

# KAVAYITRI BAHINABAI CHAUDHARI NORTH MAHARASHTRA UNIVERSITY, JALGAON

॥अंतरी पेटवू ज्ञानज्योत॥



1990  
'A' Grade  
NAAC Re-Accredited  
(4<sup>th</sup> Cycle)

## National Education Policy 2020

### SUBJECT BASKET

For

## M. Sc. (BOTANY) Part-I Semester- I & II

For

### Affiliated Colleges

(With effect from - June 2023)

**Semester-wise Code, Structure and Titles of  
the Courses For  
Master of Science (M. Sc.) Botany  
Semester I, II, III & IV  
(As per NEP-2020 Pattern)**

**For  
Affiliated College w.e.f. June, 2023-2024  
Semester-wise Course Structure, Course Code and Credit  
distribution of Two Years/ One Year **M. Sc. Programme.****

**Abbreviations:**

- **T:** Theory Course
- **DSC:** Discipline Specific Core Course
- **DSE:** Discipline Specific Elective Course
- **VSC:** Vocational Skill Courses
- **SEC:** Skill Enhancement Courses
- **GE/OE:** Generic/open elective
- **IKS:** Indian Knowledge System
- **RM:** Research methodology
- **CEP:** Community engagement and service
- **MIL:** Modern Indian language
- **VSEC:** Vocational skill and Skill enhancement courses
- **OJT:** On Job Training: Internship/ Apprenticeship
- **Co-curricular Course (CC)**
  - a) **CC-1: CC-120: Sports and Yoga**
  - b) **CC-2: CC-130: Cyber Security**
  - c) **CC-3: CC-220: Human Rights and Environment Law**
  - d) **CC-4: CC-229: Communication Skills and Personality Development**
- **Value Education Courses (VEC)**
  - a) **VEC1: ES-118: Environmental Science**
  - b) **VEC2: CI-129: Constitution of India**
- **Indian Knowledge System (IKS):**
  - a) **IK: 119: Ayurvedic Medicine in Ancient India**
- **P:** Practical course
- **MIN:** Minor subject
- **ES:** Environment studies
- **CI:** Constitution of India
- **ENG:** English
- **RP:** Research Project

• Ability Enhancement Courses (AEC)

- a) AEC-1: EG: 101 – English -1
- b) AEC-2: EG: 102 – English -2
- c) AEC-3: MR: 201 – Marathi -1
- d) AEC-3: HN: 201 – Hindi -1
- e) AEC-3: MR: 202 – Marathi -2
- f) AEC-3: HN: 202 – Hindi -2

**Semester-wise Course Structure, Course Code and Credit distribution of  
Two Years/ One Year **M. Sc BOTANY** Programme as per NEP2020, for Affiliated Colleges  
w.e.f – June 2023.**

**SEMESTER – I, Level – 6.0**

Course	Course Type	Course Code	Course Title	Credits	Teaching Hours/Week			Marks (Total 100)			
					T	P	Total	Internal (CA)		External (UA)	
								T	P	T	P
DSC-25	DSC	BO-411	Plant Systematics- I (Algae, Fungi and Bryophytes)	4	4	--	4	40	--	60	-
DSC-26	DSC	BO-412	Molecular biology	2	2	--	2	20	--	30	-
DSC-27	DSC	BO-413	Taxonomy of Angiosperms	4	4	--	4	40	--	60	-
DSC-28	DSC	BO-414	Practical based on BO-411	2	--	4	4	--	20	--	30
DSC-29	DSC	BO-415	Practical based on BO-412 & BO-413	2	--	4	4	--	20	--	30
DSE-5	DSE	BO-416(A)	Plant Biotechnology	4	4	--	4	40	--	60	-
		BO-416(B)	Seed Processing Techniques	4	4	--	4	40	--	60	-
		BO-416(C)	Fermentation Technology	4	4	--	4	40	--	60	-
RM	RM	RM-417	Research Methodology	4	4	--	4	40	--	60	-

**SEMESTER – II, Level – 6.0**

DSC-30	DSC	BO-421	Plant Systematics II (Pteridophytes, Gymnosperm and Paleobotany)	4	4	--	4	40	--	60	-
DSC-31	DSC	BO-422	Genetics	2	2	--	2	20	--	30	-
DSC-32	DSC	BO-423	Plant Physiology	4	4	--	4	40	--	60	-

DSC-33	DSC	BO-424	Practical based on BO-421	2	--	4	4	--	20	--	30
DSC-34	DSC	BO-425	Practical based on BO-422 & BO-423	2	--	4	4	--	20	--	30
DSE-6	DSE	BO-426(A)	Techniques in Plant Science	4	4	--	4	40	--	60	-
		BO-426(B)	Plant Ecology and Phytogeography	4	4	--	4	40	--	60	-
		BO-426(C)	Agricultural Botany	4	4	--	4	40	--	60	-
OJT	*OJT/Int.	BO-427	On Job Training	4	--	8	8	--	40	--	60

**Semester-wise Course Structure, Course Code and Credit distribution of  
Two Years/ One Year **M. Sc BOTANY** Programme as per NEP2020, for Affiliated Colleges  
w.e.f – June 2023.**

**SEMESTER – III, Level – 6.5**

Course	Course Type	Course Code	Course Title	Credits	Teaching Hours/Week			Marks (Total 100)			
					T	P	Total	Internal (CA)		External (UA)	
								T	P	T	P
DSC-35	DSC	BO-511	Plant Development and Reproduction	4	4	--	4	40	--	60	--
DSC-36	DSC	BO-512	Plant Breeding and Evolution	2	2	--	2	20	--	30	--
DSC-37	DSC	BO-513	A. Phycology Special Paper- I B. Mycology Special Paper- I C. Angiosperm Taxonomy Paper- I D. Physiology Special Paper- I	4	4	--	4	40	--	60	--
DSC-38	DSC	BO-514	Practical based on BO-511 & BO-512	2	-	4	4	--	20	--	30
DSC-39	DSC	BO-515	Practical based on Sp. Paper BO-513 (A/B/C/D)	2	-	4	4	--	20	--	30
DSE-7	DSE	BO-516(A)	Biostatistics and Bioinformatics	4	4	--	4	40	--	60	--
		BO-516(B)	Banana Technology	4	4	--	4	40	--	60	--
		BO-516(C)	Forensic Botany	4	4	--	4	40	--	60	--
RP	RP	BO-517	Research Project	4	-	8	8	--	40	--	60

**SEMESTER – IV, Level – 6.5**

DSC-40	DSC	BO-521	A. Phycology Special Paper- II B. Mycology Special Paper- II C. Angiosperm Taxonomy Paper- II D. Physiology Special Paper- II	4	4	--	4	40	--	60	--
DSC-41	DSC	BO-522	A. Phycology Special Paper- III B. Mycology Special Paper- III C. Angiosperm Taxonomy Paper- III D. Physiology Special Paper- III	4	4	--	4	40	--	60	--
DSC-42	DSC	BO-523	Practical based on Sp. Paper BO-521 (A/B/C/D)	2	-	4	4	--	20	--	30
DSC-43	DSC	BO-524	Practical based on Sp. Paper BO-522 (A/B/C/D)	2	-	4	4	--	20	--	30
DSE-8	DSE	BO-525(A)	Post Harvest Technology	4	4	--	4	40	--	60	--
		BO-525(B)	Green House Technology	4	4	--	4	40	--	60	--
		BO-525(C)	Green Belt and Green Credit	4	4	--	4	40	--	60	--
RP	RP	BO-526	Research Project	6	-	12	12	--	60	--	90

**Cumulative Credits For Second Year – 44**

**2 Years-4 Sem. PG Degree (88 credits) after Three Year UG Degree or 1 Year-2 Sem PG Degree (44 credits) after Four Year UG Degree**

**Cumulative Credits For First Year – 44\*** Students need to complete one month on job training (OJT) or internship in any industry related to major subject.

## Programme: M.Sc. Botany Programme Outcomes (POs)

### Programme: M.Sc. Botany Programme Outcomes (POs)

After the completion of the M.Sc Botany Programme, the students will be in a position to

**PO1: Domain knowledge:** Demonstrate knowledge of basic concepts, principles and applications of the specific science discipline.

**PO2: Resource Utilisation.** Cultivate the skills to acquire and use appropriate learning resources including library, e-learning resources, ICT tools to enhance knowledge-base and stay abreast of recent developments.

**PO3: Analytical and Technical Skills:** Ability to handle/use appropriate tools/techniques/equipment with an understanding of the standard operating procedures, safety aspects/limitations.

**PO4: Critical thinking and Problem solving:** Identify and critically analyse pertinent problems in the relevant discipline using appropriate tools and techniques as well as approaches to arrive at viable conclusions/solutions.

**PO5: Project Management:** Demonstrate knowledge and scientific understanding to identify research problems, design experiments, use appropriate methodologies, analyse and interpret data and provide solutions. Exhibit organisational skills and the ability to manage time and resources.

**PO6: Individual and team work:** Exhibit the potential to effectively accomplish tasks independently and as a member or leader in diverse teams, and in multidisciplinary settings.

**PO7: Effective Communication:** Communicate effectively in spoken and written form as well as through electronic media with the scientific community as well as with society at large. Demonstrate the ability to write dissertations, reports, make effective presentations and documentation.

**PO8: Environment and Society:** Analyse the impact of scientific and technological advances on the environment and society and the need for sustainable development

**PO9: Ethics:** Commitment to professional ethics and responsibilities **PO10: Life-long learning:** Ability to engage in life-long learning in the context of the rapid developments in the discipline.

## Programme Specific Outcomes (PSOs)

By the end of the Programme, the students will be able to

### **PSO1: Academic competence:**

1. Recall fundamental concepts, state principles and outline processes underlying in the field of Botany, its different sub fields and its linkage with related disciplinary areas/subjects.
2. Demonstrate an understanding of a wide range of physiological, biochemical, cellular, molecular, developmental processes in plant cell.
3. Execute botanical excursion tour for correct taxonomic identification, collection, preservation of plant specimens.

### **PSO2: Personal and Professional Competence:**

1. Carry out activities effectively as an individual or a member of a team or leader of a group to fulfil the responsibilities related to group activities.
2. Analyse data and samples procured during experiments, projects, and field work.
3. Formulate the ideas, draft scientific reports, authenticate conclusions, present effectively with effective communication skills.
4. Implement self-learning, discipline, and take logical correct approach for solving problems.

### **PSO3: Research Competence:**

1. Apply appropriate techniques to solve and analyse problems with specific reference to biological techniques and instrumentations.
2. Integrate knowledge of fundamental aspects of Botany with applied aspects to design the experiment, interpret the data, and provide valid conclusions.
3. Assess problems, identify, formulate research literature, and test probable solutions for challenges in various fields of Botany.

### **PSO4: Entrepreneurial and Social competence:**

1. Employ the applied knowledge of Botany for self-employment with demonstration of true values of leadership, co-operation, and teamwork.
2. Associate the impact of anthropogenic factors, importance of conservation, diversity, and our social role in sustainable development.
3. Execute social competence including listening, speaking, observational, effective interactive skills and presenting skills to meet global competencies.

**Kavayitri Bahinabai Chaudhari North Maharashtra University, Jalgaon**  
**MSc. Botany Part - I: Semester - I & II**

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**Programme at a Glance Syllabus for M. Sc. Botany**

**Board of Studies in Botany**

Name of the program (Degree)	: M.Sc. Botany
Faculty	: Science and Technology
Duration of the Program	: Two years (four Semesters)
Medium of Instruction	
and Examination	: English
Exam Pattern	: 60: 40 (60 marks University exam and 40 marks continuous internal assessment)
Passing standards	: 40% in each exam separately (Separate head of passing)
Evaluation mode	: NEP 2020
Credits of the program	:88

**Semester – I<sup>st</sup>**

DSC-25 [4T]	BO-411	Plant Systematics- I (Algae, Fungi and Bryophytes)	60 L
DSC-26 [ 2T]	BO-412	Molecular biology	30 L
DSC-27 [4T]	BO-413	Taxonomy of Angiosperms	60 L
DSC-28 [2P]	BO-414	Practical based on DSC-25	30 L
DSC-29 [2P]	BO-415	Practical based on DSC-26 & 27	30 L
DSE-5 [4T]	BO-416 (A)	Plant Biotechnology	60 L
	BO-416 (B)	Seed Processing Technology	
	BO-416 (C)	Fermentation Technology	
RM [4T]	RM-417	Research Methodology	60 L



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**M. Sc. Botany Part - I: Semester - I**

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<b>DSC- 25 Major (Core) Course [Lectures: 60][4T]</b> <b>BO-411 Plant Systematics - I (Algae, Fungi and Bryophytes)</b>		
<b>Course Objectives:</b>		
<ol style="list-style-type: none"> <li>1. To study salient features of Algae, Fungi and Bryophytes.</li> <li>2. To know the diversity of Cryptogamic plants in nature.</li> <li>3. To study the life cycle patterns in cryptogams.</li> </ol>		
<b>Course outcomes:</b>		
<ol style="list-style-type: none"> <li>1. Able to differentiate cryptogamic plants.</li> <li>2. Able to describe life cycle patterns in cryptogams.</li> <li>3. Higher cognitive skills will develop.</li> </ol>		
<b>Unit 1</b>	<b>Introduction to Algae</b> <ol style="list-style-type: none"> <li>1. Introduction: Definition, Occurrence and Habitat General characters, and similarities and differences with Fungi and Bryophyte.</li> <li>2. Reproduction; Life cycle and Alternation of generation.</li> <li>3. Algae in human welfare.</li> </ol>	<b>03</b>
<b>Unit 2</b>	<b>Classification of algae</b> <ol style="list-style-type: none"> <li>1. Basis of algal classification and nomenclature; Classification of algae According to F. E. Fritsch (1945) and Parker (1982) up to class and subclass:</li> <li>2. Comparative account of the algal classes, with respect to pigments, reserve food, cell wall, chloroplast and eyespot, flagella</li> </ol>	03
<b>Unit 3</b>	<b>Study of importance classes of algae</b> <b>A. Cyanophyceae</b> <ol style="list-style-type: none"> <li>i) Introduction, Ecology of Blue Green Alga,</li> <li>ii) Thallus organization, Ultra cell structure &amp; Heterocyst, Heterocyst function</li> <li>iii) Reproduction and Economic role</li> </ol> <b>B. Chlorophyceae</b> <ol style="list-style-type: none"> <li>i) General characters, Range of thallus structure, Structure of Cell</li> <li>ii) Method of reproduction.</li> </ol> <b>C. Phaeophyceae</b> <ol style="list-style-type: none"> <li>i) General characters, Range of thallus structure</li> <li>ii) Method of reproduction</li> </ol> <b>D. Rhodophyceae</b> <ol style="list-style-type: none"> <li>i) General characters, Range of thallus structure</li> <li>ii) Method of reproduction</li> </ol> <b>E. Introduction and General Characters of following Class</b> <ol style="list-style-type: none"> <li>i) <i>Bacillariophyceae</i></li> <li>ii) <i>Euglenophyceae</i></li> </ol>	14

