of Plant Taxonomy; Study of Basic Principles and Recent Angiosperm Phylogeny Group (APG) System of Classification. Taxonomic Literature: Checklist, Catalogue, Floras, Monographs, Indices and Journals, Taxonomic Keys And DNA Barcoding
UNIT II:	International code of Botanical Nomenclature Type method, valid publication, Rule of priority, Author citation, conservation of names and rejection of names, Herbarium Preparation and use, Digital Herbarium, Role of Botanical Garden. Different theories of origin of angiosperms.
UNIT III:	Basic principles of phytochemical techniques, Classification of Phytochemicals. Extraction and Isolation of Phytochemicals, Spectrophotometry- Principle and application, UV Visible and Infra-Red Spectroscopy, Chromatographic techniques- Paper chromatography, Thin Layer Chromatography (TLC), High Performance Liquid Chromatography(HPLC), Gas Liquid Chromatography (GLC).
UNIT IV :	Study Of Following Secondory Metabolites With Respect To Their Chemistry, Biological Activity And Role- Terpenes, Flavonoids, Simple Phenolics, Phenolic Glycosides, Tannins, Anthraquinone, Saponins, Steroids And Alkaloids, Pigments (anthocyanin and betacyanin),, Resins, Gums And Volatile Compound.
UNIT V :	Definition, history, scope and objectives, development and applications of Pharmacognosy, Medicinal plants cultivation and its benefits Pharmacognostic studies of following drug plants:(Nomenclature, Morphology, Anatomy, Chemistry, Uses and Adultrants) *Datura metel,*

	Solanum surattense, Zingiber officinale,Ocimum sanctum, Centella asiatica , Asparagus racemosus,Commiphora weightii, Tinospora cordifolia, Boerhavia diffusa, Plumbago zeylanica, Cissus quadraungaris Withania somnifera,Adhatoda zeylanica Ethnobotany: Defination, scope and significance.

Syllabus Prescribed for 2023 Year

P.G. Programme

Programme : **M.Sc. Botany**

Semester: III

Code of the Course	**Subject Title of the Couse/ Subject**	**No. of periods/ week**
DSE II	**Angiosperm Taxonomy, Phytochemistry and Pharmacognosy**	**04**

UNIT I	History of Angiosperm classification from herbals to the present day. Types of classification-artificial, natural and phylogenetic Brief account of Pre-Darwinian Classification. Post-Darwinian developments in classification, Study of Modern systems – Takhtajan; Dahlgren, and Thorne's system of classification.
UNIT II	Adaptation and morphological peculiarities in Angiosperms, Taxonomic evidence: Palynology; embryology, , Phytochemical systematics and molecular systematics. Numerical taxonomy. Living fossils of Angiosperms: Winteraceae, Degeneriaceae, Tetracentraceae, Trochodendraceae, Eupomatiaceae.
UNIT III	Comparative account of vegetative and floral morphology, inter-relationships;phylogeny and distribution of plant families belonging to following subclasses as per Cronquist's system (As illustrated by following orders and families). **a) Magnoliidae:** Ranunculales- Ranunculaceae, Berberidaceae, Lardizabalaceae, Menispermaceae. **b) Hamamelideae**: Urticales- Ulmaceae, Moraceae,Cannabaceae, Urticaceae. **c) Caryophyllidae**: Caryophyllales- Nyctaginaceae, ,Cactaceae, Aizoaceae,Molluginaceae, Chenopodiaceae,Portulacaceae, Amaranthaceae. **d) Dillenidae-** Malvales,Tiliaceae, Sterculiaceae, Bombacaceae, Malvaceae.

UNIT IV	**e) Rosidae**: Geraniales- Oxalidaceae, Geraniaceae Balsaminaceae. **f) Asteridae** –Solanales- Solanaceae, Asterales- Asteraceae. **g) Alismatidae**-Alismatales-Butomaceae, Limnocharitaceae,Alismataceae. **h) Zingiberidae**- Zinziberales-,,Heliconiaceae, Musaceae, Zingiberaceae, Costaceae,Cannaceae, Marantaceae. **i) Liliidae**- Liliales- Liliaceae, Amaryllidaceae, Iridaceae, Agavaceae, Dioscoreaceae.
UNIT V	Medicinal plants as future source of new drugs, Cultivation Practices of Medicinal Plants Medicinal plants and its benefits. Plants used by ethnic groups as food, medicines (Ethnomedicine), beverages, fodder, fibre, resins, oils, fragrances and other uses. General good agriculture practices for medicinal herbs: Source, selection and authentication herbal materials. Collection, harvesting, drying, packaging, storage and preservation of herbal raw materials..,

Suggested Readings :

1. Comparative Phytochemistry - Swain, T., Academic Press.
2. Chemistry in Botanical classification - Nobel symposia medicine and natural science, Benz, G. and J.Santesson, Academic Press.
3. Pharmacognosy - Kokate C.K., A.P.Purohit and S.B.Gokhale, Nirali Prakashan.
4. Trease and Evan's Pharmacognosy : W.C.Evans, Saunders.
5. Plant systematics, a phylogenetic approach - Jude, Campell, Kellog & Stevans, Sionaur Association Inc.USA.
6. Biochemical systematics: Alston, R.E. & B.L.Turner, Prentice Hall.
7. Origin and Early Evolution of Angiosperms, Breek C.B. (Ed), Columbia University Press.
8. The Seeds of Dicotyledons Vols. I & II, Corner, E.J.H., Cambridge University Press.
9. Morphology of the Angiosperms, Eames, A.J., MC Graw Hill.
10. Plant Chemototaxonomy: Harborne J.B. and B.L.Turner, Academic Press.
11. Pollen Morphology & Taxonomy of Angiosperms: Eradtman, G., Almvist & Wiksei Stoekholm.
12. Taxonomy of Vascular Plants, Lawrence: H.M., MC Millan.
13. Taxonomy of Angiosperms, Naik: V.N., Tata McGraw Hill.
14. The families of flowering plants Vol. I & II: Hutchinson, J., Hutchinsu London.
15. Principles of Angiosperms Taxonomy : Davis H. & V.H, Heywood, Von Nostrand.
16. International Code of Botanical Nomenclature, Voss.E.C.(Ed.), Regnum Vegetable utrecht.
17. A Punched card key to the Dicot Families of South India: Saldhana C. & C.K.Rao, Arvind Publishers, Bangalore.
18. Phytochemistry and Angiosperm Phylogeny: Young D.J., & Siegler, Prager.
19. An Integrated System of Classification of flowering Plants: Cronguist, A., Columbia University Press.
20. Flowering Plants Origin & Dispersal: Takhtajan, A., Oliver & Boyd.
21. Evolution and Phylogeny of flowering plants: Hutchinson, J., Academic Press.
22. Evolution and Systematics: Solbrig, O.T., McMillan.
23. Morphology of Angiosperms: Sporne, K.R., Hutchinson, London.
24. Origin and Early Evolution of Angiosperms: Beck, C.G. (Ed.), Columbia University Press.
25. Palaeobiology of Angiosperms Origin: Hughes, N.H., Cambridge University Press. 26) Chromosome Atlas of the Flowering Plants of the Indian Subcontinent: Kumar, International Book. Distributors.

26. Taxonomy & Ecology: Heywood, V.H.Ed., Acadenue Press.
27. Numerical Taxonomy: Sneath, P.H.A. & R.R.Sokal, W.H.Freeman & Co.San Fransisco.
28. Manual of Cultivated Plants: 2nd Ed., Baily, L.H., Macmillan
29. Traditional plant medicines as sources of new drugs. P J Houghton in Pharmacognosy Trease and Evan's.16 Ed .2009 2. Cunningham, A. B. (2001).
30. Applied Ethnobotany. Earthscan publishers Ltd. London & Sterling, VA, USA Cotton, C.M. (1996).
31. Ethnobotany-Principles and application. John Wiley& Sons Ltd., West Sussex, England.
32. An introduction to Ethnobotany, Moredale Publ. London 6. Jain, S. K. (1981)
33. Glimpses of Indian Ethnobotany. Oxford & IBH publishing Co. Pvt. Ltd., New Delhi

Learning Outcomes:

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

1. Learn and apply the knowledge of Plant Taxonomy for identification and distinguish them family wise.
2. Apply taxonomic tools in taxonomic classification, modern and numerical taxonomy.
3. Acquire the skills of Phytochemical analysis from important medicinal plants.
4. Understand the significance of traditional knowledge of ethnomedicine.
5. Acquire the knowledge of cultivation & marketing of herbal products.

Syllabus Prescribed for 2023 Year **PG Programme**

M. Sc. Botany Semester II Semester III

Code of the Course/ Periods/Week)	**Title of the Course/Subject**	**(No. of**
Subject	**(Laboratory/Practical/practicum/ hands-on/Activity)**	**06**
Practical VI	**Practical Based on DSE I & II**	

Laboratory Exercises :

1) Description of locally available dicot and monocot species. Identification upto species level with the help of flora.

2) Use of cytological data in Taxonomic studies - Karyotype analysis. Preparation of Karyograms; and Idiograms (to be done with the help of permanent preparation / diagram / photoplate).

3) Comparison of different species of a family to calculate similarity coefficient and preparation of dendrograms (numerical taxonomy).

4) Study of different taxonomic features like stomatal types, pollen types, trichome types, crystals etc.

5) Detection of secondary metabolites in plant material by quick tests. Detection of flavonoids, irridoids; leucoanthogenins, anthroquinones, alkaloids, saponins, differentiating anthocyanins from bactacyanins. Chemically differentiating angiosperm wood from gymnosperms wood.

6) Pharmacognostic studies of any 5 of the locally available medicinal plants.

7) Frequent field visits to study local flora are expected. One short tour within state and one long tour to other state to study the vegetation and biodiversity of angiosperms. Students

should submit atleast 80 herbarium specimens locally available and available abunduntally and 10 plants of medicinal importance which are available abundantally. (collectively) prepared according to international norms. Excursion report should be supported by field diary and photographic presentation of the flora.

8). Field trip to tribal settlement to survey, document and frame hypothesis on people-plant relationship.

Sant Gadge Baba Amravati University, Amravati

Practical Examination Botany Semester- III (CBCS New)

Practical VI

Angiosperm Taxonomy, Phytochemistry and Pharmacognosy

Practical Schedule

Time 6hrs Marks-80

Q.1) Systematic description of two Angiospermic plants (one from Dicotyledons and one from Monocotyledons)	20 Marks
Q.2) Preparation of artificial key	10 Marks
Q.3) Karyotype studies	10 Marks
Q.4) Detection of secondary plant metabolites of given plant material	10 Marks
Q.5) Morphological and analytical characterization and Uses of given drug plant material	10 Marks
Q.6) Spotting (3 Morphology of Angiosperms, 2 on root, leaf, fruit drug plant from syllabus)	10 Marks
Q.7) Viva voce	10 Marks

Part B

Syllabus Prescribed for 2023 Year **PG. Programme**

Programme **M.Sc. Botany**

Semester III

Code of the Course Subject	Title of the Couse/ Subject	No. of periods/ week
DSE-I	Molecular Systematics of Plants- Elective-I	04

Cos : On completion of the course, the student should be able to

1. Discuss and apply principles of delimitation and identification of species and other taxa
2. Account for the central concepts of the field and principles of phylogenetic analysis, especially based on the parsimony criterion
3. Discuss and apply methods to generate relevant molecular data, mainly sequence data
4. Choose and apply existing software in the included course parts, from generating relevant molecular data to phylogenetic analysis
5. Critically analyse, evaluate, compile, and present the results of phylogenetic analyses.

Unit-I	Taxonomy - Role, scope; Systematics- importance, evolution and phylogeny. Fossil Angiosperms and phylogeny Flower structure and Evolution offlower.
Unit-II	Taxonomic categories and characters: structure of' taxonomic hierarchy; taxonomic categories (supra-specific, species, and intra-specific); taxonomic characters (kinds and criteria). Systems of classification; artificial (Carl Linaeus), natural (Bentham and Hooker) and, phylogenetic systems (Takhtajan-Cronquist) Phenetics (principles selection of characters. character-taxon matrix, similarity matrix).
Unit-III	3.1 Study of the following Polypetalae families with special reference to their phylogeny, geographical distribution and plants of economic importance and common examples - Rananculaceae, Nymphaeceae, Violaceae, Papaveraceae, Polygalaceae.
Unit-IV	4.1 Concepts and Techniques in Systematics: Three Domain Concept in Systematics, two, five and six kingdom classification. Concept of species taxonomic diversity within species. Molecular Phylogeny-use of Proteins, DNA and RNA and other Markers.
Unit-V	Basic concepts in Systematics, taxonomy and phylogeny Nature of data used in taxonomy and Phylogeny Definition and description of Phylogenetic trees and various methods Clustering method -UPGMA Cladistic method - Parsimony Phylogenetic Analysis softwares Phylip, PAUP

Suggested Reading:

1. Felsenstein, J. 2004. Inferring phylogenies. Sunderland, Mass., Sinauer Associates, Inc. Hall, B. G. 2011. Phylogenetic trees made easy: a how-to manual (4th edition). Sunderland: Sinauer Associates. Hillis, D. M., C. Moritz and B. K. Mable, eds. 1996.
2. Molecular systematics. Sunderland, Mass.: Sinauer Associates. Kitching, I. J., P. L. Forey, C. J. Humphries and D. M. Williams. 1998. Cladistics: the theory and practice of parsimony analysis. Oxford: Oxford UniversityPress.
3. Li, W.-H. 1997. Molecular evolution. Sunderland, Mass.: Sinauer Associates. Schuh, R. T. 2000. Biological systematics. Comstock Publishing Associates,

Ithaca. Soltis, P. S., D. E. Soltis and J. J. Doyle, eds. 1992. Molecular systematics of plants. New York: Chapman and Hall. Soltis, D. E., P. S. Soltis and J. J. Doyle, eds. 1998.

