

**Kavayitri Bahinabai Chaudhari  
North Maharashtra University, Jalgaon**

॥अंतरी पेटवू ज्ञानज्योत॥



'A' Grade  
NAAC Re-Accredited  
(3<sup>rd</sup> Cycle)

**SYLLABUS**

**For**

**Master of Science (M. Sc.)  
[ Botany]**

**M.Sc. Part-II<sup>nd</sup> (Sem-III and IV)**

**Choice Based Credit System  
(Outcome Based Curriculum)**

**2022 – 2023**

**PROGRAMME 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	:	CGPA
Total Credits of the program	:	88 (68 core credits including 4 credits of project/ dissertation, 04 skill enhancement credits, 08 subject elective credits and 08 audit credits)

**Summary of Distribution of Credits under CBCS Scheme for  
M.Sc. BOTANY**

Sr. No	Type of course	Sem I	Sem II	Sem III	Sem IV
01	Core	16	20	16	12
02	Skill based	04	--	-	-
03	Elective	-	-	04	04
04	Project	-	-	-	04
05	Audit	02	02	02	02
06	Total Credits	22	22	22	22

Subject Type	Core	Skill based	School Elective	Project	Audit	Total
Credits	64	04	08	04	08	88
<b>Total Credits = 88</b>						

**Kavayitri Bahinabai Chaudhari North Maharashtra University, Jalgaon**

**M.Sc. Botany**

**Choice Based Credit System (Outcome Based Curriculum) with effect from**

**2021 -2022**

**Course credit scheme**

Semester	(A) Core Courses			(B) Skill Based / Elective Course			(C) Audit Course (No weightage in CGPA)			Total Credits (A+B+C)
	No. of Courses	Credits (T+P)	Total Credits	No. of Courses	Credits (T+P)	Total Credits	No. of Courses	Credits (Practical)	Total Credits	
I	4	8 + 8	<b>16</b>	1	4 + 0	4	1	2	2	<b>22</b>
II	4	12 + 8	<b>20</b>	1	0 + 0	--	1	2	2	<b>22</b>
III	4	8 + 8	<b>16</b>	1	4 + 0	4	1	2	2	<b>22</b>
IV	4	8 + 8	<b>16</b>	1	4 + 0	4	1	2	2	<b>22</b>
<b>Total Credits</b>		<b>68</b>			<b>12</b>			<b>8</b>		<b>88</b>

(T-Theory, P-Practical)

**Structure of curriculum**

		First Year				Second Year				Total Credit Value
		Semester I		Semester II		Semester III		Semester IV		
		Credit	Course	Credit	Course	Credit	Course	Credit	Course	
(A)	<b>Prerequisite and Core Courses</b>									
	Theory	4	2	4	3	4	2	4	2	36
	Practical	4	2	4	2	4	2	4	2	28
(B)	<b>Skill Based / Subject Elective Courses</b>									
1	Theory /Practical	4	1	--	--	4	1	4	1	16
(C)	<b>Audit Course (No weightage in CGPA calculations)</b>									
1	Practicing Cleanliness	2	1							2
2	Personality and Cultural Development Related Course	--	--	2	1	--	--	--	--	2
3	Technology Related + Value Added Course	—	—	—	—	2	1	—	—	—
4	Professional and Social + Value Added Course							2	1	2
	<b>Total Credit Value</b>	<b>14</b>	<b>6</b>	<b>14</b>	<b>6</b>	<b>14</b>	<b>6</b>	<b>14</b>	<b>6</b>	<b>88</b>

**List of Audit Courses (Select any ONE course of Choice from Semester II; Semester III and Semester IV)**

Semester I (Compulsory)		Semester II (Choose One)		Semester III (Choose One)		Semester IV (Choose One)	
		Personality and Cultural Development		Technology + Value Added Course		Professional and Social + Value Added Course	
Course Code	Course Title	Course Code	Course Title	Course Code	Course Title	Course Code	Course Title
AC-101	Practicing Cleanliness	AC-201A	Soft Skills	AC-301A	Computer Skills	AC-401A	Human Rights
		AC-201B	Sport Activities	AC-301B	Cyber Security	AC-401B	Current Affairs
		AC-201C	Yoga	AC-301C	Seminar + Review Writing	AC-401C	Banana Fruit Processing
		AC-201D	Music	AC-301D	Biodiversity & Conservation	AC-401D	Intellectual Property Rights (IPR)