<b>Unit 4</b>	<b>Fungi – Introduction:</b> 1. Distinguishing characters, Thallus structure, Hyphal modifications 2. Nutrition 3. Classification of fungi up to classes as per- Ainsworth et al., system (1973). 4. Economic importance- Fungi in biotechnology, fungi as food.	03
<b>Unit 5</b>	<b>A) Myxomycota:</b> i) Distinguishing characters. ii) Structure of thallus and reproductive bodies. iii) Life cycle pattern with reference to <i>Pysarum</i> . <b>B) Mastigomycotina:</b> i) Distinguishing characters. ii) Thallus structure and reproduction (Asexual and sexual). iii) Life cycle pattern with reference to <i>Plasmopara</i> . <b>C) Zygomycotina:</b> i) Distinguishing characters ii) Thallus structure, Heterothallism and reproduction. iii) Life cycle pattern with reference to <i>Mucor</i> .	09
<b>Unit 6</b>	<b>A) Ascomycotina:</b> i) Distinguishing characters. ii) Thallus structure, structure of asci, Types of ascocarps. ii) Life cycle pattern with reference to <i>Eurotium</i> . <b>B) Basidiomycotina:</b> i) Distinguishing characters. ii) Thallus structure, Types and Structure of basidia and basidiocarps. iii) Life cycle pattern with reference to Teliomycete.s <b>D) Deuteromycotina:</b> i) Distinguishing characters. ii) Thallus structure, fructifications, Types of conidia.	08
<b>Unit 7</b>	<b>Introduction to Bryophytes</b> <b>A) Introduction:</b> - General characteristics, habitat, reproduction, structure of gametophyte & sporophyte. <b>B) Classification:</b> - Classification of Bryophytes up to orders by G.M. Smith 1955). <b>C) Economic importance of Bryophytes</b> <b>D) Evolution of gametophytes &amp; sporophytes in Bryophytes.</b>	05
<b>Unit 8</b>	Distinguishing features, phylogeny & evolutionary tendencies of the following orders with their affinities. <b>Hepaticae :</b> ( Marchantiales, Jungermannias, Metzerials and <i>Calobryales</i> <b>Anthocerotae:</b> Anthocerotales. <b>Musci:</b> Polytrichales.	15
<b>Suggested readings:</b> 1. Bold, H and Wynne M.J. (1978) Algal structure and reproduction. Prentice Hall of India Pri.Ltd.New Delhi, India. 2. Bony, A.D. (1978) Phytoplankton.Edward Arnold Pub.Ltd. London, U.K. 3. Chapman, V.J. and Chapman D.J. (1979) The Algae. English Language Book Society and Mc.millan,Co, London, U.K.		

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26. Kendrick B. (1994) *The Fifth Kingdom (paperback)*, North America, New York Publisher:
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28. Mehrotra R.S. and Aneja K.R. (1990) *An Introduction To Mycology*. New Age Publishers, New Delhi, India.
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**Kavayitri Bahinabai Chaudhari North Maharashtra University, Jalgaon**  
**M. Sc. Botany Part - I: Semester -I**

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<b>DSC- 26 Major (Core) Course [Lectures: 30] [2T]</b> <b>BO-412 Molecular Biology</b>		
<b>Course Objectives:</b>		
<ol style="list-style-type: none"> <li>1. To study molecular biology about genetic material, its replication.</li> <li>2. To study transcription, translation post-translation modification of a protein.</li> <li>3. To study gene regulation in prokaryotes and eukaryotes.</li> <li>4. The course will mainly focus on the study of principal molecular events of cell incorporating DNA Replication, Transcription and Translation in prokaryotic as well as eukaryotic organisms.</li> </ol>		
<b>Course outcomes:</b>		
<ol style="list-style-type: none"> <li>1. Understanding concept of molecular biology in detail.</li> <li>2. Understand the molecular details of DNA replication in prokaryotes and eukaryotes.</li> <li>3. Explain the mechanisms of protein synthesis.</li> <li>4. Explain nucleic acid structure.</li> </ol>		
<b>Unit 1</b>	<b>Introduction to Molecular biology</b> Definition, milestones of molecular biology, scope and importance molecular biology Structure of different types of nucleic acids, hydrolysis of nucleic acids. DNA: Watson-Crick model of DNA, Chemical composition of DNA, Forms of DNA (A, B, Z), Properties of DNA & Function of DNA RNA: Definition, Structure and function of different types of RNA, Different between DNA and RNA	<b>6</b>
<b>Unit 2</b>	<b>DNA Replication:</b> Definition of DNA replication. Types of DNA replication Mechanism of DNA replication in Prokaryotes and Eukaryotes Models of DNA replication (Rolling circle model of replication, D-loop replication & Liner replication model) Brief note: - Okazaki Fragments, Lagging strand, Leading strand and DNA Polymerase.	<b>6</b>
<b>Unit 3</b>	<b>Unit-3 Gene &amp; Genetic Code</b> 3.1 Definition, characteristics, Structure and Functions of Gene. One Gene One Enzyme hypothesis Promoter in Prokaryotes and Promoter in Eukaryotes. Definition Characteristics & properties of genetic code. Brief note: - Pribnow Box, TATA Box, Coding Sequence.	<b>6</b>
<b>Unit 4</b>	<b>Protein synthesis and processing</b>	<b>6</b>

	<p>Required components for Transcription.  Central dogma of molecular biology  Steps of transcription (Initiation, Elongation and Termination)  Inhibitors of transcription (Lac repressor, Rifampicin, Alpha amanitin, Actinomycin D &amp; Platinum anti- tumor drugs)  Mechanism of Translation (Activation of amino acid, Attachment of activation of amino acid, Imitation of polypeptide chain, Elongation of polypeptide chain &amp; Termination of polypeptide chain)</p>	
<b>Unit 5</b>	<p><b>Unit-5 Regulation of Gene Expression</b>  Definition of gene expression  Reasons for regulation of gene expression  Regulation of gene expression in Prokaryotes. (Operon concept, LACOperon TRP Operon),  Regulation of gene expression in Eukaryotes.</p>	<b>6</b>
<p><b>Suggested readings:</b></p> <ol style="list-style-type: none"> <li>1. De Robertis and De Robertis (2005) Cell and Molecular Biology, 8thEd, Lippincott Williamand Wilkins U.S.A.4. Eldon john Gardner, Michel J. Simmons and D. Peter Snustad (1991) Princiles of genetics 8<sup>th</sup>Ed . Wiley India edition, New Delhi, India.</li> <li>2. Gupta, P. K. (2007) Genetics: Classical to Modern. Rastogi Publications, Meerut, India.</li> <li>3. Gerald Karp (2008). Cell and Molecular biology: Concepts and experiments (V Edn). John Wiley &amp; Sons</li> <li>4. H.S. Bhamaah, 1990, Molecular cell Biology, Anmol Publication New Delhi.</li> <li>5. James Jorwell, Honey Ladish, 1986. Molecular cell biology scientific American</li> <li>6. Prescott, D.M.1988 Cells: Principles of Molecular structure and function. Johes and Bortlet pub. Boston.</li> <li>7. S.C. Rastogi, 1995, Concepts, in Molecular Biology. Reeta Area, 1998, Cell biology, Anmol Publications, New Delhi.</li> <li>8. Waston, I.D. Et. Al. 1965. Molecular, Biology of the gene. 4th Ed.</li> <li>9. Karp, G. Cell and Molecular biology: Concepts and experiments (V Edn). John Wiley &amp; Sons, 2008. Print.</li> <li>10. Pal Jayanta and Saroj S. Ghaskadabi Fundamentals of Molecular Biology, Oxford Higher Education.</li> <li>11. Rastogi V.B Concepts in Molecular Biology.</li> <li>12. Twyman R.M (2003) (Third Reprint). Advanced Molecular Biology. Viva Books Pvt. Ltd., New Delhi.</li> <li>13. <a href="https://microbenotes.com">https://microbenotes.com</a>.</li> <li>14. <a href="https://www.uou.ac.in/sites/default/files/slm/BSCBO-301.pdf">https://www.uou.ac.in/sites/default/files/slm/BSCBO-301.pdf</a></li> <li>15. <a href="https://www.easybiologyclass.com/molecular-biology-online-tutorials-lecture-notes-study-materials/">https://www.easybiologyclass.com/molecular-biology-online-tutorials-lecture-notes-study-materials/</a></li> <li>16. <a href="https://thebiologynotes.com">https://thebiologynotes.com</a></li> </ol>		

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<b>DSC- 27 Major (Core) Course [Lectures: 60] [4T]</b> <b>BO-413 Taxonomy of Angiosperms</b>		
<b>Course Objectives:</b>		
<ol style="list-style-type: none"> <li>1. To study aims, principles and methods in taxonomy.</li> <li>2. To study taxonomic structure of Angiosperms.</li> <li>3. To study Cronquist system of classification.</li> <li>4. To study recent APG system of classification and evolutionary trends.</li> <li>5. To study morphological peculiarities and biological importance of plants.</li> </ol>		
<b>Course outcomes:</b>		
<ol style="list-style-type: none"> <li>1. Student provide with importance of classification in Angiosperms.</li> <li>2. They will get the knowledge of recent system of classification in Angiosperms.</li> <li>3. This course helps to make them aware of wild plants their habit and habitat from field tour.</li> <li>4. Student will know biological adaption and evolutionary trends of angiosperm.</li> </ol>		
<b>Unit 1</b>	<b>Taxonomy</b> <ol style="list-style-type: none"> <li>1. Aim, principles and methods in taxonomy.</li> <li>2. Basic Concepts of Biosystematics and Taxonomy, Trends in biosystematics, Chemotaxonomy, Cytotaxonomy.</li> <li>3. Taxonomic Tools – Floras, monographs, Herbaria, Botanical survey of India (Regional &amp; zonal center, activity)</li> </ol>	12
<b>Unit 2</b>	<b>System of classification</b> <ol style="list-style-type: none"> <li>1. Review of Pre- Darwinian and Post Darwinian classification</li> <li>2. Cronquist system of classification: Introduction, principles, Outline, Merits and demerits.</li> </ol>	12
<b>Unit 3</b>	<b>Angiosperm phylogeny group (APG)</b> <ol style="list-style-type: none"> <li>1. Introduction</li> <li>2. Principles of APG</li> <li>3. APG-III (2003) system of classification: Introduction, Comparative study with Bentham and Hooker System</li> <li>4.</li> </ol>	12
<b>Unit 4</b>	<b>Nomenclature:</b> <ol style="list-style-type: none"> <li>1. Introduction</li> <li>2. Principles of Plant Nomenclature (I-VI)</li> <li>3. Recent code of Plant Nomenclature (Schenzhen Code)               <ol style="list-style-type: none"> <li>a) Typification</li> <li>b) Author citations</li> <li>c) Rejection of Names</li> <li>d) Retention of names</li> </ol> </li> </ol>	12

<b>Unit 5</b>	<p><b>A] Biological importance and morphological peculiarities of the families.</b> Nepenthaceae, Orobanchaceae, Balanophoraceae, Rafflesiaceae, Podostemnaceae, Orchidaceae</p> <p><b>B] Study of evolutionary trends in taxonomy</b> i) Evolution of Inflorescence ii) Evolution of floral nectaries iii) Evolution of Androecium iv) Evolution of Gynoecium</p>	12
<p><b>Suggested readings:</b></p> <ol style="list-style-type: none"> <li>1. Agashe SN (1995). Paleobotany, Oxford and IBH Publ. Co. Pvt. Ltd, New Delhi.</li> <li>2. Briggs David (2009). Plant microevolution and Conservation in Human-influenced Ecosystems. Cambridge University Press.</li> <li>3. Cook T. (1903). The Flora of Presidency of Bombay, Vol. I (Indian Reprint) Bishen Singh, Mahendra Pal Singh, Dehradun</li> <li>4. Cronquist, A. (1981). An Integrated System of Classification of Flowering Plants Columbia University Press, New York</li> <li>5. Cronquist, A. (1988). The Evolution and Classification of Flowering Plants (2nd ed.) Allen Press, U.S.A.</li> <li>6. Davis, P. H. and V. H. Heywood (1991). Principles of Angiosperm Taxonomy. Today and Tomorrow Publications, New Delhi.</li> <li>7. Eames A J (1961). Morphology of Angiosperms, McGraw Hill Book Co.</li> <li>8. Erdtman G (1966). Pollen Morphology and Plant Taxonomy of Angiosperms (An introduction to Palynology - I), Hafner Pub. Co. London.</li> <li>9. Hickey M and King C (2000). The Cambridge Illustrated Glossary of Botanical Terms. Cambridge University Press, UK.</li> <li>10. Jain S. K. and Rao R. R. Handbook of Field and Herbarium Methods, Today and Tomorrow Publishers, New Delhi.</li> <li>11. Jones S B and Luchinger A E (1986). Plant Systematics 2nd edn, McGraw Hill Book Co.</li> <li>12. Judd et al. (2007). Plant Systematics – A phylogenetic approach. Sinauer Pub. 3rd edition</li> <li>13. Judd W. S., Campbell, C. S., Kellogg, E. A., Stevens P. F. and M. J. Donoghue 2008. Plant Systematics: A phylogenetic Approach. Sunderland, Massachusetts, USA.</li> <li>14. Kubitzki K (1977). Flowering Plants Evolution and Classification of Higher Categories. Plant Systematics – Evolution Supplement I.</li> <li>15. Kuijt J. (1969). The biology of parasitic flowering plants. California University Press.</li> <li>16. Lawrence George H. M. 195.1 Taxonomy of Vascular Plants. Oxford and IBH Publ. Co. Pvt. Ltd. New Delhi.</li> <li>17. Leadley E. and S. Jury (ed.) (2006). Taxonomy and Plant conservation. Cambridge University Press.</li> <li>18. Manilal, K. S. and M. S. Muktesh Kumar [ed.] (1998). A Handbook of Taxonomic Training. DST, New Delhi.</li> <li>19. Naik, V. N. (1984). Taxonomy of Angiosperms. Tata McGraw-Hill Publication Com. Ltd. New Delhi.</li> <li>20. Quicke, Donald, L. J. (1993). Principles and Techniques of Contemporary Taxonomy. Blakie Academic &amp; Professional, London</li> <li>21. Radford A E (1986). Fundamentals of Plant Systematics, Harper and Row N Y.</li> </ol>		



22. Simpson M. Plant Systematics, Academic Press, 2nd edition.
23. Singh G (2004). Plant Systematics, 2nd edn, Oxford and IBH, New Delhi.
24. Sivrajan V V (1984). Introduction to Principles of Plant Taxonomy, Oxford and IBH, New Delhi.
25. Smith P M (1976). The Chemotaxonomy of Plants, Edward Arnold Pub. Ltd.
26. Sporne K R (1974). Morphology of Angiosperms, Hutchinson University Library, London.
27. Stace C A (1989). Plant Taxonomy and Biosystematics.
28. Stewart W N and Rothwell G W (2005). Paleobotany and the Evolution of Plants, 2nd edn, Cambridge University Press.
29. Subrahmanyam K. Aquatic angiosperms. BSI. India.
30. Takhtajan, A. (1962). Flowering plants- Origin and Dispersal.
31. Taylor, D. V. and L. J. Hickey (1997). Flowering Plants: Origin, Evolution and Phylogeny. CBS Publishers & Distributers, New Delhi.