4. Molecular systematics of plants II DNA sequencing. Boston: Kluwer Academic Publishers. Williams, D. M. and M. C. Ebach. 2008. Foundations of systematics and biogeography. New York, Springer. Yang, Z. 2006. Computational molecular evolution. Oxford, Oxford University Press.
5. Kormondy, E.J. (1996). Concepts of Ecology. Prentice Hall, U.S.A. 4th edition.
6. Sharma, P.D. (2010) Ecology and Environment. Rastogi Publications, Meerut, India. 2. Simpson, M.G. (2006). Plant Systematics. Elsevier Academic Press, San Diego, CA, U.S.A.
7. Singh, G. (2012). Plant Systematics: Theory and Practice. Oxford & IBH Pvt. Ltd., New Delhi. 3rd edition.

Learning Outcome:

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

7. Understand historical development of taxonomy.
8. Explain concept of species. Order sub and super categories of species according to Linne hierarchy.

Part B

Syllabus Prescribed for 2023 Year **PG. Programme**

Programme **M.Sc. Botany**

Semester III

Code of the Course Subject	Title of the Couse/ Subject	No. of periods/ week
DSE-II	Molecular Systematics of Plants- Elective-II	04

Cos

: On completion of the course, the student should be able to

This course covers state-of-the-art methods for reconstructing phylogenies. We will cover the theoretical basis for different phylogenetic analyses and learn how to use some of the software packages available for conducting these analyses. Inferences that rely heavily on phylogenetic trees (eg. analyses of character evolution, divergence time estimation, and studies of diversification rates) will also be covered.

Unit-I	Fine structure of gene, split genes, pseudogenes, non-coding genes, overlapping genes and multi-gene families. Genome sequencing methods, Genome annotation at different levels, Comparative genome sequencing. Molecular Phylogenetics Origins, Applications of Molecular Phylogenetics. Phylogenomic comparisons, introduction to programs, Phylogenetic analyses: tree terminology and parsimony, Phylogenetic analyses to determine relationships and interpret character evolution. Single gene disorders- conventional and contemporary methods. Candidate gene identification; Genetic polymorphism and disease susceptibility.
Unit-II	Gene Expression Analysis using Microarrays and RNA-Seq, Application of DNA microarrays for the analysis of gene expression, protein-DNA binding, chromatin structure, chromatin modifying complexes, and RNA polymerase occupancy. Error models and data normalization techniques for high-resolution array technologies. Clustering genes

	into sets and discovering gene set features that can be used for diagnostic purposes. 2.3 Importance of chromatin structure in contemporary modelling, relationship between chromatin structure and transcriptional regulation.
Unit-III	Barcoding Basics: DNA Isolation, Amplification and Sequencing DNA Barcoding: The DNA barcoding of 4 chloroplast genes (*mat*K, *rbc*L, *ndh*F, *mat*K , *ycf*1 etc.)
Unit-IV	Introduction and history of developments in taxonomy: merits and demerits of major systems of classification. Angiosperm Phylogeny Group (APG) system of classification (APG III and IV) of Angiosperms Phylogeny Group (IV) Classification, Taxonomic evidences: anatomical, embryological, palynological, cytological and biochemical.; biosystematics; concepts and components; Aims of systematics; direct and indirect methods of plant identification; practice of taxonomic key; Phylogenetic analysis (Parsimony, Maximum likelihood, Bayesian approaches, Neighbor Joining.
Unit-V	Plant Molecular Systematics: DNA and amino acid sequence data, types of sequence data. sequence alignment; computer applications in systematics. Barcoding concept and DNA fingerprinting; Phylogenomic approach towards understanding plant systematics.

Suggested Reading:

1. Retrieving, viewing and printing of the specific protein sequence (by accession no. or name) using a public database site.
2. Exploring the NCBI, ExPASy, www.ebi.ac.uk/Tools etc. websites for information and tools available there.
3. Pairwise alignment of Protein and DNA sequences & data interpretation.
4. Local and global alignment of sequence data and comparing both results.
5. Retrieving DNA and/or protein sequences of a given item (by name or accession number) from GENBANK. Performing a sequence similarity search using the BLAST.
6. Retrieving this protein sequence of a given organism and downloading the structure of this protein from existing database. Short-listing protein sequences of highest similarity from the list of BLAST search result and doing a multiple sequence alignment (Using CLUSTALW). Finding out the regions of exact/good match in the protein sequences of these sequences.
7. Aligning nucleotide sequences; designing a degenerate primer of 20 bases from nucleotide alignment data, and calculate the level of degeneracy of this primer.
8. Learning about the Phylip/MEGA program and its uses for the construction of phylogenetic trees.
9. Searching and downloading protein structure data using Entrez. Viewing the structure using public domain software.
10. Protein structures: Visualizing and analysis of inter atomic distances, H-bond calculations, secondary structure analysis and salt bridge analysis of protein structures using different software. Prediction of 3D structure of protein.
11. Angiosperm Phylogeny Group (2003) An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG II. Botanical Journal of the Linnaean Society 141: 399-436.
12. Cracknell AP, Hayes L (2009) Introduction to Remote Sensing. CRC Press, Boca Raton, USA (Special Indian Edition).
13. Crawford DJ (2003) Plant Molecular Systematics. Cambridge University Press, Cambridge, UK.

14. Cronquist A (1981). An integrated system of classification of flowering plants. Columbia Evolution. Taylor and Francis, London.
15. Jain S.K. (1995). Manual of Ethnobotany. Scientific Publisher; Second edition (1995).
16. Judd WS, Campbell CS, Kellogg EA, Stevens PA and Donoghue MJ (2002). Plant Systematics: A Phylogenetic Approach. Sinauer Associaes, Inc., Massachusetts.
17. Nei M and Kumar S (2000). Molecular Evolution and Phylogenetics. Oxford University Press, New York. 8. Raven PH, Begr LR, Hassenzahl DM (2008). Environment. 6th edition. John Wiley & Sons, Inc., New York. Semple C and Steel MA (2003). Phylogenetics. Oxford University Press, Oxford.
18. Simpson MG (2006). Plant Systematics. Elsevier, Amsterdam.

Learning Outcome:

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

1. Structure of Genes
2. Phylogenetic analysis
3. DNA Barcoding

Syllabus Prescribed for 2023 Year **PG Programme**
Programme: M. Sc. Botany

Semester I Code of the Course/Subject	**Title of the Course/Subject** (Laboratory/Practical/practicum/hands-on/Activity)	**(No. of Periods/Week)**
Practical – 6	Practical based on DSC I & II	06

DSE Molecular Systematics of Plants- Elective-I and II

Laboratory Exercises

Major Experiments

1. Live plants/ Herbarium specimens of the following families will be provided in the class for description and identification (classification based on APG II, 2003):
2. Basal Angiosperm and Magnoliids: Nymphaeaceae, Magnoliaceae
3. Basal Monocots: Araceae, Alismataceae
4. Petaloid monocots: Liliaceae, Smilacaceae, Alliaceae, Orchidaceae
5. Commelinids: Commelinaceae, Poaceae, Cyperaceae
6. Basal Eudicots and Caryophyllids: Ranunculaceae, Caryophyllaceae
7. Rosids: Euphorbiaceae, Rosaceae, Fabaceae, Cucurbitaceae
8. Asterids: Solanaceae, Lamiaceae, Apiaceae, Asteraceae

Minor Experiments

9. Writing exercise
10. Nomenclature exercise
11. Classification exercise
12. Cladogram construction and analysis
13. PCR Based amplification of genes.
14. Sequencing protocol.
15. Method of gene Annotation.
16. Blast analysis of DNA sequence.
17. Primer designing using computers.
18. Identification of MUMs (Maximum unique matches)
19. DNA extraction from plants.
20. Effect of BLOSSUM on sequence Analysis.

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI
PRACTICAL EXAMINATION
M.Sc. I Botany, Semester- II (CBCS)

PRACTICAL VI:- (Molecular Systematics of Plants- Elective-I and II)

TIME: -6 Hrs. **Maximum Marks: -80 + 20 = 100**

Q.1	Setting and Working on any one major experiment.	**25**
Q.2	Setting and Working on any one minor experiment.	**15**
Q.3	Setting and Working on any one computational experiment.	**25**
Q.4.	Spotting	**15**
Q.5.	**Internal marks:** Practical Record (10); Viva voce (05); Student overall performance and Activity – Botanical Excursion with field study report / Monograph and Attendance (05)	**20**

CBCS Elective-I Plant Tissue Culture Elective-I

Cos: On completion of the course, the student should be able to

1. To lean the basic principles of plant tissue culture
2. To demonstrate the methods in Plant Tissue Culture
3. Understand the applicability of Plant Tissue culture in relation to present day problems.
4. To gain the Knowledge about laboratory organization for plant tissue culture.
5. Understand various Aseptic techniques for plant tissue culture.

Unit-I	Plant tissue culture: History, principles. Laboratory organization, design and layout, equipment's Nutrient media and their types, importance, Preparation of stocks, pH and Buffers and their significance in media. Media Constituents: Vitamins, Unidentified supplements, carbohydrate for energy source, Nitrogen source and organic supplements, complex substances, hormones, Activate charcoal
Unit-II	Concept of totipotency, cells differentiation and dedifferentiation. Factors affecting vascular tissue differentiation Callus culture: induction of callus, transfer, subcultures, morphological features and growth kinetics. Micropropagation: steps, advantages, applications and challenges. 2.4 Synthetic seed- technique, advantages, applications.
Unit-III	Somatic embryogenesis: steps, induction, direct and indirect somatic embryogenesis, factors affecting somatic embryogenesis, Comparative account with zygotic embryogenesis and applications. Somaclonal variations: explant source, effect of genotypes, and media components, causes, advantages and applications. Genetic basis of somaclonal variation
Unit-IV	Haploid production: Pollen culture; steps, culture requirements, significance. Androgenesis: Anther culture: culture requirements, steps, screening of haploids and applications Gynogenesis: Ovule and ovary culture and applications Distant hybridization: concept and applicability in haploid production, Role of haploid and polyploids in plant improvement.
Unit-V	Cell culture: Isolation of Single cell, different techniques for Single Cell Culture (SCC), advantages of SCC. Suspension culture: types of suspension culture, Cell growth measurement, viability tests, synchronization of cultures, applications, factors affecting single cell culture. 4.3. Endosperm culture: steps and applications 4.4 Embryo culture, steps and applications. Embryo rescue technique.

Suggested Reading:

1. Bhojwani, S.S. 1990. Plant Tissue Culture: Theory and Practical (a revised edition). Elsevier Science Publishers, New York, USA.
2. Bhojwani, S.S. 1996. Plant Tissue Culture: Application and Limitations. Elsevier Science Publishers, New York, USA.
3. Vasil, I.K. and Thorpe, T.A. 1994. Plant Cell and Tissue Culture. Kluwer Academic Publishers, the Netherlands.
4. Shantharam, S. and Montgomery, J.F. 1999. Biotechnology, Biosafety and Biodiversity. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
5. Glick, B.R. and Thomson, J. E. 1993. Methods in Plant Molecular Biology and Biotechnology. CRC Press, Boca Raton, Florida.
6. A Text Book of Biotechnology, R. C. Dubey, S. Chand Publication

Learning Outcome:

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

1. List out, identify and handle various equipments in plant tissue culture lab.
2. Demonstrate the procedures of preparation of media.
3. Exhibit skills on inoculation, establishing callus culture and micropropagation and other cultures.
4. Acquire skills in observing and measuring callus growth

CBCS Elective-II Plant Tissue Culture- Elective-II

Cos: On completion of the course, the student should be able to

1. Acquire a critical knowledge on applications of plant tissue culture.
2. Demonstrate skills related to various *In vitro* techniques through hands on experience
3. Understand the cell culture technique for production of secondary metabolites.
4. Comprehend the applications of plant hormones in plant tissue culture.

Unit-I	Somatic hybridization – methods, selection of hybrids, advantages and applications. Role of Somatic Hybrids and Cybrids in plant improvement. Cybridization and production of cybrids. Protoplast Culture: History, Principle, types. Isolation and Purification techniques, Protoplast fusion, regeneration of protoplast, Viability tests. 1.4.Application/s and factors affecting protoplast culture.
Unit-II	2.1.Transgenic plants: Introduction, advantages and limitations. *Agrobacterium tumefaciens* mediated, *Agrobacterium rhizogenes* mediated transformation. Binary vector system. Selection of transformants: selectable markers, reporter gene. Virus mediated transformation, types and applications in crop biology. Direct Gene transfer methods: Physical and Chemical methods. Screening of transformed cells. 2.6. Pathogen (Virus) indexing-significance, methods, advantages, applications.
Unit-III	Production of Secondary Metabolites: principle, types of culture, optimization of yield, elicitors use and their types, commercial aspects, applications, limitations Hairy root cultures - methods, applications. Metabolic Engineering and Industrial Products: History and applications.

	3.4.Metabolic flux analysis, Determining the optimal genetic manipulations, manipulation of phenylpropanoid pathway, shikimate pathway; alkaloids.
Unit-IV	Molecular farming: concepts, production of edible vaccines, plantibodies, medicines, therapeutic proteins. Shoot Organ culture for alkaloids, pigments, perfumes, flavours, insecticides, anticancerous agents and pharmaceutically important compounds. 4.3. Production of biodegradable plastics.
Unit-V	5.1.Transgenic breeding: applications in crop improvements, technological advances. 5.2 Applications of Plant Tissue Culture in Agriculture, Horticulture and Forestry. Achievements and current trends in improvement of cereals, vegetable crops, oil yielding plants, ornamental plants and forest trees. Intellectual Property Rights in relation to Plant Tissue Culture products.