## Semester-wise Course Structure of M.Sc. Botany

### Semester I

Course	Course Type	Course Title	Teaching Hours/ Week			Marks (Total 100)				Credits
			T	P	Total	Internal		External		
						T	P	T	P	
BOT-101	Core	Plant Systematics-I (Algae, Fungi & Bryophytes)	4	--	4	40	--	60	--	4
BOT-102	Core	Taxonomy of Angiosperms	4	--	4	40	--	60	--	4
BOT-103	Core	Practical Based on Bot. 101	--	4+4	8	--	40	--	60	4
BOT-104	Core	Practical Based on Bot. 102	--	4+4	8	--	40	--	60	4
BOT-105	Skill Based	Applied Plant Biotechnology	4	--	4	40	--	60	--	4
AC-101	Audit Course	Practicing Cleanliness	-----	2	2	--	100	--	--	2
<b>Total Credit for Semester I: 22 (T = Theory: 8; P = Practical:8; Skill Based:4; Audit Course:2)</b>										

### Semester II

Course	Course Type	Course Title	Teaching Hours/ Week			Marks (Total 100)				Credits
			T	P	Total	Internal		External		
						T	P	T	P	
BOT-201	Core	Plant Systematics-II (Pteridophytes, Gymnosperm & Palaeobotany)	4	--	4	40	--	60	--	4
BOT-202	Core	Plant Physiology and Biochemistry	4	--	4	40	--	60	--	4
BOT-203	Core	Cytogenetics and Molecular Biology	4	--	4	40	--	60	--	4
BOT-204	Core	Practical based on BOT 201 & BOT 202	--	4+4	8	--	40	--	60	4
BOT-205	Core	Practical based on BOT 203	--	4+4	8	--	40	--	60	4
AC-201 A/B/C/D	Audit Course (Select any one)	AC-201 A: Soft Skills AC-201 B: Sport Activities AC-201 C: Yoga AC-201 D: Music	--	2	2	--	100	--	--	2
<b>Total Credit for Semester II: 22 (T = Theory: 12; P = Practical:8; Skill Based:00; Audit course:2)</b>										

### Semester III

Course	Course Type	Course Title	Teaching Hours/ Week			Marks (Total 100)				Credits
			T	P	Total	Internal		External		
						T	P	T	P	
BOT-301	Core	Plant Development & Reproduction	4	--	4	40	--	60	--	4
BOT-302	Core: Special Paper	BOT-302 A: Phycology Special Paper-I BOT-302 B: Mycology Special Paper-I BOT-302 C: Angiosperm Special Paper-I	4	--	4	40	--	60	--	4
BOT-303	Core	Practical Based on BOT 301	4	--	4	40	--	60	--	4
BOT-304	Core	Practical Based on BOT 302 (Special Paper)	--	4+4	8	--	40	--	60	4
BOT-305	Elective ( <b>Select anyone</b> )	BOT 305 A: Biostatistics and Bioinformatics BOT 305 B: Techniques in plant Sciences	4	--	4	40	--	60	--	4
AC-301 A/B/C/D	Audit Course ( <b>Select anyone</b> )	AC-301 A: Computer Skills AC-301 B: Cyber Security AC-301 C: Seminar and Review Writing AC-301 D: Biodiversity and Conservation	--	2	2	--	100	--	--	2
<b>Total Credit for Semester III: 22 (T = Theory: 8; P = Practical:8; Skill Based:4; Audit Course:2)</b>										