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<b>DSC- 28 Major (Core) Course [Lectures:60] [2P]</b> <b>Practical – I</b> <b>Based on DSC-25 BO-414 Plant Systematics- I</b> <b>(Algae, Fungi and Bryophytes)</b>	
<b>Course Objective:</b> To Study the occurrence, diversity, structural organization and reproduction of algae, fungi and bryophytes.	
<b>Course Outcome:</b> Students acquaint the occurrence, diversity, structural organization and reproduction of algae, fungi and bryophytes.	
<b>Algae: (05 Practicals)</b>	
Representative genera belonging to following Classes and orders of Algae with respect to Morphological, reproductive structures and classification with reasons according to F.E. Fritsch (1956)).	
<b>Practical -1</b>	<b>Cyanophyceae:</b> Any six forms.
<b>Practical -2</b>	<b>Chlorophyceae:</b> Any Ten forms.
<b>Practical - 3</b>	<b>Phaeophyceae:</b> Any Three forms.
<b>Practical - 4</b>	<b>Rhodophyceae:</b> Any Three forms.
<b>Practical - 5</b>	<ul style="list-style-type: none"> <li>i. Xanthophyceae : Any Two forms.</li> <li>ii. Bacillariophyceae- Any Four forms.</li> <li>iii. Euglenophyceae- Any Two forms.</li> </ul>
<b>Fungi: (05 Practicals)</b>	
Representative genera belonging to following divisions and subdivisions of fungi with respect to vegetative, reproductive structures and classification with reasons according to Ainsworth et al. (1973).	
<b>Practical - 6</b>	<ul style="list-style-type: none"> <li>i) <b>Myxomycota</b> -Any two forms</li> <li>ii) <b>Mastigomycotina</b>- Any two Forms</li> </ul>
<b>Practical -7</b>	<b>Zygomycotina</b> - Any four forms
<b>Practical - 8</b>	<b>Ascomycotina</b> - Any four t forms
<b>Practical -9</b>	<b>Basidiomycotina</b> - Any four forms
<b>Practical -10</b>	<b>Deuteromycotina</b> - Any four form
<b>Bryophytes: (05 Practicals)</b>	
<b>Practical: 11</b>	Morphological, Anatomical and Reproductive studies of the following: <b>Hepaticae- Marchantiales:</b> i) <i>Targionia</i> , ii), <i>Plagiochasma</i>
<b>Practical: 12</b>	Morphological, Anatomical and Reproductive studies of the following: <b>Hepaticae- Marchantiales:</b> i) <i>Asterella</i> , ii) <i>Dumortiera</i>
<b>Practical:13</b>	Morphological, Anatomical and Reproductive studies of the following: <b>Hepaticae- Jungermanniales:</b> i) <i>Pellia</i> , ii) <i>Fossombronia</i> , iii) <i>Pallavicinia</i> ,

	iv) <i>Porella</i> , v) <i>Frullania</i> ( <b>Any Two</b> )
<b>Practical: 14</b>	Morphological, Anatomical and Reproductive studies of the following: <b>Anthocerotae- Anthocerotales:</b> i) <i>Anthoceros</i> , ii) <i>Notothylyus</i>
<b>Practical: 15</b>	Morphological, Anatomical and Reproductive studies of the following: <b>Musci-Polytrichales:</b> i) <i>Polytrichum</i> , ii) <i>Pogonatum</i>
<b>Note:</b>	
<ol style="list-style-type: none"> <li>Excursion tour is compulsory to observe algae, fungi and bryophytes in nature.</li> <li>Tour report along with photographs must be submitted at the time of practical examination.</li> <li>Duly certified journals are compulsory at the time of practical examination.</li> </ol>	
<b>Suggested readings:</b>	
<b>Algae:</b>	
<ol style="list-style-type: none"> <li>Bold, H and Wynne M.J. (1978) Algal structure and reproduction. Prentice Hall of India Pri.Ltd. New Delhi, India.</li> <li>Bony, A.D. (1978) Phytoplankton. Edward Arnold Pub.Ltd. London, U.K.</li> <li>Desikachary, T. V. (1959) "<i>Cyanophyta</i>" Indian Council of Agricultural Research, New Delhi.</li> <li>Gandhi, H. P. (1960) The Diatom flora of the Bombay and Salsette islands. <i>J. Bombay Nat. Hist. Soc</i></li> <li>Gonzalves, E. A. and H. P. Gandhi (1952-54) A Systematic account of the diatoms of Bombay and Salsette-I -III. <i>J. Indian Bot. Soc.</i></li> <li>M.O.P. Iyengar and T. V. Desikachary (1981) Volvocales, <i>Indian Council of Agricultural Research, New Delhi.</i></li> <li>Philipose, M. T. (1967) Chlorococcales, <i>Indian Council of Agricultural Research, New Delhi.</i></li> <li>Prescott, G. W. (1966) Algae of the Western Ghat lakes area exclusive desmids and diatoms, <i>Bull. Cranbrook Inst. Sci.</i></li> <li>Sarode, P. T. and N. D. Kamat (1984) <i>Freshwater Diatoms of Maharashtra</i>. Saikrupa Prakashan, Aurangabad,</li> <li>Sarma, Y. S. R. and M. Khan (1980) Algal taxonomy in India, <i>Today and Tomorrow, Book Agency, New Delhi.</i></li> </ol>	
<b>Fungi:</b>	
<ol style="list-style-type: none"> <li>Ainsworth, Sussman and Sparrow (1973) The fungi. Vol IV A &amp; IV B. Academic Press. London, U.K.</li> <li>Alexopolous C.J., Minms C.W. and Blackwell M. (1999) (4th edn) Introductory Mycology. Willey, New York, USA.</li> <li>Barron, G L (1968) The genera of Hyphomycetes from soil, The Williams and Wilkins Co., Baltimore.</li> <li>Bhat, D. J.(2010) Fascinating microfungi (Hyphomycetes) of Western Ghats - India, by Broadway Book Centre Publishers &amp; Distributors, Pungim, Goa, India.</li> <li>Ellis, M B (1971) Dematiaceous Hyphomycetes, Commonwealth Mycological Institute, Kew, England. UK.</li> <li>Ellis, M B (1976) More Dematiaceous Hyphomycetes by Commonwealth Mycological Institute, Kew, England, UK.</li> <li>Kiffer ,E &amp; Morelet M (2000) The Deuteromycetes, Mitosporic fungi Classification and Generic Keys , New Hampshire,</li> <li>Kirk, P M, Cannon P F, Minter D W &amp; Stalper J A.(2008) Ainsworth &amp; Bisby's Dictionary of fungi, 10th edition by CAB International, Wallingford.</li> <li>Pande Alaka (2008) Ascomycetes of Peninsular India, Scientific Publishers (India), Jodhpur , India</li> <li>Rao, G. P., Manoharachary, C., Bhat, D. J., Rajak, R. C., &amp; Lakhanpal, T. N.</li> </ol>	

(eds.)(2003) Frontiers of Fungal Diversity in India - Prof. Kamal Festschrift Volume,  
International Book Distributing Co. Lucknow, India.

21. Subramanian, CV (1971) Hyphomycetes, ICAR, New Delhi, India .

**Bryophytes:**

22. A.Rashid (1998) An Introduction to Bryophytes Vikas Publishing house Pvt. Ltd.  
New Delhi, India
23. Kashyap, S.R. (1929) Liverworts of the Western Himalayas and the Punjab  
Plain (illustrated): Part 2. Chronica Botanica, New Delhi.
24. Parihar, N.S. (1980) Bryophytes: An introduction to Embryophyta. Vol.I Central Book  
Depot, Allahabad, India.

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<p><b>DSC- 29 Major (Core) Course [Lectures: 60] [2P]</b>  <b>Practical - II</b>  <b>BO-415 Based on DSC-26 BO-412 Molecular Biology and</b>  <b>DSC-27 BO-413 Taxonomy of Angiosperms</b></p>	
<p><b>Course Objective:</b>                  To learn various instruments, solutions required in molecular biology laboratory, estimate nucleic acids.                  To study the morphological characters, floral formula, floral diagrams, classification, peculiar characters of angiosperms and to prepare artificial keys and to identify the genera and species.</p>	
<p><b>Course Outcomes:</b>                  Students acquainted in various instruments, solutions required in molecular biology laboratory, estimation nucleic acids.                  Students understood the morphological characters, floral formula, floral diagrams, classification, peculiar characters of angiosperms and to prepare artificial keys and to identify the genera and species.</p>	
<p><b>Practical 1-5</b></p>	<p><b>Study of families (Sensu: Bentham &amp; Hooker System) w.r.t. morphological characters, floral formula, floral diagram and classification with reasons-</b>                  Ranunculaceae, Menispermaceae, Papaveraceae, Capparidaceae, Portulacaceae, Sterculiaceae, Tiliaceae, Malpighiaceae, Zygophyllaceae, Meliaceae, Rhamnaceae, Moringaceae, Papilionaceae, Myrtaceae, Cucurbitaceae, Umbelliferae, Rubiaceae, Plumbaginaceae, Apocynaceae, Boraginaceae, Convulvulaceae, Scrophulariaceae, Bignoniaceae, Acanthaceae, Verbenaceae, Labiatae, Nyctagineae, Chenopodiaceae, Polygonaceae, Scitamineae, Amaryllidaceae, Liliaceae, Commelinaceae, Typhaceae, Cyperaceae, Graminae (Any 10 families from different series)</p>
<p><b>Practical 6-7</b></p>	<p>Identification of genus and species from locally available wild plants using regional and state floras (At least 20 plant species from locally available families).</p>
<p><b>Practical 8</b></p>	<p>Preparation of artificial bracketed/indented dichotomous keys based on vegetative &amp; reproductive characters from different families, genera and species. (Specimens from different family, same family, different genera of same family, Species from same genera.)</p>
<p><b>Practical 9-10</b></p>	<p>Study of morphological and biological peculiarities of the specimens from following families. Nepenthaceae, Balanophoraceae, Podostemnacae, Orobanchaceae, Rafflesiaceae, Orchidaceae.</p>
<p><b>Practical based on BO-412 Molecular Biology</b></p>	

<b>Practical 11</b>	Study of following instruments for principle, working and uses in molecular biology. (Laminar airflow hood, Gel electrophoresis unit, Centrifuge machine, Spectrophotometer, pH meter and Autoclave)
<b>Practical 12-13</b>	Preparation of solutions, buffers and reagents (Molar solution NaOH, Normal solution, Tris-HCl buffer, TE buffer, TBE buffer, Gel loading dye, 0.7% to 2.0 % Agarose). -
<b>Practical 14</b>	Determine DNA concentration and purity using UV- visible spectrophotometer.
<b>Practical 15</b>	Estimation of RNA, following the orcinol method.

**Suggested Readings:**

1. Kar and Halder, (2009) Cell Biology Genetics Molecular Biology; New Central Book Agency (P) Ltd. Kolkata, India.
2. Karp, G. (1999) Cells and Molecular Biology concepts and Experiments; Hohn Wiley & Sons Inc. USA.
3. S. Sadasivam and A. Manickam (1991) New Age International Publisher.
4. Verma, Agarwal, (2005) Cell Biology, Genetics, Molecular Biology, Evolution and Ecology: S.Chand and Company, New Delhi, India.
5. Cooke, T. (1958) Flora of Presidency of Bombay Vol.I-II, Botanical Survey of India, Calcutta, India.
6. Hooker, J.D.(1872-1897) Flora of British India, Vol. I-VII, Reeves & Co., London.
7. Kamble, S.Y. and S.G. Pradhan (1988) Flora of Akola District, Maharashtra, Botanical Survey of India, Calcutta, India.
8. Kshirsagar, S.R. and D.A.Patil (2008) Flora of Jalgaon District, Maharashtra, Bishen Singh Mahendra Pal Singh, Dehra Dun, India.
9. Kulkarni, B.G. (1988) Flora of Sindhudurg, Botanical Survey of India, Calcutta, India.
10. Lakshminarasimhan, P.& B.D. Sharma (1991) Flora of Nashik District, Botanical Survey of India, Calcutta, India.
11. Naik, V.N. (1999) Flora of Marathwada, Vol. I-II, Amrut Prakashan, Station Road, Aurangabad, India.
12. Patil, D.A. (2003) Flora of Dhule and Nandurbar District (Maharashtra). Bishen Singh Mahendra Pal Singh, Dehra Dun, India.
13. Shah, G.L. (1978) Flora of Gujarat State, Vol. 1-2, Vallabh Vidyanagar, Gujarat, India.

**Note:**

1. Excursion tour is compulsory to observe algae, fungi and bryophytes in nature.
2. Tour report along with photographs must be submitted at the time of practical examination.
3. Duly certified journals are compulsory at the time of practical examination.