Suggested Reading:

1. Pullaiah. T. and M.V.Subba Rao. 2009. Plant Tissue culture. Scientific Publishers, New Delhi.
2. Bhojwani, S.S. and Razdan, M.K., (1996). Plant Tissue Culture: Theory and Practice. Elsevier Science Amsterdam. The Netherlands.
3. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.
4. Bhojwani, S.S. and Bhatnagar, S.P. (2011). The Embryology of Angiosperms. VikasPublicationHouse Pvt. Ltd., New Delhi. 5th edition.
5. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics. John Wiley and Sons, U.K. 5th edition.
6. Stewart, C.N. Jr. (2008). Plant Biotechnology & Genetics: Principles, Techniques and Applications. John Wiley & Sons Inc. U.S.A.

Learning Outcome:

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

13. Understand the invitro culture techniques and their applicability.
14. Acquire the necessary skills for establishment of in vitro culture.

Syllabus Prescribed for 2023 Year **PG Programme**
Programme: M. Sc. Botany

Semester I Code of the Course/Subject	**Title of the Course/Subject** (Laboratory/Practical/practicum/hands-on/Activity)	**(No. of Periods/Week)**
Practical – 6	Practical based on DSE I & II	06

Laboratory Exercises:

1) Basic Laboratory preparation : Fumigation, Washing of Glasswares, Cotton plugs. Autoclaving, Sterilization.
2) Preparation of M.S. Media and its Sterilization
3) Study of callus induction using suitable explant and its establishment and

maintenance of callus.

4) To develop shoot culture of any medicinal, economically important plant of your région.
5) To develop root culture of any medicinal, economically important plant of your région.
6) Organogenesis and plant regeneration through clonal propagation.
7) Embryogenesis in cultured cell from different explants.
8) Anther / Pollen culture with suitable media for production of haploids
9) Cell suspension culture from different tissues.
10) Embryo culture and embryorescue of different plant species.
11) Effect of various growth hormones on cell divisions and cell proliferation.
12) Isolation of Protoplast and its Purification
13) To Culture Protoplast.
14) To Study Protoplast Viability.
15) Artificial seedpreparation.
16) Invitro Cytology of Callus tissue
17) To Prepare Bacterial Culture Media.
18) To prepare Agrobacterium culture and selection of transformants.
19) To Study Cocultivation Techniques for infection process.
20) To study protoplast fusion using PEG
21) Selection of salt tolerance,amino acids analogous resistance through cell cultures.
22) To Study Hardening of tissue cultureraised plants.
23) To Visit to forest area to study important plant species / Any National Tissue Culture laboratory / Tissue culture Labinstate and prepare the report of the visit and submit

PRACTICAL SCHEDULE

Plant Tissue Culture

Time: 6 hrs. **Marks - 80**

Q.1 To study organogenesis using various explants	15
Q.2 To study Anther/ Pollen Culture	**15**
Q.3 To Prepare artificial / Synthetic seed	15
Q.4. Isolation of protoplast and check its viability	10
Q.5. Comment on the given experiment	10
Q.6.Instrumentation	05
Q.7. Spotting	10

Practical Internal

Q.1. Record	05
Q 2. Visit Report	05
Q.3 .Viva Voce	10

Part B

Syllabus Prescribed for 2023 Year **PG. Programme**

Programme **M.Sc. Botany**

Semester III

Code of the Course Subject	Title of the Couse/ Subject	No. of periods/ week
DSE-I	**Advanced Plant Physiology -I**	**04**

Cos : On completion of the course, the student should be able to
The course will deal with various advanced plant physiological fundamental aspects, evolutionary physiology, secondary metabolites and defence system

Unit-I	**Water, minerals uptake and transport** Physiological regulation of mineral homeostasis, absorption and adaptive strategies under different environmental conditions; Soil–Plant–Atmosphere Continuum. Hydraulic conductance, Aquaporins. Mineral uptakes through Plant–microbe interactions (rhizoplane, rhizosphere, endosphere, and phyllosphere), their role in providing nutrients, vitamins, energy minerals, and protection them from pathogens; plant holobionts; regulation of nutrient transport, homeostasis (iron and phosphorus uptake). Micronutrient acquisition.
Unit-II	**Evolutionary dynamics of photosynthesis** Evolution and diversity of photosynthesis from bacteria to higher plants, Carbon-concentrating mechanisms in bacteria, algae and plants. Damage avoidance and repair; photoprotectant in cyanobacteria and higher plants. Stoichiometry of electron transport yields. Evolutionary timeline and phylogenetic distribution of Rubisco; Photorespiratory bypasses and energy cost, facultative CAM, Economically important C_4 and CAM species, Turbocharging rice, Artificial photosynthesis, Photosynthetic fungi and animals
Unit-III	**Translocation of Photosynthetes** Regulation of translocation of photosynthates, signalling mechanism for transport of photo assimilates flow; factors affecting translocation, sieve elements sealing, P-proteins; companion cells as reservoir; comparative account of source to sink transport in symplastic and apoplastic phloem leaders Role of Sucrose–H+ symporter; polymer-trapping model; Phloem Unloading; sink-to-source transition.
Unit-IV	**Plant responses against environmental challenges:** Signal perception, transduction and responses against different environmental changes and challenges (water, light, temperature, elevated CO2, mineral toxicity and salt). Osmoprotectants, stress proteins, Oxidative stress: reactive oxygen species (ROS) – role of scavenging systems (SOD, catalase etc.). Functions of HSPs chilling stress. Phytochelatins, role of membrane lipids in high temperance tolerance. Molecular regulation and crosstalk among different signalling pathways.
Unit-V	**Photomorphogenesis and Sensory physiology** Regulation of Photomorphogenesis and skotomorphogenesis Wavelength-specific photoreceptors (Phytochromes, Cryptochromes, Phototropins etc), E3 ubiquitin ligases and TFs crosstalk; signal cascade for morphogenic responses. Synergic effect of BRs and Auxins and other growth regulators Sensory physiology: Biochemical and biophysical mechanisms of sense of touch, electric self-defense, taste, light, explosion, sleeping and rhythms. Stimuli/mechanical force triggered movements; actin-myosin motors; neurotransmitters in plants.

Suggested Reading:

1. Davies, P.J. (2004). Plant Hormones: Biosynthesis, Signal Transduction, Action. 3rd Edition, Kluwer Academic Publisher, Dordrecht, The Netherlands.

2. Jordan, B.R. (2006). The Molecular Biology and Biotechnology of Flowering, 2nd Edition, CAB International, Oxfordshire, U.K.
3. Nelson, D.L. and Cox, M.M. (2008). Lehninger Principles of Biochemistry (5thed.). New York
4. Buchanan, Gruissem and Jones. 2002. Biochemistry and Molecular Biology of Plants. American Society of Plant Biologists.
5. Annual Review of Plant Biology (formerly Annual Review of Plant Physiology and Plant Molecular Biology).
6. **BASIC REFERENCES:** Alberts et al., Molecular Biology of the Cell (parts related to plants); Salisbury and Ross, Plant Physiology; Taiz and Zeiger, Plant Physiology; Hopkins and Huner, Introduction to Plant Physiology.
7. **CURRENT LITERATURE** (JOURNAL ARTICLES): Plant Physiology, The Plant Cell, Journal of Plant Physiology, Physiologia Plantarum, Plant Physiology and Biochemistry, Postharvest Biology and Technology, Hortscience, Journal of the American Society for Horticultural Science, Science, Nature, Scientific American etc.
8. Many plant physiology journals can be viewed via the net. The URL of one of the sites listing these journals is: http://www.e-journals.org/botany/

Learning Outcome:

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

1. The students will learn and demonstrate the physiological mechanisms of Water, minerals uptake and transport; they can correlates with present day's challenges for plant growth, development and survival.
2. The students will understand the evolutionary history of photosynthetic organisms and their adaptability in changing environmental conditions; they can interpret the photosynthetic productivity in relation to changing climatic conditions and food security
3. They will acquire the knowledge and demonstrate the various mechanisms of translocation of photosynthetic products to different sink
4. The students will learn various plant responses against environmental changes and challenges; they can understand unique strategies of plants to resolve the various stresses

Part B

Syllabus Prescribed for 2023 Year **PG. Programme**

Programme **M.Sc. Botany**

Semester III

Code of the Course Subject	Title of the Couse/ Subject	No. of periods/ week
DSE-II	**Advanced Plant Physiology -II**	**04**

Cos : On completion of the course, the student should be able to

The course will deal with various advanced plant physiological fundamental aspects, evolutionary physiology, secondary metabolites and defence system

Unit-I	**Assimilation of Mineral and Nitrogen Fixation** Assimilation of nitrite, nitrate reductase role, ammonium assimilation; transamination reactions; asparagine and glutamine link carbon and nitrogen metabolism Biological Nitrogen Fixation (BNF); Free-living and symbiotic nitrogen fixation, Nod factors, Nif genes, symbiosis; nitrogenase enzyme complex, Carbon and nitrogen (C/N) balance signalling in plants under elevated CO2 condition. Application of BNF for crop improvement. Sulfur and phosphate Assimilation.
Unit-II	**Plant secondary metabolites and responses:** Biosynthesis, storage, functions and role of flavonoids, phenolics, terpenoids, alkaloids, steroids, anthocyanin, Coumarins and lignin; plant-microbe interaction; plant-plant interaction; Antinutritional factors.

	Plant responses to herbivory; constitutive defense mechanisms; induced phytochemical responses; biochemical mechanisms of allelopathy.
Unit-III	**Flowering challenges and Molecular foundations of floral diversity** Flowering challenges, evolutionary basis of rewards for pollination, epigenetic modifications; environmental plasticity under abiotic stresses; impact on pollen development; carbohydrate metabolism; induction of hormone signalling etc. Origins of floral diversity; MADS box genes cluster; Homologs of ABCDE genes; Duplications of class E genes; Role of MADS box genes in variations of floral morphology; Downstream targets of floral development genes; role of Nozzle/ Sporocyteless, Rabbit ears (RBE), Superman (SUP) genes in flower development.
Unit-IV	**Programmed cell death (PCD) and Senescence** Types of PCD in plants during vegetative and reproductive stages. Different environmental or internal signals for induction of senescence; Receptor like Kinases (RLKs) in Leaf Senescence. Altered metabolism during senescence and its regulation. The oxidative stress and the anti-oxidative strategies. Hormonal modulations. Environmental, genetic and molecular regulation of PCD; Role polyamines (PAs) and transglutaminase in PCD.
Unit-V	**Analytical approaches and molecular techniques**: Analysis of gene expression at RNA and protein level in plants during different physiological phenomena and stress responses, Global expression profiling by NGS and comparative proteomics analysis. Protein sequencing methods, detection of post translation modification of proteins. Detection of molecules using northern blot, western blot, immunoprecipitation and immunofluorescence.

Suggested Reading:

1. Davies, P.J. (2004). Plant Hormones: Biosynthesis, Signal Transduction, Action. 3rd Edition, Kluwer Academic Publisher, Dordrecht, The Netherlands.
2. Jordan, B.R. (2006). The Molecular Biology and Biotechnology of Flowering, 2nd Edition, CAB International, Oxfordshire, U.K.
3. Nelson, D.L. and Cox, M.M. (2008). Lehninger Principles of Biochemistry (5thed.). New York
4. Buchanan, Gruissem and Jones. 2002. Biochemistry and Molecular Biology of Plants. American Society of Plant Biologists.
5. Annual Review of Plant Biology (formerly Annual Review of Plant Physiology and Plant Molecular Biology).
6. **BASIC REFERENCES:** Alberts et al., Molecular Biology of the Cell (parts related to plants); Salisbury and Ross, Plant Physiology; Taiz and Zeiger, Plant Physiology; Hopkins and Huner, Introduction to Plant Physiology.
7. **CURRENT LITERATURE** (JOURNAL ARTICLES): Plant Physiology, The Plant Cell, Journal of Plant Physiology, Physiologia Plantarum, Plant Physiology and Biochemistry, Postharvest Biology and Technology, Hortscience, Journal of the American Society for Horticultural Science, Science, Nature, Scientific American etc.
8. Many plant physiology journals can be viewed via the net. The URL of one of the sites listing these journals is: http://www.e-journals.org/botany/

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1. The students will learn and demonstrate the physiological mechanisms of Water, minerals uptake and transport; they can correlates with present day's challenges for plant growth, development and survival.
2. The students will understand the evolutionary history of photosynthetic organisms and their adaptability in changing environmental conditions; they can interpret the photosynthetic productivity in relation to changing climatic conditions and food security
3. They will acquire the knowledge and demonstrate the various mechanisms of translocation of photosynthetic products to different sink

4. The students will learn various plant responses against environmental changes and challenges; they can understand unique strategies of plants to resolve the various stresses

Syllabus Prescribed for 2023 Year **PG Programme**
Programme: M. Sc. Botany Semester I

Code of the Course/Subject	**Title of the Course/Subject (Laboratory/Practical/practicum/ hands-on/Activity)**
	(No. of Periods/Week - 6)
Practical – 6	**Practical based on DSE I & II**

Laboratory exercises

1. Bioassay of Gibberllins - Amylase release test from seeds
2. Effects of high light intensity on chloroplast activities
3. Estimation of peroxidase activity
4. Estimation of Relative Water Content (RWC)
5. Estimation of Rubisco by ELISA
6. Estimation of Sodium, Potassium & Calcium in plant material by Flame-photometry.
7. Estimation of Stomatal Index and Stomatal Frqeuency
8. Estimation of Super Oxide Dismutase, Catalase and Peroxidase
9. Isolation of plant genomic DNA, estimation by UV spectroscopy.
10. Isolation of plant total RNA, estimation by UV spectroscopy and gel electrophoresis.
11. SDS-PAGE analysis of proteins
12. Separation of esters and perioxidases by native PAGE.
13. The determination of secondary metabolites by TLC or HPTLC
14. To Demonstrate the Activity of Catalase and Study the Effect of pH and Enzyme Concentration
15. To Study the Effect of Light Intensity and Bicarbonate concentration on O2 Evolution in Photosynthesis
16. The separation of amino acids by two dimensional chromatography
17. Demonstration of phototropism, geotropism, hydrotropism & seismonasty Analysis for total nitrogen (organic nitrogen) in plant tissues Measurement of leaf area Leaf area index. and leaf thickness

QUESTION PAPER (PRACTICALS)

PAPER-XI, XII: Advanced Plant Physiology (Elective-I and II)

Time: **4 hours** *Max.Marks*: 100

1) Conduct the given experiment and interpret the results – (A)	20
2) Conduct the given experiment and present the results– (B)	20
3) Minor experiment- (C)	15
4) Minor experiment- (D)	15
5) Identify and write critical notes on the following (E, F, G, H, I)	10
6) Record	10
7) Viva-Voce/Assignment	10

Part B

Syllabus Prescribed for 2023 Year **PG.Programme**

Programme **M.Sc.**

Botany Semester I

Code of the Course Subject	Title of the Couse/ Subject	No. of periods/ week
DSE-I	**Title of Subject** **Basic and Applied Mycology Elective-I**	**04**

Cos:

Upon completion of this course successfully, students would be able to

1. To learn the basic techniques used to collect, grow, observe, and identify fungi.
2. Study important groups of fungi Ascomycota, Basidiomycota, Deuteromycota.
3. To appreciate the beneficial roles fungi play in biotechnology, Nanotechnology, and the Pharmacy.
4. Able to understand the negative impact of certain fungi on humans.