### Semester IV

Course	Course Type	Course Title	Teaching Hours/ Week			Marks (Total 100)				Credits
			T	P	Total	Internal		External		
						T	P	T	P	
BOT-401	Core: Special Paper	BOT-401 A: Phycology Special Paper-II BOT-401 B: Mycology Special Paper-II BOT-401 C: Angiosperm Special Paper-II	4	--	4	40	--	60	--	4
BOT-402	Core: Special Paper	BOT-402 A: Phycology Special Paper-III BOT-402 B: Mycology Special Paper-III BOT-402 C: Angiosperm Special Paper-III	4	--	4	40	--	60	--	4
BOT-403	Core	Practical based on BOT 401 & BOT 402	—	4+4	8	--	40	--	60	4
BOT-404	Core	Practical: Project Dissertation	--	4+4	8	--	40	--	60	4
BOT-405	Elective ( <b>Select any one</b> )	BOT-405 A: Plant Ecology & Phytogeography BOT-405 B: Industrial Botany	4	--	4	40	--	60	--	4
AC-401 A/B/C/D	Audit Course ( <b>Select any one</b> )	AC-401 A: Human Right AC-401 B: Currant Affairs AC-401 C: Banana Fruit Processing AC-401 D: Intellectual Property right (IPR)	—	2	2	— <sup>E</sup>	100	--	--	2
<b>Total Credit for Semester IV: 22 (T = Theory: 8; P = Practical:8; Skill Based:4; Audit Course:2)</b>										

### Distribution of Course papers for M. Sc. Part II (Botany)

Subject Code	Title of the Paper		Duration (Hrs./Wk)	Max. Mark	Exam. Time (Hrs.)
<b>M.Sc. Part II</b>					
<b>Semester III : Theory Courses</b>					
BOT-301	Plant Development & Reproduction	Core course	04	100	03
BOT -302	BOT-302 A: Phycology Special Paper-I BOT-302 B: Mycology Special Paper-I BOT-302 C: Angiosperm Special Paper-I	Core course	04	100	03
BOT-305	BOT 305 A: Biostatistics and Bioinformatics BOT 305 B: Techniques in plant Sciences	Skill based	04	100	03
<b>Semester III : Practical Courses</b>					
BOT-303	Practical Based on Bot. 101	Core course	<b>04+04</b>	<b>100</b>	<b>06</b>
BOT-304	Practical Based on Bot. 102	Core course	<b>04+04</b>	<b>100</b>	<b>06</b>
AC-301 A/B/C/D (Select any one)	AC-301 A: Computer Skills AC-301 B: Cyber Security AC-301 C: Seminar and Review Writing AC-301 D: Biodiversity and Conservation	Audit Course	<b>02</b>	<b>100</b>	
<b>Semester IV : Theory Courses</b>					
BOT-401	BOT-401 A: Phycology Special Paper-II BOT-401 B: Mycology Special Paper-II BOT-401 C: Angiosperm Special Paper-II	Core course	<b>04</b>	<b>100</b>	<b>03</b>
BOT-402	BOT-402 A: Phycology Special Paper-III BOT-402 B: Mycology Special Paper-III BOT-402 C: Angiosperm Special Paper-III	Core course	<b>04</b>	<b>100</b>	<b>03</b>
BOT-403	Practical based on BOT 401 & BOT 402	Core course	<b>04</b>	<b>100</b>	<b>03</b>
<b>Semester II : Practical Courses</b>					
BOT-404	Practical: Project Dissertation	Core course	<b>04+04</b>	<b>100</b>	<b>06</b>
BOT-405 (Elective)	BOT-405 A: Plant Ecology & Phytogeography BOT-405 B: Industrial Botany	Core course	<b>04</b>	<b>100</b>	<b>06</b>
AC- 401 A/B/C/D (Select any one)	AC-401 A: Human Right AC-401 B: Currant Affairs AC-401 C: Banana Fruit Processing AC-401 D: Intellectual Property right (IPR)	Audit Course	<b>02</b>	<b>100</b>	