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<b>DSE-5 Major (Core) Course [Lectures: 60][4T]</b> <b>BO-416 (A) Plant Biotechnology /</b> <b>BO-416 (B) Seed Processing Technology /</b> <b>BO-416 (C) Fermentation Technology /</b>		
<b>BO-416 (A) Plant Biotechnology</b>		
<b>Course Objectives:</b> <ol style="list-style-type: none"> <li>1. Imbibe the basic knowledge of different aspects of Biotechnology and tissue culture.</li> <li>2. Understand the knowledge of methods in biotechnology.</li> <li>3. Understand the knowledge of advanced techniques in Biotechnology biology used in study of plants.</li> </ol>		
<b>Course outcomes:</b> <ol style="list-style-type: none"> <li>1. The students will be able to understand the use of biotechnology in botany.</li> <li>2. The students will be able to understand the various branches of biotechnology in plant science.</li> <li>3. The students will be able to know the recent biotechnology in study of plants.</li> <li>4. The students will be able to know of application of genes, proteins and secondary metabolites in plant science.</li> </ol>		
<b>Unit 1</b>	<b>Biotechnology</b> Basic concept and brief introduction of biotechnology, History, Scope and Importance, Commercial application of biotechnology. <b>Introduction to tissue culture</b> Principle of plant tissue culture, Tissue culture laboratory, Equipment's in Tissue culture laboratory, Preparation of Media, Media composition, Cellular totipotency Plant Growth Regulators and their Role, Different type of media, Different types of explants of, Sterilization, Different methods of sterilization -Heat, Radiation and chemical.	<b>10</b>
<b>Unit 2</b>	<b>Cell and organ culture</b> Plant organ culture; shoot tip, shoot apical meristem, root, leaf, embryo culture, factors influencing embryogenesis, suspension culture in stationary and stirred tank reactors, isolation of single cells and their culture, measurement of growth.	<b>10</b>
<b>Unit 3</b>	<b>Fermentation biotechnology and biomass production</b> History of fermentation, Methods of sterilizations, Principles of microbial growth, Alcohol fermentation, Citric acid fermentation, Antibiotic (Penicillin) fermentation, Introduction to biomass, Concept of SCP, its need and application, Mass culture of algae for protein.	<b>10</b>

<b>Unit 4</b>	<b>RECOMBINANT DNA TECHNOLOGY</b> Gene cloning, Vectors, Role of Agrobacterium, Gene cloning techniques – Gene gun, Electroporation, Microinjection, Liposome mediated gene transfer, Ultra sonication and Pollen Mediated gene transfer	<b>10</b>
<b>Unit 5</b>	<b>TRANSGENIC PLANTS</b> Transgenic crops in India, Resistance against Abiotic and biotic stress, improved crops productivity, Nutraceutical improved crops, transgenic plants for edible vaccine and antibodies.	<b>10</b>
<b>Unit 6</b>	<b>APPLICATIONS OF PLANT TISSUE CULTURE</b> Applications in agriculture and horticulture, Applications in forestry. Applications of tissue culture in pharmaceuticals industry, In situ and ex-situ conservation. In vitro mutagenesis and its application. Production of transgenic plants.	<b>10</b>
<p><b>Suggested readings:</b></p> <ol style="list-style-type: none"> <li>1. Henry, R.J. Practical application of plant molecular Biology, Champman and Hall</li> <li>2. Kalyan kumar De. Introduction to Plant Tissue culture,</li> <li>3. Bhojwani, Plant Tissue Culture.</li> <li>4. Montell S.H. Mathews, J.A., Meker, R.A. Principles of Plant Biotechnology.</li> <li>5. Glover, D.M. and Hanes, B.D. (eds.) 1995. DNA cloning 1: A practical approach, core techniques, 2nd edition, PAS, IRL press at Oxford University Press.</li> <li>6. Plant cell culture protocols. Humana Press, Inc. New Jersey, USA.</li> <li>7. Shaw, C.H. (ed.) 1998, Plant Molecular Biology. A practical approach IRI Press, Oxford.</li> <li>8. Smith, R.H. 2000. Plant Tissue culture: Techniques and Experiments. Academic Press, New York.</li> <li>9. Susan R. Barnum (1998). Biotechnology: an introduction. Thomson Brooks/cole.</li> <li>10. George Acquaah (2005). Understanding biotechnology. Pearson.</li> <li>11. Biotechnology; P.K. Gupta</li> <li>12. B. D. Singh (2006) Plant Biotechnology, Kalyani Publishers</li> </ol>		



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**DSE-5 Major (Core) Course [Lectures: 60][4T]**  
**BO-416 (B) Seed Processing Technology**

**Course Objectives:**

1. Student will gain expertise in the field of seed science & technology.
2. To impart knowledge on the principles and techniques of seed processing for quality up gradation and of storage for maintenance of seed quality.

**Course outcomes:**

1. Students will be able to believe the role of good quality seed in agriculture.
2. Students will be able to grasp the significance of basic principles of seed production in crop plants.
3. Students will be able to build private seed farms.
4. Students will be able to impart knowledge about various tools involved in hybrid seed production of crop plants.

<b>Unit 1</b>	<b>Introduction:</b> Principles of seed processing; methods of seed drying including dehumidification and its impact on seed quality. Relative humidity and equilibrium moisture content of seed; Thumb rules of seed storage; loss of viability in important agricultural and horticultural crops, viability equations and application of monograph.	<b>12</b>
<b>Unit 2</b>	<b>Seed cleaning equipment and their functions:</b> Preparing seed for processing; functions of scalper debearder, scarifier, huller, seed cleaner and grader. Screen cleaners, specific gravity separator, indented cylinder, velvet-spiral-disc separators, colour sorter, delinting machines; seed blending.	<b>12</b>
<b>Unit 3</b>	Assembly line of processing and storage, receiving, elevating and conveying equipments, plant design and layout, requirements and economic feasibility of seed processing plant.	<b>12</b>
<b>Unit 4</b>	Seed treatments-methods of seed treatment, seed treating formulations and equipment, seed dis-infestations, identification of treated seeds; Packaging: principles, practices and materials; bagging and labeling. Seed storage: Seed drying and storage; drying methods-importance and factors affecting it, changes during storage, concepts and significance of moisture equilibrium, methods of maintaining safe seed moisture content. Methods to minimize the loss of seed vigour and viability; factors influencing storage losses. Storage methods and godown sanitation. Storage structures. Storage problems of recalcitrant seeds and their conservation.	<b>12</b>

<b>Unit 5</b>	Concept of seed ageing and deterioration, its causes, symptoms, mechanisms and related theories; different changes associated with the loss of vigour and viability during storage; application of physiological and biochemical techniques for evaluation of seed ageing; genetics of seed viability; effect of seed ageing on crop performance; maintenance of viability and vigour during storage; seed amelioration techniques, mid storage corrections etc.	<b>12</b>
<p><b>Suggested readings:</b></p> <ol style="list-style-type: none"> <li>1. Arora, S.K. Hariyana Men Subjion ki Utpadan Prodhyokiki. Scientific Pub. India. B.P.</li> <li>2. Ghildyal and R.P. Gupta, 2002. Soil Structure: problems and Management, ICAR, New Delhi.</li> <li>3. Bassett, M.J. (1986) Breeding vegetable crops. AVI Publishing Comp.</li> <li>4. Dennis R. Decoteau (2000) Vegetable Crops. Prentice Hall.</li> <li>5. Desai BB, Katecha, PM &amp; Salunke DK.1997. Seed Hand Book: Biology, Production, Processing and Storage.</li> <li>6. Marcel Dekker. Desai BB. 2004. Seeds Handbook. Marcel Dekker.</li> <li>7. George RAT. 1980. Vegetable Seed Technology. A Technical Guide to Vegetable Seed Production, Processing, Storage and Quality Control. FAO, Rome.</li> <li>8. Harihar Ram. (1997). Vegetable Breeding; Principles and Practices.</li> <li>9. Jagminder Hartman HT &amp; Kester DE. 2000. Plant Propagation: Principles and Practices.</li> <li>10. Prentice Hall. Inns, N.L. (1983). Breeding field vegetables, Asian vegetable Research and Development Centre.</li> <li>11. Tainan...Taiwan ISTA (1983). Seed Technology in the tropic. The International Seed Testing Association, reprinted by Scientific Publishers, India</li> <li>12. Kelly AF &amp; George RAT. (Eds.).1998. Encyclopedia of Seed Production of World Crops. John Wiley &amp; Sons.</li> <li>13. Jeswani, L.M. and Baldev, B. (1997). Advances in pulse production technology, ICAR, New Delhi.</li> <li>14. McDonald MB Jr &amp; Copeland LO. 1997. Seed Production of Crops: Principles and Practices. Chapman &amp; Hall.</li> <li>15. Miller, B. McDonald and Lawrence O. Copeland, (1998). Seed Production: Principles and Practices. CBS publishers and distributors, 11 Darya Ganj, New Delhi.</li> <li>16. Mini, C. and Krishnakumary, K. (2004). Leaf Vegetables: Agrotech Publishing Academy, Sector-5, Hiran magri, Udaipur.</li> <li>17. Prem Singh Arya, (2000) Off-Season Vegetable Growing In Hills. A.P.H. Publishing Corporation, 5-Ansari Road, Daryaganj, New Delhi.</li> <li>18. Salunkhe DK, Desai BB &amp; Bhat RN. 1987. Vegetable and Flower Seed Production. Agricole Publ. Academy.</li> <li>19. Singh SP. 2001. Seed Production of Commercial Vegetables. Agrotech.</li> <li>20. Suman Bhati and Uma Verma (1997). Fruits and vegetable processing. CBS. Publ. Book Agency. New Delhi Work.</li> <li>21. Paul (1997). Vegetable production and marketing. Daya Publ. House, Devram.</li> </ol>		

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**DSE-5 Major (Core) Course [Lectures: 60][4T]**  
**BO-416 (C) Fermentation Technology**

**Course Objectives:**

After completion of this course, student will be able to understand

1. The aim of fermentation technology course is to know current bio-resources and their exploitations on the production of microbial products.
2. The main objective of this course is to train students practically in basic principles of food and industrial microbiology.
3. Design of various reactors used in Industries.
4. Criteria for selection of media for microbial growth and Methods for strain improvement and preservation of cultures.
5. Upstream as well as downstream processing involved in fermentation industries
6. The content of the precise course include nature of the bio-resources, industrially important microorganisms, up and down stream process, functions of the fomenters, primary and secondary metabolites and production of recombinant products.

**Course outcomes:**

After completion of this course the student can able to

1. Understand the basics of microbial metabolites in industry and its economic importance.
2. Apply the knowledge of molecular biology and microbial genetics to develop industrially important microorganism.
3. The course will also provide meticulous ideas on different types of fermentors and their functions.
4. Use the most common equipment, materials and methods related to fermentation processes, microbial growth and cultivation and sterilization.

<b>Unit 1</b>	<b>Introduction to Fermentation Technology:</b> History, Scope and Development of Fermentation technology, Introduction to fermentation processes, industrially important microorganisms-Isolation, screening, and preservation of industrially important microorganisms.	<b>15</b>
<b>Unit 2</b>	<b>Fermentation raw materials:</b> Media for industrial fermentation, Criteria used in media formulation, sterilization, raw materials and process control. Downstream processing- Separation processes and recovery methods for fermentation products.	<b>15</b>
<b>Unit 3</b>	<b>Strain Improvement:</b> Natural selection, mutation and screening of improved cultures, random and strategic screening methods, Use of recombinant DNA technology, protoplast fusion etc. Principles of overproduction of primary and secondary metabolites with relevant examples.	<b>15</b>
<b>Unit 4</b>	<b>Fermentor design:</b> Basic designs of Fermentor; Type of fermentors: Waldhof, Tower, Deepjet, Cyclone column, Packed tower and airlift fermenter; Scale up study and Product development; Down-stream processing and Product recovery; Regulation and safety.	<b>15</b>

**Suggested readings:**

1. Stanbury, P.F., Hall, S., Whitaker, A. (1998), Principles of Fermentation Technology, 2nd edn. Butterworth-Heinemann Ltd.
2. Ward O.P., (1999), Fermentation Biotechnology – Principles, Process and Products. Prentice Hall Publishing, New Jersey.
3. Rehm, H.J., Reed, G.B., Puehler, A. and Stadler (1993), Biotechnology, Vol. 1-8, VCH Publication.
4. Prescott, S.C. and Dunn, G.C (1992), Industrial Microbiology, 4th Edition CBS Publication, New Delhi.
5. Demain, A. I. and Davies, J. E. (1999) Manual of Industrial Microbiology and Biotechnology, 2nd Edition, ASM Press, Washington D.C.
6. Glazer and Nikaido (1998) Microbial Biotechnology By WH Freeman & Company, New York.
7. Crueger, W. and Kruger. (2002), Biotechnology – A Textbook of Industrial Microbiology, 2nd Edition, Panima Publishing Corporation, New Delhi.
8. Mansi, E.I., Bryce, T and Francis, (1999). Fermentation Microbiology and Biotechnology. London, Philadelphia.
9. Crueger, W., and Crueger, A., (2000). Biotechnology: A Text Book of Industrial Microbiology, Panima Publishing Corporation, New Delhi/Bangalore.
10. Okafer, N., (2007). Modern Industrial Microbiology & Biotechnology. Scientific Publishers, Enfield, USA.

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**RM-417 Research Methodology [Lectures: 60] [4T]**

**Course Objectives:**

- To make the students familiar with the,
1. To learn the basics of science, scientific research its importance.
  2. To learn the Ethics and plagiarism precautions to be taken while doing research.
  3. To understand the detailed referencing and literature review procedure before beginning the research.
  4. To understand the process of writing research papers, research project report and research proposal.
  5. To learn various advanced tools useful for the science and aware about the laboratory safety

**Course outcomes:**

- On completion of this course, the students will be able to:
1. Students will understand the basic concept of science and scientific research.
  2. Learn and follow the ethical guidelines while doing research avoid plagiarism in research publications.
  3. Able to write a comprehensive literature review on a given research topic.
  4. To able to write a crisp research proposal or research project independently.
  5. To learn most advanced chemistry tools for the efficient research work.
  6. Acquire knowledge about various hazardous chemical handling procedures and implement it while working in the laboratory.