Unit-I Fungal Symbiosis	1.1:Mycorrhizae Ectotrophic, endotrophic and Ectendotrophicmycorrhizae. 1.2 :Morphology and structure of Arbuscular mycorrhizal fungi. 1.3 :Phosphorus uptake of AM fungi. 1.4 :Role and importance of AM fungi in agriculture. 1.5 :Rhizosphere and phyllosphere General account and importance of rhizosphere and phyllosphere mycoflora.
Unit-II Medical mycology	2.1 : General account of dermatophytic fungi. 2.2 : Humandiseasescaused by dermatophytesviz. *Tineapedis, Tinea capitis, Tinea barbae, Tinea corporis and Tinea manum*. 2.3 :Birds and Animal dermatophytic fungi and the diseases caused by them.
Unit-III Industrial mycology	3.1 : Antibiotics - Penicillium, Cephalosposin & Griseofulvin. 3.2 : Industrial production of Penicillin. 3.3 : Organic acids - Citric acid, Gluconic acid, Lactic acid.
Unit-IV Industrial and Nonindustrial fungal metabolites	4.1 :Enzymes - Amylases, Proteases, Lipases, Pectinases, Cellulases. 4.1 : Phytoalexins : General account, types and importance. 4.3: Mycotoxins _ General acount, types and importance. 4.4: Aflatoxins - General account, types & Importance.
Unit-V Fungi in Human Welfare	5.1 : Role of microorganisms in Biodegradation of organic wastes. 5.2 : Biodeterioration of noncellulosic and cellulosic materials.

	Fungi in medicine-Mycoproteins & Food processing-Fungus fermented foods, fungi in cheese production. Edible mushrooms and their cultivation practices.

Suggested Reading:

1. Illustrated Generic names of Fungi Miguel Ulloa, E. Aguirre-Acosta APS PRESS 2019
2. Illustrated Dictionary of Mycology Miguel Uloa, Richard T. Hanlin Amer Phytopathological Society; 2000 ISBN-10: 0890542570; ISBN-13: 978-0890542576
3. Introductory Mycology, 4ed C.J. Alexopoulos, C.W. Mims, M. Blackwell Wiley; Fourth edition, 2007 ISBN-10: 8126511087; ISBN-13: 978-8126511082
4. K. R. Aneja An Introduction to Mycology New Age International Private Limited; Second edition; 2015 ISBN-10: 8122437966; ISBN-13: 978-8122437966
5. Alexopoulos, Mims and Blackwell. Introductory Mycology, Fourth Edition. John Wiley & Sons, New York, 1996
6. Arora, David, Shepherd, Glenn, Economic Botany, Vol. 62, #3, The New York Botanical Garden Press, Bronx, NY, 2008
7. Ainsworth, G.C. and A.S.Sussman (eds). The Fungi, An advance Treatise Vol.I, II, III & IV Academic Press, New York. 48. Alexopoulos, C.J. and Mims C.W. (1979).
8. Introductory Mycology 3rd Edition, John Wiley and Sons, Inc. Wiley, New York.
9. Alexopoulos, C.J., Mims and Black well (1996) 4th ed. John Wiley and Sons, Inc. Wiley, New York.
10. Aneja, K.R. (1993) Experimental in Microbiology, Plant Pathology & Tissue Culture, Wiswa Prakashan, New Delhi.
11. Bessey, E.A. (1950) Morphology and Taxonomy of Fungi. The Blakiston co. Philadelphia.
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13. Butler E.J. and S. J. Jones (1949) Plant Pathology, Macmillan & Co. New York.
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19. Pande, P.B. (1997) Plant Pathology, S. Chand & Co. New Delhi. 61. Preece and Dickeson. Ecology of leaf surface microorganism Academic Press, New York.
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24. Text Book Of Fungi 2010, R.C.Gupta ,O.M.Prakash Sharma Oxford publication.
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- www.mycobank.org
- www.mycologyonline.org
- www.aspergillus.org.uk
- www.fungusfocus.com
- www.mycology.adelaide.edu.au

Learning Outcome:

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

- Summarize the characteristic features of fungi
- Compare between myxomycota and eumycota.
- List the general characters of mastigomycotina.
- Describethe ways of asexual and sexual reproduction in ascomycotina
- List the characteristic features of ascomycotina and their classification
- Differentiate between famous genera within ascomycetes.
- Write economic importance of Aspergillus and Penicillium.
- Subdivide the different classes in basidiomycetes
- Summarize the characters of deuteromycotina
- Compare between studied genera within deuteromycotina

Semester IV Code of the Course/Subject	**Title of the Course/Subject** (Laboratory/Practical/practicum/hands-on/Activity)	**(No. of Periods/Week)**
Practical –VI	Practical Based on DSE-I Basic and Applied Mycology	**06**

Laboratory Exercises

1. Study of the following genera:

Taphrina, Emericella, Chaetomium, Morchella, Neurospora, Erysiphe, *Uncinula, Phyllactinia, Sphaerotheca* and *Claviceps*. *Puccinia, Ustilago, Termitomyces, Pleurotus, Auricularia, Ganoderma, Polyporus, Lycoperdon, Dictyophora, Geastrum, Cyathus, Alternaria*, *Fusarium*, *Colletotrichum*, *Curvularia*, *Helminthosporium*, *Phoma, Phyllosticta, Ascochyta Botryodiplodia, Macrophoma, Diplodia, Cercospora.*

2. Isolation of Endophytic fungi.
3. Isolation of Keratinophilic Fungi.
4. Isolation of Secondary Metabolites from fungi.
5. Synthesis of Nanoparticles from fungi.

Part B

Syllabus Prescribed for the 2023 Year **PG.Programme**

Programme **M.Sc. Botany**

Semester III

Code of the Course Subject	Title of the Couse/ Subject	No. of periods/ week
DSE II	**Title of Subject**	**04**

Plant Pathology-Elective-II

Cos:

1. Study from basic to advance pathological aspects
2. Study the various symptoms developed in crop plants by the infection of various causal agents.
3. Study the various techniques and applications for the identification of fungal, bacterial, viral, phytoplasma, nematodal, and non-parasitic diseases on crop plants.

Unit-I	**Principles and Mechanism of Plant diseases.** :History, Classification and importance of plant pathology. :Host parasite relationship, interaction and mechanism of infection. :Defence mechanism in plants - Biochemical defence mechanism of phenolic compounds, enzymes and toxins. :Koch's Postulate - Principles and method.
Unit-II	**Disease management and Forecasting.** : Chemical and Biological management of Plant disease control. : Integrated Pest management (IPM) :The Forms of epidemic conditions for decline of epidemics. Methods used in disease Forecasting. Forest Pathology and it's impact (General account)
Unit-III	**Fungal diseases of cereals and oil seed crops.** : Diseases of cereals - Rust and smuts of wheat, Blast and blight of rice, smuts and leaf spot of Jowar. Ergot, Green ear and downy mildew of Bajra. : Important diseases of oil seed crops -Soyabean, Groundnut, Sunflower, Safflower and Mustard. General knowledge and importance of seed pathology.
Unit-IV	**Important fungal diseases of vegetables & Fruits.** : Diseases of vegetables - Brinjal, Tomato, Potato, Chilli, Bhindi, Cabbage and cucurbits. : Diseases of Fruit crops - Citrus, Papaya, Banana, Mango and grapes. : General account of post harvest diseases of vegetables and fruits and it's control.
Unit-V	**Bacterial and Viral diseases.** :Bacterial diseases, Blight of rice, Tundu disease of wheat, Angular leaf spot of cotton, soft rot of fruits and vegetables. :Viral diseases - Mosaic and leaf curl of Papaya, Yellow vein mosaic of Bhindi, Viral diseases of Tomato and Potato. :Phytoplasmal diseases - little leaf of Brinjal, Grassy shoot of sugarcane, & Sesamum Phyllody.

Suggested Reading:

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2. Ainsworth, G.C., and A.S.Sussman (eds). The Fungi, An Advance Treatise Vol.I, II, III & IV Academic Press, New York.
3. Alexopoulos, C.J. (1962). Introductory Mycology John Wiley Eastern Pvt.Ltd.
4. Alexopoulos, C.J. and Mims C.W. (1979). Introductory Mycology 3rd Edition, John Wiley and Sons, Inc. Wiley, New York.
5. Alexopoulos, C.J., Mims, and Black well (1996) 4th ed. John Wiley and Sons, Inc. Wiley, New York.
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Culture, Wiswa Prakashan, New Delhi.
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10. Balkhande L.D. & L.V. Gangawane (2000) Production of auxins Phyollosphere mycoflora and wheat plant resource development, Saraswati Prakashan Aurangabad, P.160-165.
11. Barnett, J.H. (1968) Fundamentals of Mycology. The English Language Book Society and Edward Arnold Publication, Limited.
12. Butler E.J. and S.J. Jones (1949) Plant Pathology, Macmillan & Co. New York.
13. Buckyng Pugh G.J.F. (1971) Auxin productions by phyllosphere fungi Nature Vol. 231 P.332.
14. Dickenson and Preece Mycology of aerial plant surfaces, Academic Press, New York,
15. Dube, R.C. and D.K. Maheshwari (1999) A.Text Book of microbiology, S.Chand & Co. Ltd.
16. Dube, R.C. and D.K. Maheshwari (2000) Practical Microbiology - S.Chand & Co. Ltd.
17. Gruen, H.E. (1959) The production of IAA by Phycomyces blakesleanus Mycol.57 683-694.
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21. Mehrotra, R.S. and Aneja, K.R. (1990) An Introduction to Mycology, Willey Eastern Private Limited.
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26. Pande, P.B. (1997) Plant Pathology, S.Chand & Co. NewDelhi.
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32. Schlegel, H.G. (1996) General Microbiology, 7th Edition, Cambridge University Press.
33. Snowdon, A.L. (1991) A color Atlas of Postharvest diseases & disorders of fruits & vegetables Vol.I & II Wolfe Scientific, London.
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36. Thind, T.S. (1998) Diseases of field crops and their management, National Agricultural Technology, Information Centre, Ludhiana.
37. Vaidya, J.G. (1995) Biology of thefungi, Satyajeet Prakashan, Pune.
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D.R. Berry Edward Arnold, London.
42. D.J. Bagyaraj (1992) Vesicular Arbuscular Mycorhiza application in Agriculture.
43. Emmons, C. W., C. H. Bin ford, J.P. Utz and Know Chung (1977) Medical Mycology, Lea and Febigo, Philadelphia.
44. Holliday, P. Fungus disease of tropical plants (1980), Cambridge University Press, Cambridge.
45. Booth C. (1972) Fusarium (lab guide to the identification of major species C.M.I. Kew, Surrey, England
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48. Dikison, C.H. and G.J.F. Pugh (1974) Biology of Plant Litter decomposition. Academic Press, London.
49. A.C. Gaur (1999) Microbial Technology for composition of Agricultural residues by improved methods, I.C.A.R., New Delhi.
50. Singh, R.S. (1992). Introduction to Principles of Plant Pathology. Oxford & IBH Publishing Co.Pvt. Ltd., New Delhi.
51. Dasgupta, M.K. (1988). Principles of Plant Pathology. Allied Publishers Limited., New Delhi.
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53. Singh, R.P. (1997). Plant Pathology. Central Book Depot, Allahabad.
54. Sambamurty, A.V.S.S. (2006). A Text Book of Plant Pathology. IK International., New Delhi.
55. Neergaard, Paul (2005). Seed Pathology Vol. I & II. Palgrave Macmillan Press, London.

Learning Outcome:

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

1. Identify and diagnose plant diseases accurately.
2. Analyze the impact of plant diseases on agriculture and the ecosystem.
3. Develop sustainable and environmentally friendly approaches to plant disease management.
4. Students will get job opportunities in the agriculture and seed industries.