## M.Sc. Part-II Semester-III Botany: Core Courses

Core Course	<b>BOT-301 PLANT DEVELOPMENT AND REPRODUCTION</b>	Lectures <b>60</b>
<p><b>Course Objectives</b></p> <ol style="list-style-type: none"> <li>1.To study vascular tissues, structure of woods and anomalous secondary growth</li> <li>2.To study historical development of embryology</li> <li>3.To study structure and development of microsporangium, megasporangium and endosperm.</li> <li>4.To study methods of pollination and fertilization</li> <li>5.To study applications of embryology in plant tissue culture</li> </ol> <p><b>Course Outcomes</b></p> <ol style="list-style-type: none"> <li>1.Able to differentiate vascular tissue</li> <li>2.Able to identify embryological stages</li> <li>3.Expertise in tissue culture technique</li> </ol>		
<b>Unit-1</b>	<p style="text-align: center;"><b>Growth of Plants</b></p> <p><b>1.1 Meristems:</b> Classification based on</p> <ol style="list-style-type: none"> <li>a) Origin and development</li> <li>b) Plane of division</li> <li>c) Function and position</li> </ol> <p><b>1.2 Theories of zonation and differentiation</b></p> <ol style="list-style-type: none"> <li>i. Apical cell theory</li> <li>ii. Histogen theory</li> <li>iii. Tunica-carpus theory</li> <li>iv. Korper- Koppe theory</li> <li>v. Cytohistological zonation</li> <li>vi. Concept of quiescent center</li> </ol> <p><b>1.3 Study of stomata and Trichomes</b></p> <ol style="list-style-type: none"> <li>a) Introduction</li> <li>b) Classification of stomata by: <ol style="list-style-type: none"> <li>i) Metcalfe and Chalk</li> <li>ii) Stebbins and Khush</li> </ol> </li> <li>c) classification of Trichomes by <ol style="list-style-type: none"> <li>i) Uphof's</li> <li>ii) Ramayya's</li> </ol> </li> </ol>	<b>11</b>
<b>Unit-2</b>	<p style="text-align: center;"><b>Vascular Tissues</b></p> <p>2.1 Cambium: Origin, Structure, Types</p> <p>2.2 Differentiation of xylem and Phloem elements and their phylogeny</p> <p>2.3 Study of Woods:</p> <ol style="list-style-type: none"> <li>i) Dicotyledonous woods</li> <li>ii) Gymnospermous woods</li> <li>iii) Reaction woods</li> <li>iv) Sap and Heart wood</li> </ol> <p>2.4 Axial parenchyma and their Distribution:</p> <ol style="list-style-type: none"> <li>i) Apotracheal</li> <li>ii) Paratracheal</li> <li>iii) Boundary parenchyma</li> </ol> <p>2.5 Anomalous Secondary Growth in Plants :</p> <ol style="list-style-type: none"> <li>a) Dicot stem: <ol style="list-style-type: none"> <li>i. Normal cambium with abnormal activity</li> </ol> </li> </ol>	<b>14</b>

	<p>ii. Abnormal cambium with abnormal activity b) Monocot stem : Dracaena, Palms</p>	
<b>Unit-3</b>	<p>3.1 Introduction 3.2 Contribution of Strasburger and P. Maheshwari 3.3 Microsporangium: i) Development and structure of microsporangium ii) Wall layers of microsporangium iii) Types of Tapetum iv) Pollenkitt and sporopollenin v) Microsporogenesis vi) Pollen units 3.4 Male gametophyte: structure, development and spermatogenesis 3.5 Study of certain abnormal developments (i) Pollen formation in Cyperaceae (Pseudomonad) (ii) Pollen embryo sac 3.6 Megasporangium: A) i) Development ii) Structure iii) Megasporeogenesis B) Types of female gametophytes (embryo sac) 3.7 Pollination and Fertilization: A) Self-pollination: i) methods of pollination ii) structure of stigma and style B) Pollen germination: i) pollen-tube formation ii) sperm- cell C) pollen-pistil interaction: i) pollen recognition ii) acceptance-rejection iii) pollen incompatibility D) Entry of pollen tube: i) through stigma, style and embryo sac ii) transfer of pollen tube contents into embryo sac iii) fusion of gametes and fusion of nuclei</p>	<b>12</b>
<b>Unit-4</b>	<p>4.1 Endosperms: i) Introduction ii) development and structure of endosperms iii) Physiology and cytology of endosperms with suitable examples. iv) Function of endosperms 4.2 Polyembryony : i) Introduction ii) Classification of polyembryony iii) Causes of polyembryony iv) Types of polyembryony: a) simple polyembryony b) multiple embryony c) nucellar and integumentary polyembryony d) endothelial polyembryony e) zygotic, suspensor and synangial polyembryony 3 Experimental Embryology:</p>	<b>13</b>