Unit	Course Contents (Topics and subtopics)	Lectures
<b>Unit 1</b>	<p><b>Science and Scientific Research</b>                      What is Science? Characteristics of Science, Technology and techno-science, Meaning of Research, Characteristics and types of research, Importance of research activities, Principles of quality research work, Problems in research, Scientific attitude and temper, Qualities of good researcher, Scientific community, Non-science and Pseudoscience, Scientific realism.</p>	<b>12</b>
	Ref. 1: 1-24 and 49-54; Ref. 2: 1-71; Ref. 3: 1-21.	
<b>Unit 2</b>	<p><b>Design and Criteria of Scientific Research</b>                      Introduction, Research planning and design, Selection of research topic, Criteria for good research problem, Source of research Idea, Principles of good research, Criteria of good research, Guidelines for research skill and awareness, Research validity and reliability, Artefact and bias in research.  <b>Scientific methodology:</b> Rules and principles of scientific methods, Research methods versus methodology, Hypothesis and testing of hypothesis.  <b>Research ethics:</b> Principles and values.  <b>Plagiarism:</b> its types and how to avoid it.</p>	<b>12</b>

	Ref. 1: Pages: 1-24, 55-92 and 233-262; Ref. 3: 24-52.	
<b>Unit 3</b>	<p><b>Literature Survey:</b> Literature review, Approaching the literature, Scholarly literature, Data provenance and evaluation, Intellectual property.</p> <p><b>Sources of information:</b> Primary, Secondary, Tertiary sources, Patents, Journals (Print and e-journal), Type of Journals, Conference Proceedings. Journal Impact Factor, Citation index, h-index.</p> <p><b>Understanding of literature:</b> Reading A Scientific Paper, Abstracts, Current titles, Reviews, Monographs, Books, Current contents, Cross referencing, Indian patent database.</p> <p><b>Tools for Digital Literature Survey:</b> Scientific databases, e-journals, INFLIBNET, Shodsindhu, Shodhganga, Google/Google Scholar, ResearchGate, PubMed, finding and citing Information.</p>	<b>10</b>
	Ref. 1: 148-180; Ref. 4: 299-317; Ref. 5: 1569-1603	
<b>Unit 4</b>	<p><b>Scientific Writing:</b> Introduction to scientific writing, writing science laboratory Notebook.</p> <p><b>Writing Research Paper:</b> Title, Abstracts, Keywords, Introduction, Material and Methods, Results and discussion, Conclusion, Acknowledgement, References and Supplementary data. Difference between research communication and Review article, Reply to Referee comments for science research paper. Preparation of Poster and Oral Presentation.</p> <p><b>Writing Proposals:</b> Research grant and its various components</p>	<b>12</b>
	Ref. 1: 180-229; Ref. 6: 29-43; Ref. 7: Relevant Pages	
<b>Unit 5</b>	<p><b>Advanced Scientific Tools and Laboratory Safety</b></p> <p>A) <b>Advanced Tools:</b> Tools for citing and referencing: Mendeley, Zotero, Endnote etc. Styles of referencing: Referencing from reputed publishing houses National and International. Online searching Databases: Sci Finder, Scopus, Web of Science, ACM Digital Library, Pro Quest Biological Sciences (All the databases only introduction).</p> <p>B) <b>Laboratory Safety:</b> Laboratory safety, Laboratory manual, Lab as a safe place: habits, Cause of accidents and What to do in case of an accident, Personal protective equipment, Emergency equipment for general purpose. Laboratory ventilation.</p> <p>C) <b>Introduction to Intellectual Property:</b> Introduction, Role of IP in the economic and cultural development of the Society, IP Governance, IP as a Global Indicator of Innovation, Origin of IP, History of IP in India (Introduction: Patents, Copyrights and Related Rights, Trademarks, Geographical Indications, Trade Secrets, Semiconductor Integrated Circuits and Designation, Plant Varieties, Traditional Knowledge, Industrial Designs, Biodiversity Conservation). Categories of Intellectual Property, Conditions for Obtaining a Patent Protection</p>	<b>12</b>
	Ref. 8, and 9: Relevant Pages, Ref. 10: 1-44 and Relevant Pages Ref. 11 onwards: Relevant Pages and Links	

### **Suggested readings:**

1. New Delhi – 110002, (2019).
2. Research Methodology: The Aims, Practices and Ethics of Science, Peter Pruzan, Springer International Publishing (2016).
3. Research Methodology: Methods and Techniques, 3rd edition, Kothari, C.R. Published by New Age International (P) Ltd., Publishers (2004).
4. Teaching to Avoid Plagiarism How To Promote Good Source, Diane Pecorari, Use-Open University Press (2013).
5. APPENDIX A: The Literature of Organic Chemistry March's Advanced Organic Chemistry: Reactions, Mechanisms, and Structure, Seventh Edition, by Michael B. Smith and Jerry March Copyright John Wiley & Sons, Inc. (2013).
6. Joaquín Isac-García, José A. Dobado, Francisco G. Calvo-Flores, Henar Martínez-García - Experimental Organic Chemistry laboratory manual, Academic Press (2016)
7. A Practical Guide to Scientific Writing in Chemistry Scientific Papers, Research Grants and Book Proposals Tyowua, A. T., CRC Press is an imprint of Taylor & Francis Group, LLC (2023).
8. Chemical Information for Chemists: A Primer, edited by Currano, J. N., Roth, D. L. Publisher The Royal Society of Chemistry (2014).
9. Handbook of Safety in Science Laboratories Education Bureau Kowloon Tong Education Services Centre, Hong Kong (2013).
10. Intellectual Property A Primer for Academia, Tewari, R., Bhardwaj, M. Publication Bureau, Panjab University, Chandigarh, © Panjab University, Chandigarh, ISBN: 81-85322-92-9, (2021).
11. A Manual for Referencing Styles in Research, M. H. Alvi (2016)
12. <https://academic.oup.com/pages/authoring/books/preparing-your-manuscript/referencing-styles>
13. <https://revvitysignals.com/products/research/chemdraw>
14. LaTeX Beginner's Guide, Stefan Kottwitz, Packt Publishing, [http://static.latexstudio.net/wpcontent/uploads/2015/03/LaTeX\\_Beginners\\_Guide.pdf](http://static.latexstudio.net/wpcontent/uploads/2015/03/LaTeX_Beginners_Guide.pdf)
15. Falagas, M.E., Pitsouni, E.I., Malietzis, G.A. and Pappas, G. (2008), Comparison of PubMed, Scopus, Web of Science, and Google Scholar: strengths and weaknesses. The FASEB Journal, 22: 338-342. <https://doi.org/10.1096/fj.07-9492LSF>
16. Plagiarism, Citation and Referencing: Issues and Styles, A Manual for Referencing Styles in Research, Mohsin Hassan Alvi, DOI: 10.13140/RG.2.1.5149.6408 <http://bit.ly/46nFwYi>
17. Citation tools: Easing up the researchers' efforts, Dhiraj Kumar, Gyankosh: The Journal of Lib. & Info. Management Vol 4 No. 2 Jul-Dec, 2013
18. Citation Management: How to use citation managers such as End Note and Zotero. URL: <https://guides.lib.uchicago.edu/citationmanagement/>
19. <https://pubs.acs.org/doi/full/10.1021/acsguide.40303>
20. <https://edu.rsc.org/resources/how-to-reference-using-the-rsc-style/1664.article>
21. <https://www.springer.com/gp/authors-editors/journal-author/journal-authorhelpdesk/preparation/1276>
22. [https://service.elsevier.com/app/answers/detail/a\\_id/28224/supporthub/publishing/](https://service.elsevier.com/app/answers/detail/a_id/28224/supporthub/publishing/)
23. End Note: A comprehensive guide to the reference management software EndNote. URL: <https://aut.ac.nz.libguides.com/endnote>
24. Zotero: Learn how to use the reference management software Zotero. URL: <https://aut.ac.nz.libguides.com/zotero>
25. Mendeley: Learn how to use the reference management programme Mendeley. URL: <https://aut.ac.nz.libguides.com/mendeley>
26. Grammarly User Guide, <https://bpbapse2.wpmucdn.com/blogs.auckland.ac.nz/dist/3/316/files/2020/02/Grammarly-Manual-Feb-2020-1.pdf>

27. Online Resources: Publishers, Chemical Societies, Electronic Journals etc.: <https://www-jmg.ch.cam.ac.uk/data/c2k/cj/>
28. <https://scholar.google.com/>
29. <https://shodhganga.inflibnet.ac.in/>
30. <https://patents.google.com/>
31. <https://ipindia.gov.in/history-of-indian-patent-system.htm>
32. <https://www.cas.org/about-us>  
<https://clarivate.com/products/scientific-and-academic-research/researchdiscovery-and-workflow-solutions/webofscience-platform/>  
<https://www.mendeley.com/guides>



**Kavayitri Bahinabai Chaudhari North Maharashtra University, Jalgaon**  
**MSc. Botany Part - I: Semester -I & II**

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**Programme at a Glance**

**Syllabus for M. Sc. Botany**

**Board of Studies in Botany**

**Program at a Glance**

Name of the program (Degree)	: M. Sc. Botany
Faculty	: Science and Technology
Duration of the Program	: Two years (four semesters)
Medium of Instruction and Examination	: English
Exam Pattern	: 60: 40 (60 marks University exam and 40 marks continuous internal assessment)
Passing standards	: 40% in each exam separately (Separate head of passing)
Evaluation mode	: NEP 2020
Credits of the program	88

**Semester – II<sup>nd</sup>**

DSC-30 [4T]	BO-421	Plant Systematics- II (Pteridophytes, Gymnosperms and Paleobotany)	60 L
DSC-31 [ 2T]	BO-422	Genetics	30 L
DSC-32 [4T]	BO-423	Plant Physiology	60 L
DSC-33 [2P]	BO-424	Practical based on DSC-30	30 L
DSC-34 [2P]	BO-425	Practical based on DSC-31 & 32	30 L
DSE-6 [4T]	BO-426 (A) BO-426 (B) BO-426 (C)	Techniques in Plant Science Plant Ecology and Phytogeography Agricultural Botany	60 L
OJT [4T]	BO-427	On Job Training	60 L

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**M. Sc. Botany Part - I: Semester - II**

<b>DSC- 30 Major (Core) Course [Lectures: 60] [4T]</b> <b>BO-421 Plant Systematics- I</b> <b>(Pteridophytes, Gymnosperms and Paleobotany)</b>		
<b>Course Objectives:</b> <ol style="list-style-type: none"> <li>1. Describe habit and habitat of pteridophytes, their characteristics and classification.</li> <li>2. Relate telome theory with the origin of higher pteridophytes from the lower Pteridophytes and Gymnosperms.</li> <li>3. Describe stelar variation and evolution of stele in pteridophytes.</li> <li>4. Understand the phenomenon of heterospory in Pteridophytes and its significance.</li> <li>5. Explain life-cycle in Pteridophytes and Gymnosperms.</li> </ol>		
<b>Course outcomes:</b> <ol style="list-style-type: none"> <li>1. The students develop the basic understanding of important characteristics, anatomy, reproduction and evolution along with economic importance of these groups.</li> </ol>		
<b>Unit 1</b>	<b>Introduction of Pteridophytes</b> A) General characteristics, Habitat, Reproduction (Vegetative & Asexual), Sporophyte, Gametophyte (Sexual reproductive phase), Fertilization & Zygote formation, Embryo development, Life cycles (Homosporous & Heterosporous), Apogamy & Apospory B) Classification of Pteridophytes Classification of Pteridophytes up to orders proposed by Reimers (1954) C) Economic Importance D) Soral Evolution <b>Gymnosperms</b> E) Introduction, General Characters, Distinguishing features of Gymnosperms. F) Outline system of classification of Gymnosperms by Sporne (1965) G) Economic importance	<b>09</b>
<b>Unit 2</b>	<b>Distinguishing features, morphology, anatomy, reproduction, phylogeny, evolutionary tendencies and affinities of following orders:</b> i) Lycopodiales ii) Isoetales iii) Ophioglossales iv) Osmundales v) Filicales (at least 2 families)	<b>15</b>
<b>Unit 3</b>	<b>General characters, morphology, anatomy, sporogenesis, gametogenesis, embryology, affinities, evolutionary trends and phylogeny of following orders.</b>	<b>12</b>

	i) Ginkgoles ii) Coniferales iii) Gnetales (Except <i>Gnetum</i> )	
<b>Unit 4</b>	<b>Paleobotany</b> A) Introduction, Scope and importance B) Applied aspect of Paleobotany C) Techniques for fossil study, Ground thin section, Peel method, Maceration, Indian fossil flora from Upper and Lower Gondwana	<b>12</b>
<b>Unit 5</b>	<b>Study of distinctive fossil genera along with their external, internal features of following orders</b> i) <b>Psilophytales:</b> <i>Rhynia</i> , ii) <b>Lepidodendrales:</b> <i>Lepidodendron</i> (complete reconstruction), iii) <b>Calamitales:</b> <i>Calamites</i> , <i>Annularia</i> , <i>Calamostachys</i> , <i>Paleostachya</i> iv) <b>Sphenophyllales:</b> <i>Sphenophyllum</i> , v) <b>Hydropteridinea:</b> <i>Rodeitesdakshinii</i> vi) <b>Pteridospermales:</b> <i>Lyginopteris oldhamia</i> (Stem), <i>I Glossopteris</i> , <i>Vertebraria</i> , <i>Scutum</i> vii) <b>Bennettitales:</b> <i>Williamsonia sewardiana</i> , <i>W. spectabilis</i> viii) <b>Pentoxylales:</b> <i>Pentoxylon sahnii</i> (reconstruction) ix) <b>Cordaitales:</b> <i>Cordaites</i> (Stem) x) <b>Fossil Angiosperms: Monocot:</b> <i>Palmoxyton</i> , <i>Cyclanthodendron</i> , <i>Tricocites</i> xi) <b>Fossils of Dicot:</b> <i>Sahnipushpam</i> , <i>Sahnianthus</i> , <i>Enigmocarpon</i>	<b>12</b>
<b>Suggested readings:</b> <ol style="list-style-type: none"> <li>1. Andrews, H.N. (1961) Studies in Paleobotany, New York, London.</li> <li>2. Arnold, C.A. (1947) An Introduction to Paleobotany McGraw Hill Co., New York, USA.</li> <li>3. Banks, H.P. (1970) Evolution and plants of the PasT. McMillan Press Ltd. London, U.K.</li> <li>4. Bierhorst, D.W. (1971) Morphology of vascular plants Mcmillan Co. New York</li> <li>5. Bhatnagar, S. P. and Alok Moitra (1996) Gymnosperms, New Age International (P)Limited, Publishers, New Delhi.</li> <li>6. Chamberlain, C.J. (1935) Gymnosperms: Structure And Evolution. Dover publ. INC., New York,</li> <li>7. Eames, A.J. (1974) Morphology of vascular plants Mc. Grow Hill Publication Co. New Delhi.</li> <li>8. Foster, A.S. &amp; Gifford E.M. (1959) Comparative morphology of vascular plants San Francisco.</li> <li>9. Ganguli, H.C. and Kar A. K. (2001) College Botany Vol. II Book and allied Press. Ltd. Calcutta, India.</li> <li>10. Ganguly &amp; Kar (2011) College Botany Vol-II New Central Book Agency Pvt. Ltd. 4<sup>th</sup> edition.</li> <li>11. John Waltan (1953) Introduction to Study of fossil Plants. Adam and Charles Block, London, UK.</li> <li>12. Maheshwari, P and R.R. Konar (1971) Pinus CSIR New Delhi, India.</li> </ol>		