Semester IV Code of the Course/Subject	Title of the Course/Subject (Laboratory/Practical/practicum/hands-on/Activity)	(No. of Periods/Week)
Practical – VI	Practical Based on DSE-III Plant Pathology	**06**

Laboratory Exercises

1. Principles & working of tools, equipment, and other requirements in the Mycology & Plant Pathology laboratory.
2. Slide preparation, Staining, Micrometry, and measurement of organisms.
3. Sterilization Processes viz. moist heat, dry heat, flame, chemical, and radiation.
4. Drawing of Camera Lucida diagrams and knowledge of computer-based microphotography and image processing.
5. Establishment of disease and testing for resistance (Root inoculation, Stem inoculation, Leaf inoculation, Seed inoculation).
6. Preparation of different cultural media for the cultivation of Fungi and Bacteria.
7. Isolation and identification of soil-borne fungi responsible for rot, wilt diseases (Warcup and Waksman method).
8. Study of toxicity of fungi in relation to seed germination, and seedling abnormality.
9. Detection of pathogens associated with seeds (Examination of dry seeds, Blotter Test, Agar Test, Seedling symptom test).
10. Visit to Mushroom industry, Pharmaceutical, seed industries & Pathological study center.
11. Isolation of external and internal seed-borne mycoflora by blotter and Agar Plate method. (Cereals, pulses, oil seeds, fruit seeds).
12. Monographic study of locally available plant diseases caused by fungi (at least 10).
13. Study of locally available crop plant diseases caused by Bacteria (at least 5)
14. Study of locally available plant diseases caused by viruses & Phytoplasma (at least 5)
15. Demonstration of morphological & physiological changes in disease plants.
16. Demonstration of Koch's Postulate.
17. Preparation and presentation of the herbarium of pathological specimens available in the region (at least 30)
18. Preparation of Fungal spore atlas.
19. Visit to different localities for pathogenic studies (Forests, Fields, Research fields, Nurseries, Gardens).
20. Visit to Agriculture University, Plant Pathological research centers, and Seed stations.
21. Maintain field diary and photographic collection.

QUESTION PAPER (PRACTICALS)

PAPER-DSE I & II: Applied Mycology and Plant Pathology (Elective-I and II)

Time: **4 hours** *Max.Marks*: **100**

Q.1)	.Identify and describe any two fungal plant diseases.....	20 Marks
Q.2)	Identify and give salient features of two fungi from the mix culture.	20 Marks
Q.3)	Identify, classify and describe any two fungi. from given seedborne mycoflora/soil mycoflora/Rhizosphere mycoflora.....	15 Marks
Q.4)	Demonstrate Koch's postulate/pure culture technique.....	15 Marks
Q.5)	Spotting (Specimen/Slide) (01 - bacterial disease; 01-viral diseases, 01- Phytoplasmal disease;01-Fungal disease, 01- Spore slide).	20 Marks
Q.6)	Viva-Voce	10 Marks

PART B

Syllabus Prescribed for 2023 Year P.G. Programme

Programme: M.Sc. Botany

Semester: III

Code of the Course	Subject Title of the Couse/ Subject	No. of periods/ week
DSE I	**MOLECULAR BIOLOGY, BIOTECHNOLOGY ANDPLANT BREEDING-I**	**6**

COs: On completion of the course, the student should be able to

1) Follow a protocol independently, including locating materials and equipment, practicing good lab procedures and accurately performing all experimental procedures.
2) Demonstrate proficiency in maintaining a safe work place, including observation of lab safety procedures
3) Elucidate different techniques involved in genetic engineering.
4)To prepare students for research and development in respective areas.

UNIT I :	1.1 Chemical basis of life- Covalent bonds, Non-covalent bonds, Vander Waal's forces, Acids, Bases and Buffers. 1.2 Protein structure and function – Hierarchial; structure of protein (Primary, Secondary, Tertiary, Quaternary and domain structure). 1.3 Modification and degradation of proteins. Molecular chaperons. 1.4 Membrane proteins-Integral and peripheral membrane proteins and its Interaction. 1.5 Methods of separation of cell proteins – Detergents, Differential and Rate zonal centrifugation, SDS Polyacrylamide gel electrophoresis and isoelectric focusing.
UNIT II :	2.1 Nuclear genome organization – Genome size, Kinetics of DNA denaturation and renaturation, the law of DNA constancy and C- value paradox. 2.2 Kinetic classes of DNA – Repetitive and Unique DNA sequences and its significance. 2.3 Transcription in prokaryotes – Transcription unit, optimal prokaryotic promoter, Bacterial RNA polymerase,Transcription process. 2.4 Transcription in eukaryotes – RNA polymerase, transcription factors, promoters, enhancer, transcription process. 2.5 Modification in RNA – 5' Cap formation, Transcription termination, 3' end processing and polyadynalation, Splicing, Editing, nuclear export of mRNA and Mrna stability.
UNIT III :	3.1 Plant tissue culture- Laboratory structure and requirements, Different types of culture media, Importance of organic, inorganic nutrients in cell differentiations. Role of growthregulators in cell differentiation. 3.2 Anther and pollen culture techniques. 3.3 Protoplast culture and somatic hybridization – Isolation of protoplasts, culture, and fusion methods. 3.4 Techniques of Bacterial culture and selection.

UNIT IV :	4.1 Cloning techniques for *E.coli.* – Mechanical shearing, Restriction endonucleases, Synthetic linkers and adapters. 4.2 Vector systems – Plasmid, Cosmid, and Bacteriophages. 4.3 Construction of gene libraries – Genomic and c-DNA libraries. 4.4 Gene Technology in plants – Agrobacterium mediated gene transfer. 4.5 Transgenic plants – Production of transgenic plants for herbicide, insect / pest tolerance through recombinant DNA technique. Production of transgenic tomato plants with longer shelf life and better taste.
UNIT V :	5.1 Plant genetic resources- Centres of origin of food plants, concept of parallel variation, Importance of genetic diversity and conservation. 5.2 Utilization of wild species in crop improvement – Tobacco,Tomato, pearlmillet, Brassica. 5.3 Techniques of producing hybrid seeds; Barriers to interspecific hybridization; Cytoplasmic basis of sterility. 5.4 Cytoplasmic and genetic male sterility systems in hybrid seed production – Methods, Sources, Advantages and difficulties and future prospects.

PART B

Syllabus Prescribed for 2023 Year **P.G. Programme**

Programme **M.Sc. Botany**

Semester: III

Code of the Course	**Subject Title of the Couse/ Subject**	**No. of periods/ week**
DSE I	**MOLECULAR BIOLOGY, BIOTECHNOLOGY AND PLANT BREEDING-I**	**04**

COs: On completion of the course, the student should be able to

1) Follow a protocol independently, including locating materials and equipment, practicing good lab procedures and accurately performing all experimental procedures.
2) Demonstrate proficiency in maintaining a safe work place, including observation of lab safety procedures
3) Elucidate different techniques involved in genetic engineering.
4) To prepare students for research and development in respective areas.

UNIT I :	1.1 Chemical basis of life- Covalent bonds, Non-covalent bonds, Vander Waal's forces, Acids, Bases and Buffers. 1.2 Protein structure and function – Hierarchial; structure of protein (Primary, Secondary, Tertiary, Quaternary and domain structure). 1.3 Modification and degradation of proteins. Molecular chaperons. 1.4 Membrane proteins-Integral and peripheral membrane proteins and its Interaction. 1.5 Methods of separation of cell proteins – Detergents, Differential and Rate zonal centrifugation, SDS Polyacrylamide gel electrophoresis and isoelectric focusing.

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Syllabus Prescribed for 2023 Year P.G. Programme

Programme : M.Sc. Botany

Semester: III

Code of the Course Subject	**Title of the Couse/ Subject**	**No. of periods/ week**
DSE II	**MOLECULAR BIOLOGY, BIOTECHNOLOGY ANDPLANT BREEDING (ELECTIVE-II)**	**6**

Cos: On completion of the course, the student should be able to

1. Acquire a critical knowledge on molecular biology, biotechnology and plant breeding.
2. These courses are designed to develop the communication and vocabulary skills in the students.
3. Will be able to design and implement experimental procedures using relevant techniques.

UNIT I :	1.1 Chemical structure and functions of Biomolecules- Nucleic acids, Carbohydrates and lipids. 1.2 Principle, working and applications of various techniques. 1.3 Gel-filtration, ion exchange and affinity chromatography. 1.4 Thin layer and gas chromatography. 1.5 High-pressure liquid chromatography.
UNIT II :	2.1 Organisation of eukaryotic genes – Features of split genes; Pseudogenes; Exons and Introns. 2.2 Genetic code – Properties of code; Biochemical elucidation of code; suppressor, non-sense, missense and frameshift mutations. 2.3 Translation in prokaryotes and eukaryotes. 2.4 Regulation of gene expression in eukaryotes – Position effect, paramutation, Genetic imprinting. 2.5 Regulation of transcription, Transcriptional and post transcriptional gene silencing.
UNIT III :	3.1 Tools in biotechnology – Principle, techniques and application of nucleic acid hybridization; Southern, Northern and Western; Microarray and PCR. 3.2 Genomic stability – Molecular characteristics, properties and significance of eukaryotic mobile genetic elements – Ty elements in Yeast; Copia elements in Drsophila, Ac-Ds, Spm – dSpm elements in maize. Role of mobile genetic elements in evolution.
UNIT IV :	4.1 Plant viruses as gene vectors – RNA viruses, DNA viruses, Gemini viruses, and caulimovirus. 4.2 Agrobacterium mediated gene transfer – Agroinfection, vectorless gene transfer. 4.3 Directed genetic engineering of plant cells – Role of antisense RNA technology and Ribozyme in inactivation of resistance gene. Role of antisense RNA in AIDS controls. 4.4 Plant as a Bioreactor – Production of High value of protein, new or modified carbohydrates in transgenic plants. Stability of proteins and RNA produced from genes Introduced into transgenic plants.

UNIT V :	5.1 Molecular plant breeding – Molecular marker systems. Importance of molecular marker assisted breeding. Molecular markers in genome analysis: RFLP and RAPD. 5.2 Radiation biology –Radioactive isotopes, half-life of isotopes, Role of radiations in plant improvement. 5.3 Mutation breeding – Mutagens, treatment methods and its applications in crop Improvement. 5.4 Principle and application of Biometrical genetics in plant Breeding.

Suggested Reading:

1. Karp, G. 1999. Cell and Molecular Biology Concepts and Experiments (2nd edition). John Wiley &Sons, Inc.USA.

2)Lewin, B. 2000. Gene VII. Oxford University Press, New York, London.

3) Lewis, R. 1997. Human Genetics : Concepts and Applications (2nd edition). WCB McGraw Hill U.S.A.

4)Malacinski, G.M. and Freifelder, D. 1998. Essential of Molecular Biology (3rd edition). Jones and Bartlet, Publishers, Inc. London.

5)Russel P.J. 1998. Genetics (5th Edition). The Benjamin / cummings publishing company Inc. USA.

6) Snustad D.P. and Simmons, M.J. 2000. Principles of Genetics (2nd edition) John Wiley & Sons Inc. USA.

7) Alberts, B., Bray,D., Lewis,J. Raff,M., Roberts,K., and Watson,J.D., 1999. Molecular Biology of the cell. Garland Publishing, Inc., NewYork.

8) Buchanan, B.B., Gruissem, W., and Jones,R.L., 2000. Biochemistry and Molecular Biology of Plants. American Society of Plant Physiologists, Maryland, USA.

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10)Fukuik and Nakayama, S. 1996. Plant Chromosomes. Laboratory Methods, CRC Press. Boca Raton, Florida.

11) Sharma, A.K. and Sharma, A. 1999. Plant Chromosomes, Manipulation and Engineering. Harwood Academic Publishers,Australia.

12) Brown, T.A. 1999. Genomes, John Wiley & Sons (Asia) Pvt.Ltd.Singapore.

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16) Hall, R.D. (Ed.) 1999. Plant Cell Culture Protocols. Humana Press, Inc.New Jersey U.S.A. Shaw, C.H. (Ed.) 1988. Plant Molecular Biology. A Practical Approch, IRL Press, Oxord.

19) Smith, R.H. 2000. Plant Tissue Culture Techniques and Experiments. Academic Press, New York.

20) Chopra V.L.2001. Plant breeding. Theory and Practice. Oxford IBH Pvt.Ltd., New Delhi.

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22) Atherly A.G., Girten, J.R. and McDonald, J.F. 1999. The Science of Genetics, Saunder College Publishing, Fort Worth, USA.

23) Plummer, D.T. 1988. An Introduction to practical Biochemistry. Tata McGraw Hill Publishing Co.Ltd.New Delhi.

24) Wilson,K. and Goulding, K.H. (Eds), 1992. A Biologist Guide to Principles and Techniques & Practical Biochemistry (3rd Edition). ManasSaikia for Foundation Books, New Delhi.

25) Sadasivam, S. and Manickam A., 1996. Biochemical methods (2nd Edition). New Age International Publishers New Delhi.

26) Hans-Walter Heldt. 1997. Plant Biochemistry & Molecular Biology. Oxford University Press, New York.

27) Sharma, J.R. 1994. Principles and Practice of Plant Breeding. TataMcGraw Hill Publishing Company Ltd. New Delhi.

28) Rubenstein, I. Gengenbach, B.Phillips, R.L. and Green C.E. (Eds), 1980. Genetic improvement of crops. University of Minnesota Press. U.S.A.

29) Elliott, W.H. and Elliot, D.C. 1997. Biochemistry and Molecular Biology. Oxford University Press. New York.

30) Freifelder D. 1995. Molecular Biology (2nd Edition). Narosa Publishing House, New Delhi.

31) Satyanarayana, U. 1999. Biochemistry (1st Edition). ArunabhaSen Book & Allied (P) Ltd. Calcutta.

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35) Gupta, S.K.2000. Plant Breeding. Theory and Techniques. Agrobios (India) Jodhpur.
36) Singh, P. 2001. Essentials of Plant Breeding (2nd Edition). Kalyani Publishers, New Delhi.
37) Watson, J.D., Hopkins, N.H., Roberts, J.W., Steitz, J.A., and Weiner, A.M. 1987. Molecular Biology of the Gene. (4th Edition). The Benjamin / cummings Publishing Company. Inc. California.
38) Chopra, V.L., Malik,V.S. and Bhat, S.R. 1999. Applied Plant Biotechnology. Oxford & IBH Publishing Co.Pvt.Ltd. New Delhi.
39) De Robertis, E.D.P. and De Robertis, Jr.EM.P. 1999. Cell and Molecular Biology (8th Edition) B.I.PublicationPvt.Ltd. New Delhi.
40) Jahier, J. (Ed.) 1996. Techniques of Plant cytogenetics. Oxford & IBH Publishing Co.Pvt.Ltd. New Delhi.