	<ul style="list-style-type: none"> <li>i) Anther and pollen culture</li> <li>ii) ovary culture</li> <li>iii) ovule culture</li> <li>iv) nucellar culture</li> <li>v) endosperm culture</li> <li>vi) embryo culture</li> </ul>	
<b>Unit-5</b>	<p>5.1 Introduction</p> <p>5.2 Scope and Importance</p> <p>5.3 Pollen grains:</p> <ul style="list-style-type: none"> <li>A) Development of pollen grains: <ul style="list-style-type: none"> <li>i) Meiotic and post-meiotic processes</li> <li>ii) Differentiation of wall layers</li> <li>iii) Exine stratification</li> <li>iv) Polarity</li> <li>v) Symmetry</li> </ul> </li> <li>B) Structure of mature pollen grain</li> <li>C) Pollen polymorphism</li> <li>D) NPC system</li> </ul> <p>5.4 Spore/Pollen development in plants w.r.t. wall composition, exine ornamentation and apertural variations.</p> <ul style="list-style-type: none"> <li>i) Algae</li> <li>ii) Bryophytes</li> <li>iii) Pteridophytes</li> <li>iv) Angiosperms</li> </ul> <p>5.5 Applied Palynology: Geopalynology, Melittopalynology, Pollen allergy, Aerobiology Palynotaxonomy and Forensic palynology.</p>	<b>10</b>
<b>Suggested Readings</b>		
<ol style="list-style-type: none"> <li>1. Carlquist, S. (1961) Comparative Plant Anatomy, Hold, Rinehart and Winston, New York, U.S.A.</li> <li>2. Carlquist, S. (1988) Comparative Wood Anatomy: Systematic, Ecological and Evolutionary Aspects of Dicotyledonous Wood. Springer-Verlag, Berlin, Germany</li> <li>3. Cutter, D.F. (1978) Applied Plant Anatomy, Longman, London and New York, USA</li> <li>4. Cutter, E.G. (1969) Plant Anatomy: Experiment and Interpretation. Part-I : Cell and Tissues, Edward Arnold, London, UK.</li> <li>5. Eames, A.J. (1961) Morphology of Angiosperms, McGraw Hill, New York, U.S.A.</li> <li>6. Eames, A.J. and McDaniels, L.H. (1974) An Introduction to Plant Anatomy, II Ed. McGraw Hill, New York and London, UK.</li> <li>7. Easu, K. (1960) Anatomy of the Seed Plants, Wiley, New York, U.S.A.</li> <li>8. Easu, K. (1965) Vascular Differentiation in Plants. Hold, Rinehart and Winston, New York, U.S.A.</li> <li>9. Easu, K. (1977) Anatomy of Seed Plants, (II Ed.) John, Wiley and Sons, New York, U.S.A. Fahn, A. (1982) Plant Anatomy, III Ed. Pergamon Press, Oxford U.K.</li> <li>10. Fahn, A. (1995) Secretory Tissues in Plants. Academic Press. London, U.K.</li> <li>11. Foster, A.S. (1949) Practical Plant Anatomy, II Ed. Van Nostrand, New York, U.S.A. Lyndon, R.F. (1990) Plant Development. The Cellular Basis. Unwin Hyman, London, U.K.</li> <li>12. M.N.B. (1998) Wood Anatomy and Major Uses of Wood. Faculty of Forestry, University Putra Malaysia, Malaysia.</li> </ol>		