13. Pande B. P. (1994) Gymnosperms S. Hand and Co. New Delhi, India.
14. Pandey B.P. (2010) College Botany Vol-2: v. IIS. Chand & Company, 2nd edition
15. Parihar N.S. (1977) Biology & Morphology of Pteridophytes Centralbook Depot. Allahabad.
16. Parihar N.S. (2019) An Introduction to Embryophyta, Pteridophytes, Surjeetpublication 5th edition.
17. Pant D. D. (1973) Cycas and the Cycadales Central Book Depot, Allahabad, India.
18. Rashid A. (1999) An Introduction to Pteridophyta, South Asia Books, II edition.
19. Saxena and Sarabhai, R. M. (1972) Text Book of Botany, Vol. II,
20. Sharma O.P. (2017) Pteridophyta Mc. Grow Hill Education.
21. Seward, A.C. (1969) Fossil Plants Vol. I to IV, Hafner Publ. Co. New York, USA.
22. Shukla, A. C. and S.P. Misra (1982) Essentials of Palaeobotany Vikas Publishing House Pvt. Ltd. Delhi, India.
23. Siddiqui, K.A. (2002) Elements of Paleobotany Kitab Mahal, Allahabad
24. Sporne K.R. (1966) Morphology of Pteridophyta Hutchinson Univ. Library London.
25. Sporne K.R. (1967) Morphology of Gymnosperms Hutchinson Univ. Library, London, UK.
26. Surange K.R. (1966) Indian Fossil Pteridophytes CSIR, New Delhi, India.
27. Vasishtha, P. C. (1983) Botany for Degree Students Vol V Gymnosperms S. Chand & Co. New Delhi, India.
28. Vashishta P.C., Sinha A.K., Anil Kumar (2010) Pteridophyta, S Chand and Company  
Wilson N. Stewart and Gar W. Rothwell (1993) Paleobotany and Evolution of Plants-II. Cambridge Univ. Press. Cambridge.

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**M. Sc. Botany Part - I: Semester - II**

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**DSC- 31 Major (Core) Course [Lectures: 30] [2T]**  
**BO-422 Genetics**

**Course Objectives:**

1. To build knowledge on the fundamentals of genetics, heredity, or inheritance.
2. To present selected challenges and issues currently facing genetics research and communities.
3. To use the principles of chromosome transmission to predict patterns of inheritance.
4. To understand how the structure of DNA enables it to function as genetic material and explain the relationship between genotype and phenotype.
5. To understand extrachromosomal involvement in heredity
6. To understand chromosomes and their role in microbes and higher organisms.

**Course outcomes:**

1. Learn about the development of genetics historically and how a fully formed idea of genetics was introduced.
2. Study the inheritance laws that apply to higher and microbial organisms.
3. Learn about the different gene interactions and their effects.
4. Become familiar with the basics of extrachromosomal inheritance.
5. Inform experts about the concepts, theories, issues, and research findings related to the genetics framework's questions.

<b>Unit 1</b>	<p><b>Introduction:</b> Principles of Genetic sand History of Genetics</p> <p><b>Mendelian principles:</b> Dominance, independent assortment, segregation.</p> <p><b>Extensions of Mendelian principles:</b> Codominance, incomplete dominance, gene interactions, pleiotropy, genomic imprinting, penetrance and expressivity, phenocopy, linkage and crossing over, sex linkage, sex-limited, and sex-influenced characters.</p> <p><b>Concept of a gene:</b> Pseudo allele, Allele, multiple alleles, complementation tests.</p>	<b>6</b>
<b>Unit 2</b>	<p><b>Cytogenetics:</b> Physical Basis of Inheritance, Special types of Chromosomes, Sex Linkage, Extra Chromosomal Inheritance, Chromosomal aberrations</p> <p><b>Mutation:</b> Types, causes, and detection, mutant types – lethal, conditional, biochemical, loss of function, the gain of function, germinal vs somatic mutants, insertional mutagenesis.</p>	<b>6</b>
<b>Unit 3</b>	<p><b>Structural and numerical alterations of chromosomes:</b> Deletion, duplication, ploidy, inversion, translocation, and their genetic implications.</p> <p><b>Gene mapping methods</b> Linkage maps, tetrad analysis, mapping with</p>	<b>6</b>

	molecular markers.	
<b>Unit 4</b>	<b>4.1 Microbial genetics:</b> Methods of genetic transfer transformation, mapping genes by interrupted mating, conjugation, transduction and sex-duction, fine structure analysis of genes.	<b>6</b>
<b>Unit 5</b>	<b>Extrachromosomal inheritance:</b> Inheritance of Mitochondrial and chloroplast genes, maternal inheritance. <b>Quantitative genetics:</b> Polygenic inheritance, heritability, and its measurements, QTL mapping. <b>Recombination:</b> Homologous and non-homologous recombination, including transposition.	<b>6</b>

**Suggested readings:**

- 1 Benjamin A. Pierce (2010) Genetics: A conceptual approach, Fourth edition, Publisher W H Freeman & Co.
- 2 Benjamin Lewin (2009) Genes– VI, VII, VIII and IX; Oxford, Univ. Press, USA.
- 3 D. Peter Snustad, Michael J. Simmons (2015). Principles of Genetics, 7th Edition. Publisher John Wiley & Sons.
- 4 De Robertis and De Robertis (2005) Cell and Molecular Biology, 8thEd, Lippincott William and Wilkins U.S.A.
- 5 Eldon John Gardner, Michel J. Simmons and D. Peter Snustad (1991) Principles of genetics 8<sup>th</sup> Ed. Wiley India edition, New Delhi, India.
- 6 Gerald Karp (2008). *Cell and Molecular biology: Concepts and experiments* (V Edn). John Wiley & Sons
- 7 Gupta, P. K. (2007) Genetics: Classical to Modern. Rastogi Publications, Meerut, India.
- 8 Hartl D L and Jones E W (1998) Genetics Principles and Analysis; (4thed.). Jones and Barflett Publishers, USA.
- 9 Harvey Lodish, Arnold Berk, Lawrence Zipursky, Paul Matsudaira, David Baltimore, James Darnell (2000). *Molecular cell biology* (IV Edn). W H Freeman & Company.
- 10 Hexter W and Yost Jr. H T., (1977) The Science of Genetics; Prentice Hall of IndiaPvt. Ltd., New Delhi, India.
- 11 Kar and Halder, (2009) Cell Biology Genetics Molecular Biology; New Central Book Agency (P) Ltd. Kolkata, India.
- 12 Karp, G. (1999) Cells and Molecular Biology concepts and Experiments; HohnWiley& Sons Inc. USA.
- 13 Phundan Singh, (1996) Essentials of Plant Breeding; Kalyani publication, New Delhi India.
- 14 Powar, C. B (2003) Genetics I & II Himalaya Publishing House, Nagpur, India.
- 15 Powar, C. B. (1992) Cell Biology, Himalaya Publishing House Nagpur, India.
- 16 Russel, P.J. (1998) Genetics (5th edition); The Benjamin/ Cummings Publishing Company Inc., USA.
- 17 Swanson, C. P. T. Merz, and W.J. Young (1982) Cytogenetics; Prentice Hall of India Pvt. Ltd., New Delhi, India.
- 18 Verma, Agarwal, (2005) Cell Biology, Genetics, Molecular Biology, Evolution and ecology: S. Chand and Company, New Delhi, India.

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<b>DSC- 32 Major (Core) Course [Lectures: 60] [4T]</b> <b>BO- 423 Plant Physiology</b>		
<b>Course Objectives:</b> The learner will		
<ol style="list-style-type: none"> <li>1. Understand the basics of plant physiology.</li> <li>2. Understand the metabolic processes essential in plants.</li> <li>3. Understand the implementation of knowledge in plant physiology in the field of research.</li> <li>4. Know the applications of plant physiology in sustaining agriculture and natural plant diversity.</li> </ol>		
<b>Course outcomes:</b> The learner should be able to		
<ol style="list-style-type: none"> <li>1. Understand and apply the knowledge of the basics of plant physiology.</li> <li>2. Understand the various branches of plant physiology.</li> <li>3. Know the recent trends in plant physiology.</li> <li>4. Know of application of plant metabolism regulators in agriculture and allied fields.</li> </ol>		
<b>Unit 1</b>	<b>Introduction</b> Introduction, Scope and Importance of Plant Physiology Introduction to Biological Oxidation and Reduction a) Oxidation and Reduction b) Redox reactions in Biological system c) Oxidation- reduction potential and its measurement d) Biologically important Redox Systems	<b>12</b>
<b>Unit 2</b>	<b>Photosynthesis</b> Introduction and Definition Photosynthetic Pigments and their role, photosynthesis apparatus Mechanism of photosynthesis a) Light Reaction- Two pigment system, Red-Drop and Emerson Effect b) Dark Reaction- Calvin Cycle, CAM Pathway c) HSK Pathway d) Chemosynthesis	<b>12</b>
<b>Unit 3</b>	<b>UNIT. 3 Respiration</b> Introduction and Definition Mechanism of Respiration a) Glycolysis b) Kreb's Cycle c) Cyanide resistant pathway	<b>12</b>

<b>Unit 4</b>	<b>Fat Metabolism</b> Introduction a) Synthesis of fatty acids and glycerol b) Condensation of fatty acids and glycerol c) $\alpha$ - and $\beta$ oxidation d) Glyoxylate cycle (C 2 Cycle)	<b>12</b>
<b>Unit 5</b>	<b>Dormancy and Seed Germination and Stress Physiology</b> Dormancy- Introduction a) Causes of seed dormancy b) Mechanism of seed dormancy c) Methods of breaking of seed dormancy Stress- Introduction a) Water stress- Water, Cold and Salt stress b) Temperature stress- High and Low	<b>12</b>

**Suggested readings:**

1. Amarsingh (1977) Practical Plant Physiology. Kalyani Publishers, New Dehli, India.
2. Anand, B. K. & S. K. Manchanda (1976) Text Book of Physiology. Tata McGraw Hill Publications Co. Ltd, Dehli, India.
3. Arditt, J. (1969) Experimental Plant Physiology, Holt Rinehart & Winston Inc, New York.
4. Bidwell, R. G. (1979) Plant Physiology. McMillan Publishing Co. Inc. New York.
5. Bonner, J. and J. E. Varner (Eds.) (1976) Plant Biochemistry 3rd Eds. Academic Press London, UK.
6. Buchanan B. B., Gruissem W. and Jones R. L. (2000), Biochemistry and Molecular Biology of Plants, American Society of Plant Physiologists, Maryland, USA.
7. Con, E. F. and P. F. Stumpf (1976) Outlines of Biochemistry Wiley Eastern Ltd., New Dehli, India.
8. De. Robertis, E. D. P. and De Robertis, E. M. T. (1987) Cell and Molecular Biology. VIII Eds. Lea & Febiger International Edition Info -Med. Hongkong.
9. Deb, A. C. (2004) Viva & Practical Biochemistry. New Central Book Agency, Kolkata, India.
10. Delvin, R. M. and F. H Whittam (1986) Plant Physiology IV eds. CBS Publishers & Distributors, New Delhi, India.
11. Grewal, R. C. (2000) Plant Physiology. Campus Books International, Darya Ganj, New Delhi, India.
12. Hess, D. (1975) Plant Physiology. Narosa Publishing House, New Delhi, India.
13. Hill, R. & C. P. Whittingham (1957) Photosynthesis. London, UK.
14. Hopkins, W. G. (1995) Introduction to Plant Physiology. John Wiley & Sons, New Jersey, USA.
15. Jain J. L., Sunjay Jain and Nitin Jain (2008), Fundamentals of Biochemistry, S. Chand & Co Ltd.
16. Keith Wilson, John M Walker and Andreas Hofmann; Samuel Clokie (2018) Wilson and Walkers principles and techniques of biochemistry and molecular biology Cambridge, United Kingdom ; New York, NY : Cambridge University Press.



17. Mehta, S. L. Lodha, M. L. and P.V. Sane (Eds.) (1989) Recent advances in Plant Biochemistry. Pub. ICAR, New Delhi, India.
18. Mukherji, S. and A. K. Ghosh (2005) Plant Physiology. New Central Book Agency Kolkata, India.
19. Nobel, P. S. (1999) Physio-chemical and Environmental Plant Physiology (II Eds.) Academic Press, Sandiago, USA.
20. Noggle, G. R. & G. J. Fritz (1982) Introductory Plant Physiology. Prentice Hall of India New Delhi, India.
21. Taiz, L., Zeiger, P. E. E., Mller, P. E. I. M., & Murphy, P. A. C.A. (2018). Fundamentals of plant physiology. Sinauer Associates.