Learning Outcome:
Students would be able to
1.To get a basic overview of molecular biology techniques, good lab practices.
2. To get a hands on training in Molecular techniques.
3.To provide insight into principles of plant cell culture and genetic transformation.
4.To get a hands-on training in basic plant tissue culture techniques, callusing, micropropagation& analysis

Syllabus Prescribed for 2023 Year **PG Programme**
M. Sc. Botany Semester II Semester III

Code of the Course/ Title of the Course/Subject **No. Of Periods/Week)**

Subject (Laboratory/Practical/Practicum hands-on/ Activity) **06**

Practical VI Practical Based on DSE I & II

Laboratory Exercises:

1. To extract genomic DNA from leaves and to analyse the extracted DNA by Agarose Gel Electrophoresis.
2. Estimation of protein by Bradford's Method.
3. SDS – PAGE.
4.Estimation of amino acids by Thin Layer Chromatography.
5. Estimation of fatty acids by paper chromatography.
6.Mechanical isolation of mesophyll protoplasts.
7. Protoplast fusion using polyethylene glycol solution.
8. Establishment of callus from important medicinal/ ornamental/ oil yielding/ wild and endangered/ vegetatively propagated plants.
9. Emasculation and bagging of flowers of Brasicaceae, Malvaceae and liliaceae, pollinating them manually and estimating fruit and seed set.
10. Isolation of genomic DNA from Bacteria.
11. Sterilization technique in plant tissue culture.
12. Establishment of callus culture from different explant.
13. Effect of Sodium Azide on Glycine max in F1 generation.
14. Principle and working of analytical instruments Spectrophotometer, UV Transilluminator, Vertical Gel Electrophorosis, PCR, Centrifuge, Distillation Unit, Autoclave, Laminar Air flow,

15. Statistics:- Central value: mode median, mean; Dispersion: range,mean deviation, standard deviation; Frequency distribution:frequency curve, frequency histogram.

Sant Gadge Baba Amravati University, Amravati
Practical Examination Botany Semester- III (CBCS New)
Practical VI
Molecular Biology, Biotechnology and PlantBREEDING (Elective I & II)

Time 8 hrs Marks-80+20=100

Q. 1. Setting and working of any one major Molecular Biology experiment.	20 Marks
Q. 2. Perform one major Biotechnology experiment.	20 Marks
Q. 3. Perform one Plant breeding experiment.	10 Marks
Q. 4. Comment on principle and working of analytical instrument.	10 Marks
Q. 5. Spotting.	10 Marks
Q. 6. Viva-Voce	10 Marks

Internal marks:

Attendance**[5]**, Students Performance**[5]**, Practical Record Book/Laboratory Manual/Journal/Report**[5]**, Internal Viva/Assignment/Quiz/Test**[5]** — 20 Marks

Scheme of Teaching, Learning & Examination leading to the Degree in Master of Science in the Programme Botany
(Two year- Four Semester Degree Programme- C.B.C.S.)
(M.Sc. Part II) Semester IV

S. No.	Subject	Subject Code	Teaching & Learning Scheme							Duration of Exam Hours	Examination & Evaluation Scheme						
			Teaching Periods Per Week				Credits				Theory		Practical		Total Marks	Minimum Passing	
			L	T	P	Total	L/T	Practical	Total		Theory+ MCQ External	Theory Internal	Internal	External		Marks	Grade
1	DSC-XI Applied Botany	BOT 401	4	-	-	4	4	-	4	3	80	20	-	-	100	40	P
2	DSC-XII Plant Ecology	BOT 402	4	-	-	4	4	-	4	3	80	20	-	-	100	40	P
3	DSC -XIII Environmental Ecology	BOT 403	4	-	-	4	4	-	4	3	80	20	-	-	100	40	P
4	SEC- I Plant Biotechnology and Genetic Engineering	BOTS 401	4	-	-	4	4	-	4	3	80	20	-	-	100	40	P
5	Lab- 7 Practical Based on DSC XI, XII, XIII & SEC-I		-	-	6	6	-	3	3	*	-	-	-	100	100	50	P
6	Lab-8 Practical Based on Project		-	-	6	6	-	3	3	*	-	-	-	100	100	50	P
7	# Internship/ Field Work/ Work Experience @																
8	**Open elective/ GIC/ Open skill/ MOOC* Post-Harvest Technology for medicinal and Aromatic Plants**	OEC 401	4	-	-	4	4	-	4	3	80	20	-	-	100	40	P
Total						28			26						600		

L: Lecture, T: Tutorial, P: Practical

Student may complete their Internship/ Field Work/ Work experience in First or Second or Third semester of Master of Science in the Programme, according to their convenience; @ denotes Non-Examination credits.

Note: Internship/ Apprenticeship/ Field Work Experience (during vacations of semester I to III. This will carry 2 credits for learning of 60 hours or 3 Credits for learning of 90 hours. Its credits and grades will be reflected in final semester IV credit grade report.

-OEC (Optional) can be studied during semester I to IV.

Part B

Syllabus Prescribed for 2023 Year **PG. Programme**

Programme **M.Sc. Botany**

Semester IV

Code of the Course Subject	Title of the Couse/ Subject	No. of periods/week
DSC XI	**Applied Botany**	**04**

Cos :

1. To provide detailed knowledge about virus and sub-viral particles, their taxonomy, growth, reproduction and role in nature.
2. To explain the industrial aspects of microbiology for the production of various of industrial products of biological origin.
3. The course explains the application of microorganisms in environment and the role of microorganisms in industrial, food and dairy technology.
4. To understand the salient features and economic importance of algal diversity.
5. To encourage production and use of organic and biological sources of nutrients like biofertilizers, organic manure, compost for sustained soil health and fertility and improving soil organic carbon and to promote production and use of biopesticides, bio-control agents etc as alternative inputs in organic farming.
6. To facilitate, encourage and promote development of organic agriculture in the country

Unit I: (Plant Viruses)	History of plant virology Isolation, Characterization and identification of plant virus. Symptomatology and movement of plant viruses within plants. Components and physicochemical nature of plant viruses. Origin, evolution, nomenclature and classification of plant viruses. Architecture of plant viruses. Replication of plant viruses. Transmission of plant viruses. Virus vector relationship-concepts in brief. Mycoviruses, Satellite viruses, viroids, prions and satellite RNA's, Bacteriophages. Management of virus diseases with emphasis on special techniques.
Unit II: (Microbiology)	Historical background and scope of Microbiology. Ubiquitous nature of microorganisms. Impact of microbes on human affairs. Structure of prokaryotic and eukaryotic cell. Differences between Eubacteria, Archaebacteria and Eukaryotes. Salient features of different groups of microorganisms such as bacteria, fungi, protozoa and algae including their morphological features, mode of reproduction and cell cycle.
Unit III: (Industrial Biotechnology)	Organic acids- citric acid, gluconic acid, acetic acid, lactic acid, L-ascorbic acid and Itaconic acid. Lipids and polysaccharides. Microbial production of antibiotics. Antibiotics in food, feed and plant disease control. Industrial production of enzymes- amylase, cellulase, protease, pectinase, lipase, phosphatase.
Unit IV: (Algal Biotechnology)	Algae as source of food for human, animal feed, Nutraceuticals; Pharmaceuticals, biofuel, bio-ethanol, biofertilizers, industrial applications of algae. Role of algae in CO_2 sequestration, pollution indicator, bioremediation and soil fertility. Mass cultivation of algae- seaweed cultivation methods - Rope cultivation, net cultivation and raft cultivation. microalgae Culturing techniques and photo bioreactor-based production; Downstream processing. heterotrophic production. Algal Bloom - Bioluminescence, Bloom formation and Eutrophication; Harmful algal blooms and toxin production; Bloom control measures and algal toxins.
Unit V: (Elicitors and Biofertilizers)	Abiotic and Biotic Elicitors–Role in Secondary Metabolites Production through *In-vitro* Culture of Medicinal Plants. Role of Elicitors in crop improvement. Fertilizer, chemical fertilizer, Bio-fertilizers, types of Bio-fertilizer, advantages and disadvantages. Study of growth characteristics of various microbes used in biofertilizers production. Storage, shelf life, quality control and marketing. Types of biofertilizer – Bacteria (*Azospirillum*), Cyanobacteria (*Nostoc*), Fungi (*Glomus*) Nitrogenous Biofertilizers (*Rhizobium*) phosphate and Seaweed Liquid Fertilizer.
Suggested Reading:	

1. Madigan,M.T., Martinko, J.M., Bender, K., and Buckley, D. (2011)Brock Biology of Microorganisms, 13thEd., Pearson Education, USA
2. Tauro, P., Kapoor, K.K. and Yadav, K.S. (1996). Introduction to Microbiology, New Age Pub., New Delhi
3. Pelczar, M.J. et. al(2001), Microbiology- Concepts and Applications, International Ed. McGraw Hill Publication, New York
4. Black, J.G. (2012), Microbiology: Principles and Explorations, 8th Edition, John Wiley and Sons, USA.
5. Willey, J.M., Sherwood, L., and Woolverton, C. (2013) Prescott's Microbiology 9th Revised edition, McGraw Hill Higher Education, New York
6. Pommerville, J.C. (2009) Alcamo's Fundamentals of Microbiology, Jones and Bartlett Publishers.
7. Tortora, G.J., Funke, B.R., Case, C.L. (2012) Microbiology -An Introduction, 11th Edition, Pearson education Pvt. Ltd. Singapore
8. Glazer, A.N and Nikaido. H. (1995). Microbial Biotechnology. W.H.Freeman and co. New York.
9. Kumar H.D. Environmental Technology & Biosphere Management. Oxford & IBH Publishing Co. Pvt. Ltd
10. R.K. Sinha and R. Sinha, 2008, Environmental Biotechnology. Aavishkar Publisher Distributors.
11. Raskin, I (1999). Phytoremediation of Toxic Metals: Using Plants to Clean Up the Environment. Wiley-Interscience, New York.
12. Mohapatra P.K. (2006). Textbook of Environmental Biotechnology. I.K. Int. Publ., New Delhi, India. 515 pp.
13. Vinod Soni and Vinay Sharma. Text Book of Environmental Biotechnology, Aavishkar publishers.
14. Santra S.C. New Frontiers of Environmental Biotechnological Applications, ENVIS Centre on Environmental Biotechnology publisher.
15. Nathanson J. A. Basic Environmental Technology (4th Ed.). Prentice-Hall India Pvt. Ltd.
16. Demain, Arnold L. "Industrial microbiology." Science 214, no. 4524 (1981).
17. Hans-Joachim Jordening, Josef Winter Environmental Biotechnology Concepts & Application. Willey-VCH
18. Evans G.G., Furlong J. (2011). Environmental Biotechnology: Theory and Application, John Wiley & Sons, 290 pp.
19. R.K. Sinha and R. Sinha, 2008, Environmental Biotechnology. Aavishkar Publisher Distributors.
20. Raskin, I (1999). Phytoremediation of Toxic Metals: Using Plants to Clean Up the Environment. Wiley-Interscience, New York.
21. Prescott, G.W. 1984. Algae: A review, Bishan Singh, Mahendra Pal Singh. Dehradun.
22. Kumar, H.D. Introductory Phycology. 2nd Ed. Affiliated East-West Press, New
23. Morris, I. 1986. An introduction of Algae. Cambridge University Press U.K.
24. R. E. Lee. 2008.Phycology, 4th Ed. Cambridge University Press
25. V.J. Chapman. 2015. The algae, Springer
26. Joshi, M., Setty, T.K.P. and Prabhakarasetty 2006. Sustainability through Organic farming.1st Edition. Kalyani Publishers, Ludhiana, India.
27. Bavec, F. and Bavec, M. 2007. Organic Production and Use of Alternative Crops. CRC Press, Boca Raton, FL.
28. Sarath Chandran Unni M.R Sabu Thomas, 2019. Organic Farming, 1st Edn. Global Perspectives and Methods, Elsevier.
29. Niir Board 2004. The Complete Technology Book On Bio-Fertilizer and Organic Farming, National Institute Of Industrial Re.
30. A C Gaur, 2011Handbook of Organic Farming and Biofertilizers
31. Shalini Suri. 2011. Biofertilizers and Biopesticides, Aph Publishing Corporation
32. H.C. Lakshman and A. Channabasava 2o14 Vedams eBooks (P) Ltd (New Delhi, India)
33. NPCS Board of Consultants & Engineers2008, the Complete Book on Organic Farming and Production of Organic Compost, Asia Pacific Business Press Inc.
34. Ahmad Mehraban. 2013. The Basis of Organic Fertilizers, LAP LAMBERT Academic Publishing.
35. S M Singh, 2018. Organic Manure: Sources Preparation and Usage in Farming Lands, Siya Publishing House

Learning Outcome:

1. Detailed knowledge about virus and sub-viral particles would help the learners for research in the field of host pathogen interaction and management.
2. The students will know about the principles and techniques underpinning the application of biosciences to the environment.
3. Gets a detailed insight into the industrial processes carrying out in the food and dairy sector.
4. Students would be understand the interrelationship of algae and its utility.
5. The Students are able to appreciating in Organic farming is a farming method that involves growing and nurturing crops without the use of synthetic based fertilizers and pesticides.