13. Mauseth, J.D. (1988) Plant Anatomy. The Benjamin / Cummings Publ. Co. In. Menio Park, californis, U.S.A.
14. Metcalfe, C.R. (1960) Anatomy of the Monocotyledons. I Graminae. Clarendon Press, Oxford, U.K.
15. Metcalfe, C.R. and Chalk, L. (1950) Anatomy of Dicotyledonos Vol.I-II. Clarendon Press, Oxford, U.K.
- Steeves, T. A. and I. M. Sussere (1989) Patterns in Plant Development (IInd Ed.) Cambridge University Press. Cambridge, U.S.A.
16. Tomlinson, P.B. (1961) Anatomy of the Monocotyledons-II. Palmae (Ed. C.R.Metcalfe), Clarendon Press, Oxford, U.K.
17. Bhojwani S.S. and S.P. Bhatnagar S.P. (1974) Embryology of Angiosperms Vikas Publishing House (P.) Ltd., New Delhi, India.
18. Davis, G.L. (1966) Systematic Embryology of Angiosperms, John, Wiley and Sons, New York, U.S.A
19. Johri, B.M. (1984 Ed.) Embryology of Angiosperms. Springer-Verlag, Berlin, Heidelberg, New York, U.S.A.
20. Maheshwari, P. (1950) An Introduction To The Embryology of Angiosperms, McGraw Hill Book Co. New York, U.S.A.
21. Maheshwari, P. (1963 Ed.) Recent Advances In The Embryology of Angiosperms International Society of Plant Morphologists, University of Delhi. Delhi, India.
22. Percival, M.S. (1965) Floral Biology, Pergamon Press, Oxford, U.S.A.
23. Proctor, M. and Yeo, P. (1973) The Pollination of Flowers, William Collins Sons, London. Raghavan, V. (1986) Embryogenesis in Angiosperms: A Developmental and Experimental Study, Cambridge University Press. Cambridge, U.S.A.
24. Raghavan, V. (1997) Molecular Embryology of Flowering Plants, Cambridge University Press. Cambridge, U.S.A.
25. Raghavan, V. (1999) Developmental Biology of Flowering Plants, Springer- Verlag, New York, U.S.A.
26. Raven, P.H., Evert, R.F. and S. E. Eicbhom (1992) Biology of Plants (Vth Ed,) Worth, New York, U.S.A.
27. Erdtman, G. (1966) Pollen Morphology and Plant Taxonomy: Angiosperms, Hafner, New York, U.S.A
28. Erdtman, G. (1969) Handbook of Palynology. , Hafner, New York, U.S.A
29. Faegri, K. and J. Iversen (1964) Text Book of Pollen Analysis, Hafner, New York, U.S.A Faegri, K. and Van Der Pijl. L. (1979) The Principles of Pollination Ecology. Pergamon Press, Oxford. U.K
30. Nair, P.K.K. (1970) Pollen Morphology of Angiosperms: A Historical and Phylogenetic tudy. The Scholar Publishing House, Lucknow, India.
31. Nair, P.K.K. (1970) Pollen Morphology of Angiosperms. Vikas Publ. House (P.) Ltd. New Delhi, India.
32. Shivanna, K.R. and B.M.Johri (1985) The Angiosperm Pollen : Structure and Function, Wiley Eastern Ltd., New York, U.S.A.
33. Shivanna, K. R. and Rangaswamy N.S.(1992) Pollen Biology : A Laboratory Manual, Springer-Verlag, Berlin, Germany.
34. Stanley, R.G. and H.F.Linskens (1974) Pollen Biology, Biochemistry and Management, Springer, New York, U.S.A.
35. Shivanna, K.R. and Sawhney V.K. (Eds.) (1997) Pollen Biotechnology For Crop Production and Improvement, Cambridge University Press, Cambridge, U.K.