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<b>DSC-33 Practical – I: [Lectures: 60] [2P]</b> <b>BO- 424 Based on DSC -30 BO-421: Plant Systematics - II</b> <b>(Pteridophytes, Gymnosperms and Paleobotany)</b>	
<b>Course Objective:</b> To Study the occurrence, diversity, structural organization and reproduction of pteridophytes and gymnosperms To learn the types of plant fossils with their age, type of fossilization, classification, structural organization.	
<b>Course Outcome:</b> Students acquaint the occurrence, diversity, structural organization and reproduction of pteridophytes and gymnosperms. Students understand types of plant fossils with their age, type of fossilization, classification, structural organization.	
<b>Practical 1</b>	Study of External Morphology and Anatomical features (double stained preparation) of the following (with the help of material/specimen/P.S.) <b>Class: Lycopsidea: <i>Lycopodium</i></b> (Eligulate)
<b>Practical 2</b>	Study of External Morphology and Anatomical features (double stained preparation) of the following (with the help of material/specimen/P.S.) <b>Class: Lycopsidea: <i>Isoetes</i></b> (Ligulate)
<b>Practical 3</b>	Study of External Morphology of reproductive structures of the following (with the help of material/specimen/P.S.) <b>Class: Pteropsida: <i>Ophioglossum</i></b>
<b>Practical 4</b>	Study of External Morphology of reproductive structures of the following (with the help of material/specimen/P.S.) <b>Class: Pteropsida: <i>Osmunda</i></b>
<b>Practical 5</b>	Study of External Morphology of reproductive structures of the following (with the help of material/specimen/P.S.) <b>Class: Pteropsida: i) <i>Gleichenia</i>, ii) <i>Lygodium</i>, iii) <i>Pteris</i>, iv) <i>Adiantum</i> (Any Two)</b>
<b>Practical 6-7</b>	Study of External Morphology, wood anatomical features (double stained preparation) by taking T.S., T.L.S. and R.L.S. of <b>any four</b> of the following: i) <i>Pinus</i> , ii) <i>Thuja</i> , iii) <i>Cedrus</i> , iv) <i>Cupressus</i> , v) <i>Araucaria</i> , vi) <i>Agathis</i> , vii) <i>Podocarpus</i> , viii) <i>Cryptomeria</i> , ix) <i>Juniperus</i>
<b>Practical 8</b>	Study of External Morphology of male and female cone of <b>any four</b> of the following with the help of material/specimen/P.S.  i) <i>Pinus</i> , ii) <i>Thuja</i> , iii) <i>Cedrus</i> , iv) <i>Cupressus</i> , v) <i>Araucaria</i> , vi) <i>Agathis</i> , vii) <i>Podocarpus</i> , viii) <i>Cryptomeria</i> , ix) <i>Juniperus</i>

<b>Practical 9</b>	Study of External Morphology, Anatomy (T.S.) and morphology of reproductive organs (male and female cone) of <i>Ephedra</i> (P.S. / specimen)
<b>Practical 10</b>	Study of External Morphology, Anatomy and morphology of reproductive organs of <i>Ginkgo</i> (P.S. or specimen)
<b>Practical 11</b>	Study of following fossils (P.S. or specimen) <i>Rhynia</i> , <i>Lepidodendron</i> Stem, <i>Lepidocarpon</i> <i>Calamites</i> Stem, <i>Annularia</i> , <i>Sphenophyllum</i> Stem
<b>Practical 12</b>	Study of following fossils (P.S. or specimen) <i>Lyginopteris oldhamia</i> stem, <i>Neuropteris</i> , <i>Glossopteris</i> , <i>Vertebraria</i>
<b>Practical 13</b>	Study of following fossils (P.S. or specimen) <i>Rodeites</i> , <i>Pentoxylon</i> stem, <i>Cordaites</i> stem
<b>Practical 14</b>	Study of following fossils (P.S. or specimen) <i>Palmoxylon</i> , <i>Cyclanthodendron</i> , <i>Tricocites</i>
<b>Practical 15</b>	Study of following fossils (P.S. or specimen) <i>Sahnipushpam</i> , <i>Sahnianthus</i> , <i>Enigmocarpon</i>

#### Suggested Readings:

1. A. Rashid (1999) An introduction to Pteridophyta. Vikas publishing house Pvt. Ltd. New Delhi, India.
2. Parihar, N.S. (1976) Biology and Morphology of Pteridophytes. Central Book Depot, Delhi, India.
3. Sharma, O.P. (1990) Textbook of Pteridophyta. MacMillan India Ltd. Delhi, India.
4. Smith, G.M. (1995) Cryptogamic Botany Vol-II McGraw Hill. New York. USA.
5. Sporne, K.R. (1986) The morphology of Pteridophytes. Hutchinson University Library, London, UK.
6. Sundar Rajan S. (1999) Introduction to Pteridophyta. New Age International Publishers. New Delhi, India.
7. Chamberlain, C.J. (1935) Gymnosperms: Structure And Evolution. Dover publ. INC., New York,
8. Eames, A.J. (1974) Morphology of vascular plants Mc. Grow Hill Publication Co. New Delhi.
9. Foster, A.S. & Gifford E.M. (1959) Comparative morphology of vascular plants San Francisco.
10. Pande B. P. (1994) Gymnosperms S. Hand and Co. New Delhi, India.
11. Seward, A.C. (1969) Fossil Plants Vol. I to IV, Hafner Publ. Co. New York, USA.
12. Shukla, A. C. and S.P. Misra (1982) Essentials of Palaeobotany Vikas Publishing House Pvt. Ltd. Delhi, India.
13. Siddiqui, K.A. (2002) Elements of Paleobotany Kitab Mahal, Allahabad
14. Sporne K.R. (1966) Morphology of Pteridophyta Hutchinson Univ. Library London.
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<b>DSC-34 Practical - II [Lectures: 60] [2P]</b> <b>BO- 425 Based on DSC-31 BO-422: Genetics and DSC -32 BO-423: Plant Physiology</b>	
<b>Course Objective:</b> To learn role of fixative and stains in cytology. To study the cell division in plants, mitosis and meiosis. To learn various metabolic activities of plants.	
<b>Course Outcomes:</b> Students understood the role of fixative and stains in cytology. To study the cell division in plants, mitosis and meiosis. Students acquaint the metabolic activities of plants.	
<b>Practical:1</b>	Preparation of Cytological fixative and Stains (Carnoy's fluid I, II, and Navashin's fluid and Acetocarmine)
<b>Practical:2</b>	Squash preparations of onion root tips to study Mitosis using Acetocarmine stain.
<b>Practical:3</b>	Smear preparation of Maize, Onion or Rhoeo flower buds to study meiosis using Acetocarmine stain.
<b>Practical:4</b>	Determination of Mitotic index and Metaphase frequency in <i>Allium cepa</i> or other plant material.
<b>Practical:5</b>	Staining of salivary gland chromosome in ( <i>Chironomus</i> larvae/ <i>Drosophila</i> ).
<b>Practical:6</b>	To study the lipase enzyme activity.
<b>Practical:7</b>	Separation of chloroplast pigments by paper chromatography.
<b>Practical:8</b>	To determine diurnal fluctuations in titrable acid number (TAN) values of CAM succulents (e.g., Aloe, Bryophyllum, Kalanchoe- anyone).
<b>Practical:9-10</b>	Determine the absorption spectrum of chlorophyll pigments and estimate the amount of Chl-A, Chl-B and total Chlorophylls by spectrophotometer method.
<b>Practical:11</b>	Extraction and separation of free amino acid of germinating seed by circular paper chromatography.

<b>Practical: :12</b>	To extract and estimate the amount of Ascorbic acid present in green paper (raw) /lemon (Fresh).
<b>Practical:13-14</b>	Extraction and Detection of secondary plant metabolites from suitable plantmaterial i) Alkaloids ii) Phenols iii) Terpenoids iv) Proteins.
<b>Practical: 15</b>	Estimation of ether soluble fat oil of Ricinus/ Arachis seeds by Soxhlet apparatus.

1. Amarsingh (1977) Practical Plant Physiology. Kalyani Publishers, New Dehli, India.
2. Arditt, J. (1969) Experimental Plant Physiology, Holt Rinehart& Winston Inc, NewYork.
3. Bajpai P. K. (2006) Biological Instrumentation and Methodology, S. Chand Publication, New Delhi.
4. Karp, G. (1999) Cells and Molecular Biology concepts and Experiments; Hohn Wiley & Sons Inc. USA.
5. Nagavi B. G. (1989) Laboratory Hand Book of Industrial Drug Analysis, Vallabh Prakashan, Delhi.
6. S. Sadasivam and A. Manickam (1976) New Age International Publisher, S. Chand Publisher, New Delhi.
7. Srivastava and Srivastava (1976) Introduction to Chromatography
8. Verma, Agarwal, (2005) Cell Biology, Genetics, Molecular Biology, Evolution and Ecology: S.Chand and Company , New Delhi, India.

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<b>DSE-6 Major (Core) Course [Lectures: 60]</b>		
<b>BO-426 (A) Techniques in Plant Science /</b>		
<b>BO-426 (B) Plant Ecology and Plant Geography /</b>		
<b>BO-426 (C) Agricultural Botany</b>		
<b>BO-426 (A) Techniques in Plant Science</b>		
<b>Course Objectives:</b>		
<ol style="list-style-type: none"> <li>1. To familiarize modern plant extraction techniques, sample preparation for various detection and quantitation of metabolites.</li> <li>2. To provide training on the handling of various computational data analyses and molecular docking tools.</li> <li>3. To make detailed sample preparation methods and advanced microscopy such as</li> <li>4. STEM, con-focal microscopy, etc.</li> </ol>		
<b>Course outcomes:</b>		
<ol style="list-style-type: none"> <li>1. Concepts, tools and techniques related to in plants.</li> <li>2. Different methods used for genetic transformation of plants.</li> <li>3. Various case studies techniques related to basic and applied research in plant science.</li> </ol>		
<b>Unit 1</b>	<b>Basic Techniques in Botany</b> Lab maintenance and sterilization techniques Preservation of materials- types of fixatives, macerations, peeling. Whole mount preparations: Bacteria, Algae, Fungi, Bryophytes, Pteridophytes, Gymnosperms and Angiosperms Staining: Types of stains, procedure of double and multiple staining.	<b>12</b>
<b>Unit 2</b>	<b>Microscopy and Micrometry</b> Historical microscopy, principle of microscopy Types and working of light microscope Types and Working of Electron microscope (SEM and TEM), dark field microscope, Fluorescence microscopy, phase contrast microscope, Micrometry: Metric units' principles and techniques, properties of light wavelengths and resolving power of microscope.	<b>12</b>
<b>Unit 3</b>	<b>Separation Techniques</b> Basic principles of chromatography RF value calculation Adsorption, absorption, solutes and solvents Paper chromatography, column chromatography, gel filtration, ion exchange chromatography HPLC, gas chromatography Gel electrophoresis (one and two dimensional) SDS-PAGE, AGAROSE. Principle and working of centrifuge, RPM, rotors and its type	<b>12</b>

	3.8 Types of centrifuges: High speed centrifuge, Ultra centrifuge, Gradient Centrifuge	
<b>Unit 4</b>	<b>Spectroscopic Techniques and Microtomy</b> Beer's Law, Lambert's Law, Beer-Lambert Law Visible and Ultraviolet (UV) spectroscopy I. R. spectrophotometer, flow cytometry NMR and ESR spectroscopy Atomic absorption and mass spectrometry, flame photometer Microtome- Types, Serial sectioning	<b>12</b>
<b>Unit 5</b>	<b>Radioactive and Immunological Techniques</b> Properties of different types of radioisotopes in biological systems Radio degradation, half life period, radio dating, radio labeling Auto radiography safety guidance Immunological Techniques: Antibody and Antigen Classes of antibodies ELISA, Immune precipitation	<b>12</b>
<p><b>Suggested readings:</b></p> <ol style="list-style-type: none"> <li>22. Annie and Arumugam (2000). Biochemistry and Biophysics, Saras Publishing, Tamilnadu.</li> <li>23. Bisen P.S. Mathur S. (2006). Life Science in Tools and Techniques. CBS Publishers, Delhi.</li> <li>24. Egerton R.F. Physical Principle of Electron Microscopy: an Introduction to TEM, SEM and AEM.</li> <li>25. Gamborg O.L., Philips G.C. (Eds.) (1995). Plant Cell, Tissue and Organ Culture fundamental Methods. Narosa Publishing House (P) Ltd.</li> <li>26. Gunadegaram P. (1995). Laboratory Manual in Microbiology. New Age International (P) Ltd.</li> <li>27. Harborne J.B. (1998). Phytochemical Methods. Springer (I) Pvt. Ltd.</li> <li>28. Khasim S.M. (2002). Botanical Micro techniques: Principles and Practice. Capital Publishing Company.</li> <li>29. Krishnamurthy K.V. (1999). Methods in Cell Wall Cytochemistry. CRC Press. LLC.</li> <li>30. Marimuthu R. (2008). Microscopy and Microtechnique. MJP Publishers, Chennai.</li> <li>31. Pal and Ghaskadabi (2009). Fundamentals of Molecular Biology. Oxford Publishing Co.</li> <li>32. Plummer David (1987). An Introduction to Practical Biochemistry. 3rd Eds. Tata Mc Graw-Hill Publishing Company Ltd.</li> <li>33. Prasad and Prasad (1984). Outline of Microtechnique. Emkay Publications, Delhi.</li> <li>34. Sadasivam S., Manickam A. (1996). Biochemical Methods. 2nd Edn. New Age International (P) Ltd.</li> <li>35. Sass John E. (1984). Botanical Microtechniques. Tata McGraw-Hill Publishing Company Ltd.</li> <li>36. Sharma V.K. (1991). Techniques in Microscopy and Cell Biology. Tata McGraw-Hill Publishing Company Ltd.</li> </ol>		