Part B

Syllabus Prescribed for 2023 Year **PG. Programme**

Programme **M.Sc. Botany**

Semester IV

Code of the Course Subject	**Title of the Couse/ Subject**	**No. of periods/week**
DSC XII	**Plant Ecology**	**04**

Cos : The students can

1. Study of diversity and distribution of plant communities
2. Effect of climate change on vegetation.
3. Restoration of plant communities.
4. Conservation of plant and plant communities.
5. Analyze the current theories, methods and interpretations with in the field of plant ecology

Unit I:	**Basic concept and scope.** Concept, classification and scope of ecology biotic and biotic interaction. Ecological factors: Climatic, edaphic, biotic. El-nino and global warming. Ozone layer depletion and its consequences.
Unit II:	**Population and Community Dynamics** Characteristics of population, population growth curves, population dynamics, biotic potential, environmental resistances. Concept of community, phytosociological methods analytical and synthetic characters. Level of species diversity and effect, ecological niche.
Unit III:	**Vegetation development** Mechanism and types of plant succession. Climax theories and continuous concept, plant formation, association, consociations and society. Bioenergetics of succession, speciation and co-evolutions and group selection.
Unit IV:	**Ecosystem Ecology.** Structure and Functions of ecosystem Concept of ecosystem, trophic structure and energy flows Overview of Production and deposition. Structure and function of Indian Ecosystem, terrestrial (Forest and grassland) Aquatic (fresh water and marine)
Unit V:	**Ecosystem functional aspects.** Biogeochemical cycles C, N, P, S mineral cycles (pathways, Process and budgets) Ecosystem stability concept, global environment concerns and ecosystem conservation Major biomes of the world Vegetation types of the world and India, Biodiversity hotspots.

Suggested Reading:

1. Krebs, C.J. 1989. Ecological Methodology. Harper and Raw,New York, USA.
2. Ludwig, J.A. and Reynolds, J.F. 1988. Statistical Ecology, Wiley, New York.

3. Magurran, A.E. 1988. Ecological Diversity and Its Measurement, Chapman and Hall, London.
4. Pielou, E.C. 1984. The Interpretation of Ecological Data, Wiley, New York.
5. Sokal, R.R. and Rohit, F.J. 1995. Biometry , W.H.Freeman & Co. San Francisco.
6. Murray P.W. and Chapman, S.B. 1986. Methods in Plant Ecology, Blackewell Scientific Publication.
7. Misra, R. 1968. Ecology Work Book, Oxford and IBH New Delhi.
8. APHA - Standard Methods for Examination of Water and Waste Water, American Public Health Association, Washington, D.C.
9. Smith, R.L. 1996. Ecology and Field Biology. Harper Colins New York.
10. Mular - Dombuis, D. and Ellenberg, H. 1974. Aims and Methods of Vegetation Ecology, Wiley, New York.
11. Charis Park - Environment - Principles and applications, Roultedge - London & New York.
12. Smith, R.L. 1996. Ecology and Field biology, Harper Collins, New York.
13. Begon, M., Harper, J.L. and Townsend, C.R. 1996. Ecology, Blackwell Science, Cambridge, U.S.A.
14. Odum, E.P. 1971. Fundamentals of Ecology. Saunders, Philadelphia.
15. Odum, E.P. 1983. Basic Ecology, Saunders, Philadelphia.
16. Barbour, M.G., Burk, J.H. and Pitts, W.D. 1987. Terrestrial Plant Ecology. Benjamin / cummings Publication Company, California.
17. Kormondy, E.J. 1996. Concepts of Ecology. Prentice Hall of India Pvt.Ltd., New Delhi.
18. Chapman, J.L. and Reiss, J\M.J., 1988. Ecology: Principles and Applications. Cambridge University Press. Cambridge, U.K.
19. Moldan, B. and Billharz,S. 1997. Sustainability indicators. John Wiley & Sons, New York.
20. Treshow, M. 1985. Air Pollution and Plant Life. Wiley Interscience.
21. Heywood, V.H. and Watson, R.T. 1995. Global Biodiversity Assessment. Cambridge University Press.
22. Brady, N.C. 1990. The Nature and Properties of Soils, MacMillan.
23. Chandel, K.P.S., Shukla, G. and Sharma, N. 1996 - Biodiversity in Medicinal and Aromatic Plants in India : Conservation and Utilization. National Bureau of Plant Genetic Resources, New Delhi.
24. Walter, K.S. and Gillett H.J., 1998. 1997 IUCN Redlist of Threatened Plants. IUCN, The World Conservation Union, IUCN, Gland, Switzerland and Cambridge, UK.
25. Eldon, D. Enger and Bradley F. Smith (1995) Environmental sciences WBC Publishers, Boston.
26. K.C. Agrawal; (1993); Environmental Biology, Agro-botanical publishers, Bikaner.
27. P.S. Varma and V.K. Agrawal (1995) Environmental Ecology, WBC publishers, Boston

Learning Outcome:

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

- Evaluate scientific evidences by thinking critically, applying and synthesizing ecological concept, interpreting data and the primary literature about scientific claims.
- Becoming an educated consumer of ecological and scientific data.
- Communicate scientific concept verbally, graphically and in writing.
- Appreciate plants by understanding their important ecological roles

Part B

Syllabus Prescribed for 2023 Year — **PG. Programme**

Programme — **M.Sc. Botany**

Semester IV

Code of the Course Subject	Title of the Couse/ Subject	No. of periods/ week
DSC XIII	**Environmental Ecology**	**04**

Cos : The students can

1. Study of environmental relationship
2. Effect of Pollution.
3. Restoration of plant communities.

4.Conservation of plant and plant communities.

Unit I:	**Basic Concepts** General Introduction: Relation of man environment Concept of Environment and its Scope; Lithosphere, Hydrosphere, Biosphere. Energy resources; (i) Renewable and non-renewable (ii) Environmental impact assessment. PAN and green house gasses; their sources. Consequences of climate change.
Unit II:	**Environmental pollution** 1.1 Air pollution: Definition, sources and classification of air pollutants. 2.2Transport and diffusion of pollutants, effect of air pollution on man and climate. Air pollution; Natural and man made sources of air pollution, Air sampling and monitoring techniques - settle able and suspended particulate matter - dust fall jar and impingement method, high volume air sampler Soil Pollution – definition, sources and classification of soil pollutants and their impact on soil and plants and soil biota. Composting, vermicomposting and incineration of solid wastes
Unit III:	**Water Pollution.** Sources of water and its characteristics, distribution of water on earth. physical and chemical properties of water. Various types of water demand Major water pollutants Sources of water pollution Consequences of water pollution Water pollution indicators.
Unit IV:	**Conservation strategies** Principles of conservation; extinction, environmental status of plants based on IUCN. Strategies for conservation, International efforts and Indian initiation. Wetlands, Mangrove and coral reefs with respect to conservation of biodiversity. Disaster management.
Unit V:	**Sustainable Management.** Assessment and Prediction of impact on Air water, noise and biological environment. Impact of urbanization; Wasteland development. General account of legislative measures for sustainable development and management (i) Water Act, Prevention and control 1976. (ii) Environmental Protection Act, 1985 (iii) Wildlife Protection Act, 1972; WWF. Environmental Planning: Importance of planning, local, regional, state and national planning

Suggested Reading:

1. Eldon D. Enger and Bradley F Smith (1995), Environmental Sciences, WBC publishers Boston.
2. Daniel Botkin and Edward Keller (1997), Environmental Sciences, John Wiley & Sons, Ne York.
3. R.K. Dixit, (1997), Environment, Forest Ecology and Man, Rastogi Publication.
4. Jorgeson S.E. *et al*. (1995), Handbook of Environmental and Ecological modeling, Levis publications, New York.
5. William P. Cunningham and Masy Ann Cunninghan, Principle of Environmental Science. Inquisitee and applications, Tata McGraw Hill Pub. Co.Ltd., New Delhi.
6. Charis Park - Environment - Principles and applications, Roultedge - London & New York.
7. Smith, R.L. 1996. Ecology and Field biology, Harper Collins, New York.

8. Muller-Dombois, D., and Ellenberg, H. 1974. Aims and Methods of Vegetation Ecology, Wiley, New York.
9. Begon, M., Harper, J.L. and Townsend, C.R. 1996. Ecology, Blackwell Science, Cambridge, U.S.A.
10. Ludwig, J. and Reynolds, J.F. 198. Statistical Ecology, John Wiley & Sons.
11. Odum, E.P. 1971. Fundamentals of Ecology. Saunders, Philadelphia.
12. Odum, E.P. 1983. Basic Ecology, Saunders, Philadelphia.
13. Barbour, M.G., Burk, J.H. and Pitts, W.D. 1987. Terrestrial Plant Ecology. Benjamin / cummings Publication Company, California.
14. Karmondy, E.J. 1996. Concepts of Ecology. Prentice Hall of India Pvt.Ltd., New Delhi.
15. Chapman, J.L. and Reiss, J\M.J., 1988. Ecology: Principles and
16. Applications. Cambridge University Press. Cambridge, U.K.
17. Moldan, B. and Billharz,S. 1997. Sustainability indicators. John Wiley & Sons, New York.
18. Treshow, M. 1985. Air Pollution and Plant Life. Wiley Inter-science.
19. Mason, C.F. 1991. Biology of Freshwater Pollution, Longman.
20. Hill, M.K. 1997. Understanding Environmental Pollution. Cambridge University Press. Brady, N.C. 1990. The Nature and Properties of Soils, MacMillan

Learning Outcome:

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

1. Ability to demonstrate comprehensive understanding of the environment, environmental processes, theories and ethics
2. Ability to describe the mechanisms of interactions between different spheres of environment.
3. Ability to recognize and describe how about resource management and sustainability.
4. Ability to demonstrate sound understanding of the waste generation process and characteristics of different types of solid wastes.
5. Ability to identify and quantify the magnitude and intensity of Environmental pollution problems
6. Ability to assess the underlying science behind the waste driven pollution.

Part B

Syllabus Prescribed for 2023 Year **PG. Programme**

Programme **M.Sc. Botany**

Semester IV

Code of the Course Subject	**Title of the Couse/ Subject**	**No. of periods/week**
SEC I	**Plant Biotechnology and Genetic Engineering**	**04**

Cos : The students can

1. Study of Tussive culture methods
2. Able to micro-propagate the plants.
3. Utilization of rDNA technology

Unit I:	**Introduction to Plant Biotechnology:** Plant tissue culture - Laboratory organization - Methods of sterilization - medium composition and preparation - culture initiation and incubation of culture. Callus induction and establishment. Callus sub-culture and maintenance. Cell suspension culture - characteristics. Somatic embryogenesis - somatic embryo development and synthetic seed production. Somaclonal variation and applications. Experimental androgenesis and gynogenesis - Factors controlling (Physical and chemical) and Applications
Unit II:	**Micropropagation:** Micropropagation methods - axillary and adventitious budding - advantages. Plant protoplast isolation, culture and fusion. Call wall regeneration from protoplasts - application of protoplast hybridization. Biotransformation and immobilization of plant cells. Hairy root clones. Production of secondary metabolic compounds using cell and tissue culture. Molecular farming and immuno-protective drugs.

Unit III:	**Recombinant DNA technology:** Aims and strategies for transgenic development. Gene cloning vectors - Plasmids, Phages, Cosmids, Transposons, Primary vectors and plasmids - expression vectors. Enzymes in genetic engineering - exonucleases, endonucleases, restriction endonucleases, S 1 nucleases, DNA ligases, reverse transcriptase and alkaline phosphatase.
Unit IV:	**Recombinant DNA technology:** Selection of genes, Gene libraries: Genomic and cDNA library. PCR Gene transfer methods, Genetic organization of Ti plasmids, Ti plasmid mediated transfer - Agrobacterium tumifaciens, DNA mediated transfer, Calcium phosphate, PEG, DEAE, via liposomes - Microinjection, microprojectile, and electroporation, Selection of clones, marker and reporter genes in screening methods.
Unit V:	**Methods and Applications of Genetic Engineering** High throughput sequences and assembly. Human Genome Project Blotting techniques, Gene Knockout Technologies. Gene Therapy - Strategies, gene editing, silencing.

Suggested Reading:

1. Ashwini Kumar and Sopory, S. K. (Edt) 2013. Recent advances in Plant Biotechnology and its Applications, I K. International Publishing House Pvt. Ltd.
2. Bhojwani, S.S. and Razdan, M.K. 1996. Plant Tissue Culture: Theory and Practice (a revised edition). Elsevier Science Publishers, New York, USA.
3. Callow, J.A., Ford-Lloyd, B.V. and Newbury, H.J. 1997.Biotechnology and Plant Genetic Resources Conservation and Use. CAB International, Oxon, UK.
4. Chrispeels, M.J. and Sadava, D.E. 1994. Plants, Genes and Agriculture.Jones & Bartlett Publishers, Boston, USA.
5. Collin, H.A. and Edward S., 1998.Plant Cell Culture. Bios-Scientific Publishers, Oxford, UK.
6. Collins, H.A. and Edwards, S., 1998.Plant Cell Culture. Bios Scientific Publishers, Oxford, UK.
7. Dixon, R.A. (Ed.) 1987. Plant Cell Culture: A Practical approach. IRL Press, Oxford.
8. Dubey, R. C. 2014. Advanced Biotechnology, S. Chand and Company
9. Glick, B.R. and Thompson, J.E. 1993. Methods in Plant Molecular Biology and Plant Biotechnology. CRC Press, Boca Raton, Florida.
10. Govil, V. M., Agrawal, A. and Sharma, J. 2017. Plant Biotechnology and Genetic Engineering. PHI Learning Private Limted.
11. Hall, R.D. (Ed) 1999. Plant Cell Culture Protocols. Humana Press, Inc. New Jersy, U.S.A
12. Henry, R.J. 1997. Practical Applications of Plant Molecular Biology. Chapman & Hall, London, UK.
13. Jain, S.M., Sopory, S.K. and Veilleux, R.E. 1996.In Vitro Haploid Production in Higher Plants, Vols. 1-, Fundamental Aspects and Methods. Kluwer Academic Publishers, Dordrecht, Netherlands.
14. Nair, A. J. 2009. Principles of Biotechnology and Genetic Engineering, Laxmi Publications.
15. Patil, U. K. and Muskan K. 2020. Plant Biotechnology. Dreamtech Press.
16. Primrose, S.B. 1995.Principles of Genome Analysis. Blackwell Science Ltd., Oxford, UK.
17. Raghavan, V. 1997.Molecular Biology of Flowering Plants. Cambridge University Press. New York, USA.
18. Raghavan, V. 1997.Molecular Biology of Flowering Plants. Cambridge University Press. New York, USA.
19. Rajgopal, K. 2012. Recombinant DNA Technology and Genetic Engineering, Mac Graw Hill Education.
20. Rastogi, S. and Pathak, N. 2009. Genetic Engineering, Oxford Higher Education, Oxford University Press
21. Sarma P. V. G. K. 2021. A Practical Textbook of Genetic engineering in Bacteria. MJP Publisher
22. Satyanarayana, U. 2021. Biotechnology, 15th Ed. Books and Allied Private Ltd.
23. Schweizer, M. 1997. Methods in Biotechnology, CRC Press
24. Shantharam, S. and Montgomery, J.F. 1999.Biotechnology, Biosafety, and Biodiversity. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
25. Shaw, C.H. (Ed.) 1998. Plant Molecular Biology: A Practical Approach. IRL Press, Oxford.
26. Smith R.H. 2000. Plant Tissue Culture: Techniques & Experiments. Academic Press, New York.
27. Vennison, S. J. 2009. Laboratory manual of Genetic Engineering, Prentice Hall India learning Pvt. Ltd.