Core Course	<b>BOT-302 A PHYCOLOGY SPECIAL PAPER-I</b>	<b>Lectures 60</b>								
<p><b>Course Objectives</b></p> <ol style="list-style-type: none"> <li>1. The main objective is to fulfil the knowledge of rapidly expanding branch Phycology of Botanical Science.</li> <li>2. To know diversity of various algal groups.</li> <li>3. To provide a clear and sound background knowledge in respect to morphology; reproduction and interrelationships of Algae.</li> <li>4. To study different systems of classification of algae.</li> <li>5. To study and understand the local Algal diversity from various habit and habitat.</li> </ol> <p><b>Course Outcomes</b></p> <ol style="list-style-type: none"> <li>1. Able to differentiate and identify algal forms.</li> <li>2. Able to classify algae.</li> <li>3. Expertise in algal diversity and Habitat.</li> </ol>										
<b>Unit-1</b>	<ol style="list-style-type: none"> <li>1. Introduction, a brief History of Phycology, contribution of Indian algologist.</li> <li>2. Comparative account of general characters of different groups of algae. (According to F. E. Fritsch's classification).</li> <li>3. Systems of classification of algae up to orders according to F. E. Fritsch, G. M. Smith, H. C. Bold, and W. J. Wynne.</li> <li>4. Modern trends in algal systematics.</li> </ol>	<b>12</b>								
<b>Unit-2</b>	<p>Discussion of algae with reference to Reproduction, Life Cycle, Evolution, Phylogeny and interrelationships of belonging to the following algal classes (sensu F. E. Fritsch).</p> <table style="width: 100%; border: none;"> <tr> <td style="width: 50%;">1. Cyanophyceae.</td> <td style="width: 50%;">2. Chlorophyceae.</td> </tr> <tr> <td>3. Euglenophyceae.</td> <td>4. Xanthophyceae.</td> </tr> <tr> <td>5. Bascillariophyceae.</td> <td>6. Phaeophyceae.</td> </tr> <tr> <td>7. Rhodophyceae.</td> <td></td> </tr> </table>	1. Cyanophyceae.	2. Chlorophyceae.	3. Euglenophyceae.	4. Xanthophyceae.	5. Bascillariophyceae.	6. Phaeophyceae.	7. Rhodophyceae.		<b>36</b>
1. Cyanophyceae.	2. Chlorophyceae.									
3. Euglenophyceae.	4. Xanthophyceae.									
5. Bascillariophyceae.	6. Phaeophyceae.									
7. Rhodophyceae.										
<b>Unit-3</b>	<p>Brief discussion in relation to the morphology and systematic position of the following groups.</p> <table style="width: 100%; border: none;"> <tr> <td style="width: 50%;">1. Chrysophyceae.</td> <td style="width: 50%;">2. Dinophyceae.</td> </tr> <tr> <td>3. Desmophyceae.</td> <td>4. Prasionophyceae</td> </tr> <tr> <td>5. Cryptophyceae.</td> <td>6. Chloromonadophyceae</td> </tr> </table>	1. Chrysophyceae.	2. Dinophyceae.	3. Desmophyceae.	4. Prasionophyceae	5. Cryptophyceae.	6. Chloromonadophyceae	<b>12</b>		
1. Chrysophyceae.	2. Dinophyceae.									
3. Desmophyceae.	4. Prasionophyceae									
5. Cryptophyceae.	6. Chloromonadophyceae									
<p><b>Suggested Readings</b></p> <ol style="list-style-type: none"> <li>1. Anand, N. (1998). Indian Freshwater Microalgae, Bishen Singh Mahendra Pal Singh, Dehradun, India.</li> <li>2. Bold, H and Wynne. M. J (1978) Algal structure and reproduction. Prentice Hall of India pvt. Ltd. New Delhi, India.</li> <li>3. Bony, A.D. (1978). Phytoplankton. Edward Arnold pub. Ltd. London, U.K.</li> <li>4. Chapman, V.J. and Chapman D.J. (1979). The Algae. English Language Book Society and Mc. Millan, Co, London, U.K.</li> <li>5. Daws, C. J. (1981). Marine Botany. Wiley Publication Com. New York, USA.</li> <li>6. Desikachary, T.V. (1959). Cyanophyta. ICAR, New Delhi, India.</li> </ol>										