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<b>DSE-6 Major (Core) Course [Lectures: 60]</b> <b>BO-426 (B) Plant Ecology and Plant Geography</b>		
<b>Course Objectives:</b>		
1. To inspire the students about ecological importance of the environment, natural resources, various problems related to environment and its protection. 2. To make aware about conservation of biodiversity, energy. 3. To study Bioremediation, global warming and climate change, Pollution.		
<b>Course outcomes:</b>		
1. The students will understand the various conservation strategies, man made environmental issues at local, national and global level and the measures to control their adverse effects at individual and collective level. 2. Understanding the Management and Conservation strategies at national and international. 3. Understanding the key environmental issues and ecosystem Management.		
<b>Unit 1</b>	<b>Plant Ecology and Environment Management</b> <b>i. Definition, Concept and scope of Ecology, Branches of Ecology.</b> <b>ii. Management and Conservation of Natural Resources:</b> Aims, objectives and principles of conservation; Conservation policies; Conservation strategies at national and international level; Sustainable development and ecological economics. <b>iii. Environment Pollution:</b> Definition, Different types of pollutants; Sources of pollutants of air, water and soil; Effects of pollutants of air, water and soil; Control of pollution; Detailed account of Indoor pollution.	<b>15</b>
<b>Unit 2</b>	<b>Global Environmental Changes:</b> <b>i. Global warming;</b> Climate change, reasons, Factors contributing to climate change; consequences of climate change and measures to combat the problem. <b>ii. Ozone hole:</b> General account of ozone layer and hole; Factors contributing to ozone hole; Effects and Remedies. <b>iii. Environment Protection:</b> International concern and efforts for environmental protection, global plan, Stockholm Summit, priority issues; Earth Summits. <b>iv. Resource Economics:</b> Introduction and significance. <b>v. Environment Impact assessment:</b> Introduction and significance.	<b>15</b>
<b>Unit 3</b>	<b>Phytogeography:</b> <b>I. Definition,</b> principles governing plant distribution, factors affecting plant distribution, theories of distribution, different types of distribution of vegetations on the earth, continuous and discontinuous distribution. <b>II. Main Botanical regions of India,</b> Detailed study of vegetation types in Maharashtra. <b>III. Endemism:</b> causes and types. <b>IV. Remote sensing:</b> Definition and data acquisition techniques. Application of remote sensing in vegetation classification, understanding the key	<b>15</b>



	environmental issues and ecosystem management.	
<b>Unit 4</b>	<b>Environmental Biotechnology and solid waste management:</b> i. <b>Concept of waste:</b> types and sources of solid wastes including e-waste. Bioindicator and biomarkers of environmental health. Bioremediation, Phytoremediation, bioaugmentation, biofilms, biofilters, bio scrubbers and trickling filters. Use of bioreactors in waste management. ii. <b>Allelopathy:</b> Concept, mechanisms and exploitation in weed management. iii. <b>Plant Invasion:</b> Definition, factors (both Intrinsic and extrinsic) affecting invasion, Status and impact of plant invasion on native flora.	<b>15</b>
<b>Suggested readings:</b> 1. Altieri, M.A., and Liebman, M. Weed Management in Agroecosystems: Ecological Approaches. Florida, USA: CRC Press, 1988. Print. 2. Agrawal, K.C (1996) Environmental Biology, Agro-Botanical Publisher, Bikaner, India 3. Ambasta, R.S. (1990) Environment and pollution, student friends and co. Varanasi, India Botkin, D. and Keller, E. Environmental Science. New York, USA: John Wiley Publishers, 1995. Print. 4. Enger, E.D., and Smith, B.F. Environmental Science. Iowa, U.S.A.: WCB, Publi., 1992. Print. 5. Hunter, M.L. Maintaining Biodiversity in Forest Ecosystems. Cambridge: Cambridge University Press, 1999. Print. 6. Kothari, A. (1997). Understanding Biodiversity: Life Sustainability and Equity Orient Longman 7. Kumar, H.D. (1997) General Ecology, Vikas Publishing House Private Ltd. New Delhi 8. Newman, E.I. Applied Ecology. UK: Blackwell Scientific Publishers, 1994. Print. 9. Odum, E.P. Fundamentals of Ecology. USA: Saunders Toppan, 1971. Print. 10. Purohit S.S. and Ranjan R. (2007). Ecology, Environment and Pollution. Agrobios (India) 11. Ramakrishnan, P.S. Ecology of Biological Invasion in the Tropics. New Delhi: International Scientific Publications, 1991. Print. 12. Raven, P.H., Berg, L.R., and Hassenzahl, D.M. Environment. 7th ed. USA: Wiley, Hoboken, 2010. Print. 13. Shibu, J., Singh, H.P., Batish, D.R. and Kohli, R.K. Invasive Plant Ecology. New York, USA: CRC Press, Taylor and Francis Group, Boca Raton, 2013. Print. 14. Sharma P.D (2018) Ecology and Environment Rastogi Publications, Meerut-New Delhi. 15. Singh, H.P., Batish, D.R., and Kohli, R.K. Handbook of Sustainable Weed management. New York, USA: Food Products Press, 2006. Print. 16. Singh, J.S., Singh, S.P., and Gupta, S.R. Ecology, Environment and Resource Conservation. New Delhi: Anamaya Publishers, 2006. Print.		

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<b>DSE-6 Major (Core) Course [Lectures: 60]</b> <b>BO-426 (C) Agricultural Botany</b>		
<b>Course Objectives:</b>		
This course has the following objectives in order to achieve the above aims:		
<ol style="list-style-type: none"> <li>1. Understand the basic concept in agricultural botany</li> <li>2. Identify and classify some plant</li> <li>3. Appreciate the morphological, and their physiological functions</li> <li>4. To distinguish between pure and applied botany</li> <li>5. Know the relevance of botany to agriculture</li> </ol>		
<b>Course outcomes:</b>		
<ol style="list-style-type: none"> <li>1. Students will demonstrate the ability to analyze data and draw appropriate statistical conclusions.</li> <li>2. Students will demonstrate knowledge of the legal and ethical environment impacting agriculture organizations and exhibit an understanding and appreciation of the ethical implications of decisions.</li> <li>3. Students will demonstrate an understanding of and appreciation for the importance of the impact of globalization and diversity in modern agriculture organizations.</li> <li>4. Students will demonstrate an ability to work effectively with others.</li> </ol>		
<b>Unit 1</b>	<b>BASIC CONCEPTS IN AGRICULTURAL BOTANY</b>	<b>12</b>
	<ol style="list-style-type: none"> <li>i. Introduction of agricultural botany</li> <li>ii. Objectives of agricultural botany</li> <li>iii. Definition of agricultural botany</li> <li>iv. Scope of agricultural botany</li> <li>v. Importance of green Plants</li> <li>vi. Components of agricultural botany</li> <li>vii. Approaches to studying botany</li> <li>viii. The concept of agricultural botany.</li> </ol>	
<b>Unit 2</b>	<b>Plant morphology</b>	<b>12</b>
	<ol style="list-style-type: none"> <li>a) Definition of root, types of roots, structure root, functions root and root systems</li> <li>b) Definition of Stem, types of Stems, Stem functions and modifications of Stem</li> <li>c) Leaf functions, leaf morphology and leaf phyllotaxy.</li> </ol>	
<b>Unit 3</b>	<b>Plant reproduction</b>	<b>12</b>
	<ol style="list-style-type: none"> <li>a. Reproduction in gymnosperms and angiosperms</li> <li>b. Flower morphology</li> <li>c. Types of inflorescences</li> <li>d. Flower symmetry</li> <li>e. Pollen, structure and pollination</li> <li>f. Fruits and fruit classification</li> </ol>	

<b>Unit 4</b>	<b>Introduction to plant physiology</b> A. Definition and importance B. The plant cell structure and basic cell types; C. Seed structure; D. The physiology of seed germination E. Requirements for germination F. Steps in seed germination G. Plant Water Relation H. Mechanism of Water Absorption I. Mechanism of Salt Absorption J. Definition of transpiration K. Types of transpiration L. Factors affecting transpiration M. Photosynthesis N. Factors affecting Photosynthesis	
<b>Unit 5</b>	Introduction to field crops- Agricultural classification of field crops. Family description, economic parts, economic uses, value additions, in the following crops a) <b>Cereals:</b> Rice ,Wheat and maize b) <b>Millets:</b> Sorghum and Pearl millets c) <b>Pulses:</b> Soy bean, Cow pea, Black gram, and Green Gram d) <b>Oilseeds:</b> Groundnut, Caster, Sunflower and Mustard. e) <b>Fibers:</b> cotton, Jute and Sun hemp, f) <b>Sugars:</b> Sugar cane and Sugar beet g) <b>Forage crops</b> h) <b>Tree fodder.</b>	<b>12</b>
<b>Suggested readings:</b> 5 Mauseth J.D. 2003. Botany: An introduction to Plant Biology. Jones and Bartlett Publishers. ISBN 0-7637-2134-4 6 Berrie, G.K., A Berrie, and J.M.O. Eze 1987. Tropical Plant Science. Longman and Scientific Technical. ISBN 0-582-64705-3 7 Kochhar, S.L. 1981. Tropical Crops: a textbook of economic botany. MacMillan Publishers. ISBN 0-333-39241-8 8 Laetsch, W.M. 1979. Plants: Basic concepts in Botany. Little, Brown and Company, Toronto, USA. Library Catalog Card No. 78-64497 9 Baranov, V.D. Ustimenko, G.V. (1994). Mir Kulturnih Rasteniyi. Misl, P.381. 10 Coble, L.S. and Steele, W.M. (1976). An Introduction to the Botany in the Tropics, Second Edition. Longman Group Limited. 11 Dutta, A. C. (2000). Botany for Degree Students Oxford University Press 10th Edition. 12 Ebukanson and Bassey: (1992). About Seed Plants. Baraka Press and Publishers LTD. 13 Green, D.J., Stout, G.W. (2004). Biological Science, 3rd Edition. Cambridge University Press 14 James, W.O. (1975). An Introduction to Plant Physiology Seventh Edition, Oxford University Press. P.181 15 Kochhar, S. L. (2001). Economic Botany in the Tropics Second Edition, Macmillan India LTD 16 Murkin, B.M. Naumova, L.G. and Muldashev, A.A. (2000). Vissheye Rasteniyeye. M.		

Logos P.264.

- 17 Pandey, S. N. Sinha, B.K. (2003). Plant Physiology Third Edition, Vikas Publishing House PVT LTD. P.581.
- 18 "Introduction to Crop Physiology" by H. H. Hadley
- 19 Reddy, M. S. (2005). Principles of Agronomy. Kalyani Publishers.

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**Major (Core) Course [Lectures: 60]**  
**BO-427 On Job Training**

**Course Objectives:**

1. To provide work experience enabling students to apply what they learnt in the college and acquire new skills.
2. To give students an opportunity to establish interest in industrial/ commercial activities.
3. To provide foundation to prepare students to work efficiently in their jobs after the training.
4. An MSc Botany student can build a career in many paths. Starting from school teachers to microbiological and virological research, many different fields and job profiles are open for these candidates.
5. With each passing day, the demand for MSc Botany candidates in the research field is increasing. The need to tackle problems like global warming, deforestation and increasing thirst for knowing about new plants and their importance has led to an ever-increasing demand for Botany based candidates in the field of research.
6. After completing your postgraduate studies in Botany, you will be serving under the finest and reputed organizations.
7. Offers the aspirant with an option to go for further studies or doctoral-level studies.
8. It provides you with the opportunity to work in various departments of government institutions like forestry, Social forestry, Recreation gardens, Landscape gardening, Plant nursery, food processing industry, oil industry, Mushroom cultivation, Hydroponics farms etc.
9. The problems related to forests, climate change, desertification, etc, can be easily solved with a better understanding of Botany.

**Course outcomes:**

1. On-the-job training helps employees learn and perform their jobs in real-life situations while minimizing potential issues.
2. As a result, job-related knowledge is learned, retained and applied more reliably.
3. Training of an organization's workers enables them to perform their job to the best of their ability.
4. It provides the knowledge as well as the skills they require to carry out their duties effectively.

## **On Job training: Botany Career Opportunities and Job Prospects:**

A career in Botany might just be one of the most preferred careers in India. Botany as a subject is related to the study of plants and a career in it would mean studying in depth about *fungi, algae, plants, diseases, growth, metabolism and the structure* between different groups. When planning a career in Botany, the job profile can include study of plants, research, working with industries, teaching, self-employment, and being a part of many more fields.

A person who works in this field is called a botanist. It will be the job of the botanist to study plant life along with finding solutions to problems related to that of forest and agriculture. There are also botanists who deal with space travel agriculture, artificial environments, hydroponics and various other interesting areas of research.

MSc Botany course is best suited for the students who have completed their graduation in botany or integrated biology (biological sciences), and are looking to pursue a course that will have an adequate mix of mainstream biology along with genetics and biotechnology. During this course, a candidate is given a complete idea about the entire plant kingdom and plant physiology, along with some additional topics related to genetics and biotechnology, cell biology, microbiology, and ecology.

1. The course covers every aspect of plant biology in great detail. It covers topics like plant physiology, plant kingdom, Taxonomy, microbiology, genetics and ecology.
2. It is a 2 year long course which is generally divided into four semesters.
3. It is generally a theoretical course along with some opportunities for academic research which is accompanied with laboratory work.
4. The students completing this course generally go on to build a career in academics. Some students also go for research and higher studies.
5. They can seek employment as Ecologist, Morphologist, Cytologist, Taxonomist, Ethno Botanist, Mycologist, Plant Biochemist, Foresters and Researchers etc.

**Plant explorer:** Botanist with a passion for plants who could be a photographer, writer, expeditioner, etc

**Conservationist:** Is an individual who works for the conservation of the environment and is often linked to organizations working for the cause.

**Ecologist:** A person who works for the eco-system and a balanced environment.

**Environment consultant:** Some botanists qualify to work as environmental consultants, providing inputs and advice for the conservation of the environment.

**Horticulturist:** A horticulturist knows the science behind different plants, flowers, and greenery. They conduct research in gardening and landscaping, plant propagation, crop production, plant breeding, genetic engineering, plant biochemistry, and plant physiology.

**Plant biochemist:** Biochemists study the chemical and physical principles of living things and of biological processes, such as cell development, growth, heredity, and disease.

**Molecular biologist:** Molecular biologists conduct research and academic activities. The research component involves the study of biological structures in well-equipped laboratories with advanced technology to help them explore complex molecular structures and their particular functions. The equipment may include microscopes, lab centrifuges, computers with specific software that allows them to analyze obtained data, and many more.

The number of professions botanists can go into nowadays is endless. Moreover the application of plant sciences improves the yield and supply of medicines, foods, fibers, building materials and other plant products. The knowledge of plant sciences is essential for development and management of forests, parks, waste lands, sea wealth etc.

Few of the industries which one can work with are:

- Phyto chemical Industry
- Food Companies

- Arboretum
- Forest Services
- Biotechnology Firms
- Oil Industry
- Land Management Agencies
- Seed And Nursery Companies
- Plant Health Inspection Services
- National Parks
- Biological Supply Houses
- Plant Resources Laboratory
- Educational Institutions

### **Suggested readings:**

1. Mastering Professional Scrum: A Practitioner s Guide to Overcoming Challenges and Maximizing the Benefits of Agility by Stephanie Ockerman and Simon Reindl
2. Adapt by Tim Harford
3. Team of Teams by Stanley McChrystal
4. Servant Leadership by Robert K. Greenleaf
5. Scrum Mastery by Geoff Watts
6. Coaching Agile Teams by Lyssa Adkins
7. The Surprising Power of Liberating Structures by Henri Lipmanowicz and Keith McCandless
8. The DevOps Handbook by Kim, Debois, Williz and Humble
9. The Professional Product Owner by Don McGreal and Ralph Jocham
10. The Product Samurai by Chris Lukassen
11. Product Mastery by Geoff Watts
12. Lean Change Management by Jason Little
13. Reinventing Organizations by Frederic Laloux
14. Creating Great Teams by Sandy Mamoli and David Mole
15. The Serving Leader: Five Powerful Actions to Transform Your Team, Business, and Community by Ken Jennings and John Stahl-Wert
16. Turn the Ship Around!: A True Story of Turning Followers into Leaders by L. David Marquet