Learning Outcome:

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

1. To understand the fundamentals of Plant Biotechnology and Genetic Engineering

2. To understand the concepts of plant regeneration and its applications in agriculture, forestry and medicine.
3. To get insight in Recombinant DNA Technology and its application in various sectors.
4. To explore various methods of plant regeneration and gene manipulations
5. To understand and explain the applications of plant biotechnology and genetic engineering.

Semester IV Code of the Course/Subject	**Title of the Course/Subject** (Laboratory/Practical/practicum/hands-on/Activity)	**(No. of Periods/Week)**
Practical – VII	Practical Based on DSC XI, XII, XIII & SEC-I	**06**

DSC-XI Applied Botany

Laboratory Exercises:

1. Extraction of oil from algal/ plant samples
2. Analysis of seed health and quality testing
3. Synthesis of nanoparticles from plant extracts
4. To demonstrate the process of biofertilizers preparation
5. To demonstrate the process of commercialization of crude drugs
6. Invitro assay of plant crude extracts against various diseases.
7. Identification of bacterial strains using gram staining method
8. Preparation and extraction of cellulose from Agricultural By-Products
9. Extraction of ethanol from plant samples
10. Estimation of medicinal compounds from fungal/ plant samples
11. Study the antibiotic potential of crude extracts using disc/ well diffusion method
12. Analysis of water for potability and determination of MPN
13. Assessment of pollutants from water, food, and plant samples
14. Preparation of competent cells
15. To evaluate the mutagen effect on seed germination and seedling growth
16. To demonstrate the process of patent filing and granting of a patent
17. Determination of ash values of drugs
18. Study of mutation by Ames test
19. Isolation of bacteria from natural habitat – root nodules/curd/any other
20. Estimation of chloride by Argentometric method.
21. Estimation of elements using AAS
22. Estimation of Na and Ca using a flame photometer
23. Separation of phyto compounds using HPTLC and interpretation of results
24. Data interpretation of FTIR spectra
25. Data interpretation of GCMS/LCMS/HPTLC spectra
26. Interpretation and quality analysis of DNA sequences using online software
27. Editing of DNA sequences using recommended online software

DSC-XII Plant Ecology

Laboratory Exercises:

1. Study of rain Guage and measurement of rainfall
2. To study hygrometer and measurement of relative humidity.
3. Measurement of minimum and maximum temperature.
4. Measurement of Soil temp by dry wet bulb method.
5. To study pH meter and estimation of pH of water and soil.
6. To determine soil moisture content.
7. Study of Phytoplankton from pond water.
8. Study of Zooplankton from pond/river.
9. Study of biomass from grassland ecosystem.
10. Study of species dominance by Quadrat method.
11. Study of plant biodiversity on Hill slopes by line transact method.
12. To study the pH of rainwater during pre monsoon and monsoon season.

13. To determine interaction between grassland species by chi-square test.
14. Comparative study of plant diversity indices.
15. Study of mean, variance, standard deviation, standard error, coefficient of variation and t-test for ecological data.

DSC-XIII Environmental Ecology

Laboratory Exercises.

1) To measure Rainfall.
2) To study the light intensity by lux meter.
3) To determine PH of water and soil.
4) To evaluate the soil texture.
5) To determine the bulk density or apparent density (or value weight) and porosity (or pore space) of soil.
6) To determine water holding capacity of soil by rapid spot tests
7) To analyze the chemical properties of soil by rapid spot test
8) To estimate exchangeable bases (Na, K, Ca) in soil.
9) To study bio indicators of polluted water.
10) To study the morphological, anatomical adaptations in hydrophytes, Xerophytes, epiphytes.
11) To prove the biological spectrum of vegetation under study using Raunkiers life forms classification.
12) To determine P, S, K, Ca, Na in plants by chemical methods.
13) Study of fresh water communities.
14) Survey of key stone species.
15) Determination of minimum size of quadrate by species curve method.
16) Determination of minimum number of quadrate by curve method
17) Determination of quantitative characters of plant community by random sampling method (Abundance, Density, Frequency, basal cover, cavity cover etc.) and determination of quantitative characters by belt transect, line transect method and study of biological spectrum.
18) To study the rare and endangered plant species in local area. Prepare the report and causes of depletion of vegetation.
19) Study the dispersal mechanism of seeds of some local plants.
20) To find out the relationship between two ecological variables using correlation on regression analysis.
21) To determine minimum size and number of quadrates require for reliable estimate of biomass in grassland.
22) To find out association between grass land species using chi-square test.
23) To compare protected and unprotected grassland stand using community co-efficient (similarity indices.)
24) To analyze plant community using Bra-Curtis ordination method.
25) To estimate IVI of the species in woodland using a point quarter method.
26) To determine grass and net phytoplankton productivity by light and dark bottle method.
27) To determine the water holding capacity of soil collected from different locations.
28) To determine present organic carbon and organic matter in the soil of cropland, grassland and forest.
29) Visit to different forest areas to study ecosystem, biodiversity and biocomplexicity.
30) Field survey- A Survey of a part of the town or city should be carried out by the entire class in batches. Individual student will select one avenue/road and locked the tree planted on a graph paper. They will identify the trees, mention their size, canopy, shape, flowering and fruiting period and their status (healthy, diseased, infected, misused or dying) and mention or not the conditions in which they are surviving are satisfactory. The individual report will be used for subsequent monitoring either by the next batch of student / teachers/local communities/ NGO"S/ or civil authorities.

Course outcomes.

1) They will be under the concepts and principles of ecology.
2) They will be understood structure and functions of various ecosystem .
3) The various environmental factors governing these ecosystem are also clearly understood.
4) They w be understood the process of plant succession.

SEC-I Plant Biotechnology and Genetic Engineering

Laboratory Exercises:

1. Preparation of stock solution and culture media

2. Sterilization techniques and Preparation of Aseptic plant
3. Induction of callus and its growth measurement.
4. Organogenesis via callus formation in any plant species.
5. Isolation of protoplasts from various plant tissues.
6. Effect of physical (e.g. temperature) and chemical (e.g.osmoticum) factors on protoplast yield.
7. Demonstration of protoplast fusion employing PEG.
8. To check protoplast viability using Evan's Blue dye, Flourescent diacetate and phenosafranin
9. Demonstration of androgenesis in any plant species.
10. Embryogenesis in any plant material.
11. Preparation of artificial seeds.
12. Preparation of Bacterial Cultivation media
13. Bacterial cultivation and growth characteristics by streak and spread plate method
14. Isolation and estimation of Bacterial genomic DNA
15. Isolation and estimation of Onion DNA.
16. Isolation of Plasmid from E. coli strain DH5-a
17. Restriction enzyme digestion and analysis on Agarose Gel.
18. Isolation and estimation of Plant DNA.
19. RAPD Analysis.
20. Electro elution of DNA from Agarose Gels.
21. Total proteins detection on Blotting Membranes.
22. Alkaline Gel electrophoresis.
23. Purification of DNA for PCR amplification.
24. DNA fingerprinting of plant genomic DNA.
25. ELISA
26. Immunoassay
27. Antimicrobial sensitivity testing
28. PCR

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI
PRACTICAL EXAMINATION
M.Sc . II (Botany) , SEMESTER – IV (CBCS New)

Lab- 7 Practical Based on DSC XI, XII, XIII & SEC-I
(Applied Botany, Plant Ecology, Environmental Ecology and Plant Biotechnology and Genetic Engineering)
PRACTICAL SCHEDULE

Time: 6 hrs.	**Marks - 80**
Q.1. Setting and description any one experiment from Applied Botany.	15
Q.2. Setting and working of any one experiment on Environmental Ecology	15
Q.3. Setting and working of any one experiment on Plant Ecology.	15
Q.4. Setting and working of any one experiment on Plant Biotechnology.	15
Q.5. Comment on the given experiment from Genetic Engineering.	05
Q6. Comment on the given experiment from Environmental Ecology.	05
Q.7. Spotting	10
Practical Internal	
Q.8. Record	10
Q.9.Viva Voce	10

PRACTICAL – Lab- 8 Practical Based on Project

PRACTICAL SCHEDULE

Time : 1 hrs. **Max. Marks -100**

Part B
Syllabus Prescribed for 2023 Year **PG. Programme**
Programme **M.Sc. Botany**
Semester IV

Code of the Course Subject	**Title of the Couse/ Subject**	**No. of periods/ week**
BOEC IV	**Post-Harvest Technology for medicinal and Aromatic Plants**	**04**

Cos :
To impart requisite field skills in Medicinal and Aromatic Plants with emphasis on post-harvest technology. To impart knowledge about Medicinal and Aromatic Plants in the region and its utility.

Unit-I	Medicinal and Aromatic Plants (MAPs): definition, history, importance and future prospects. Medicinal Plants – past and present status in world and India. MAPs as industrial crops - constraints and remedial measures. Medicinal plant diversity & local healthcare. Medicinal plant conservation – issues and approaches. Medicinal plant conservation areas (MPCA), Non-timber forest products (NTFP),Good Agriculture Practices (GAP). Indian Himalayan region (IHR).
Unit-II	Promotion of medicinal plant sector at national level: National Medicinal Plant Board and State Medicinal Plant Boards - objectives and functions. Other organizational initiatives for promotion of MAPs at National and International levels. Demand and supply of medicinal plants. Herbal industries.
Unit-III	Scope and importance of post harvest technology. Post-harvest handling of wild and plantation crops of MAPs. Maturity indices, harvesting practices for specific market requirements, influence of pre-harvest practices, enzymatic and textural changes. Post harvest losses.
Unit-IV	Harvesting, grading and storage of medicinal plants. Post harvest handling of aromatic plants. Different methods of essential oil extraction and their drying and storage. Active content dynamics vis-a vis plant growth and post-harvest processing for evaluation of chemical constituents. Influence of post harvesting practices on active principles of MAPs.
Unit-V	Drying: introduction, drying and dehydration, osmotic drying, vacuum drying and freeze drying. Dried and dehydrated products. Enzymatic browning. Irradiation for control of spoilage during storage and transit. Value addition and Value added products. Safety standards.

Suggested Reading:

1. Advances in Horticulture. Vol. IV; by K.L. Chadha & O.P. Pareek (Eds.), Malhotra Publ. House (1996).
2. Post Harvest Physiology and Handling of Fruits and Vegetables by N.F. Haid& S.K. Salunkhe, Grenada Publ (1997).
3. Post Harvest Physiology and Storage of Tropical and Sub-tropical Fruits by S.K. Mitra, CABI(1997).
4. Post Harvest Technology of Horticultural Crops by K.P. Sudheer & V. Indira, New India Publ. Agency (2007).
5. Post Harvest. An Introduction to the Physiology and Handling of Fruits, Vegetables and Ornamentals by R. Willis, W.B. Mc Glassen, D. Graham & D. Joyce, CABI (1998).
6. Post Harvest Technology of Fruits and Vegetables, Handling, Processing, Fermentation and Waste Management, Vol I & II by Verma and Joshi (2000).
7. C.P. Kala (2010). Medicinal Plants of Uttarakhand.
8. P.C. Trivedi (2009).Indian Medicinal Plants.
9. S.S. Samant and U. Dhar. Medicinal Plants of Indian Himalaya.
10. S.K. Bhattacharjee (2004).Hand Book of Aromatic Plants.
11. S.K. Bhattacharjee (2009).Handbook of MAPs.

Learning Outcome:

1. Ability to work as a field curator of Medicinal and Aromatic Plants (MAPs)
2. Being able to identify common Medicinal and Aromatic Plants (MAPs)from diverse natural habitats.

3. Being able to cultivate Medicinal and Aromatic Plants (MAPs)
4. Being able to manage post-harvest losses of Medicinal and Aromatic Plants (MAPs) parts.

Sr. No.	Course	Code
1	DSC-XI Applied Botany	BOT 401
2	DSC-XII Plant Ecology	BOT 402
3	DSC -XIII Environmental Ecology	BOT 403
4	SEC- I Plant Biotechnology and Genetic Engineering	BOTS 401
5	Lab- 7 Practical Based on DSC XI, XII, XIII & SEC-I	
6	Lab-8 Practical Based on Project	
7	Open elective/ GIC/ Open skill/ MOOC* Gardening and Landscaping	OEC 401