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Core Course	BOT-302 B MYCOLOGY SPECIAL PAPER-I	Lectures 60
<p><b>Course Objectives</b></p> <ol style="list-style-type: none"> <li>1. To reveal historical development in mycology.</li> <li>2. To make aware principles, rules and regulations of ICBN.</li> <li>3. To know ultra-structure of fungal cells.</li> <li>4. To study different classifications for fungal organisms.</li> <li>5. To study vegetative structure of various groups of fungi.</li> <li>6. To study reproductive structure phylogeny, interrelationship and life cycle pattern of various groups of fungi.</li> </ol> <p><b>Course Outcomes</b></p> <ol style="list-style-type: none"> <li>1. Able to know history of Mycology and Nomenclature of fungi.</li> <li>2. Able to describe life cycle patterns of various groups of fungi.</li> <li>3. Higher cognitive skills about taxonomy of fungi will develop.</li> </ol>		
<b>Unit-1</b>	<p>A) History of Mycology</p> <p>B) International code and Botanical nomenclature. Principles, major rules, Revisions and recommendations, effective and valid publications, typification, rejection of names of taxa, starting date point, priority and authority.</p> <p>C) Outline classification proposed by Ainsworth (1973), Hawksworth <i>et al.</i>, (1995) and Alexopoulos <i>et al.</i>, (1996).</p> <p>D) Ultra structure of fungal cell, cell-wall composition, septa, rhizomorph</p>	<b>05</b>
<b>Unit-2</b>	<p>Discussion of fungi with reference to vegetative structure, reproductive structure, phylogeny, interrelationship (if any) and life cycle pattern of following:</p> <p>A) <b>Myxomycota:</b> Acrasiales, Dictyosteliales, Labyrinthulales, Ceratiomyxales, Physarales, Trichiales, Stemonitales, Plasmodiophorales.</p> <p>B) <b>Mastigomycotina</b> Chytridiales, Blastocladales, Saprolegniales, Lagenidiales, Peronosporales.</p> <p>C) <b>Zygomycotina:</b> Entomophthorales, Mucorales, Endogonales</p>	<b>18</b>
<b>Unit-3</b>	<p>Discussion of fungi with reference to vegetative structure, reproductive structure, phylogeny, interrelationship (if any) and life cycle pattern of following:</p> <p><b>Ascomycotina:</b> Taphrinales, Endomycetales, Protomycetales, Eurotiales, Erysiphales, Meliolales, Clavicipitales, Sphaeriales, Xylariales, Pezizales, Laboulbeniales, Myringiales, Hysteriales, Dothidiales, Pleosporales.</p>	<b>16</b>
<b>Unit-4</b>	<p>Discussion of fungi with reference to vegetative structure, reproductive structure, phylogeny, interrelationship (if any) and life cycle pattern of following:</p> <p><b>Basidiomycotina:</b> Uredinales, Ustilaginales, Auriculariales, Dacrymycetales, Tulasnellales, Aphyllophorales, Agaricales, Lycoperdales, Nidulariales, Phallales, Podaxales.</p>	<b>15</b>
<b>Unit-5</b>	<p>Discussion of fungi with reference to vegetative structure, reproductive structure, phylogeny, interrelationship (if any) and life cycle pattern of following:</p> <p><b>Deuteromycotina:</b> Blastomycetes, Hyphomycetes, Coelomycetes.</p>	<b>06</b>
<p><b>Suggested Readings</b></p> <ol style="list-style-type: none"> <li>1. Ainsworth <i>et al.</i>, (1965-73). The fungi, An advanced treatise Vol. I-IV B, Academic press, London, UK.</li> <li>2. Alexopoulos &amp; Mims (1979). Introductory Mycology, Willey Eastern Ltd. New Dehli, India. Alexopolus, Mims and Bckwell (1996) Introductory Mycology (4th Ed.). John. Willey and Sons. Inc New York., USA.</li> </ol>		

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23. Kamat M. N. (1959). Introductory Plant Pathology Prakash Publication. Pune, India.
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Core Course	<b>BOT-302 C ANGIOSPERM SPECIAL PAPER -I</b>	<b>Lectures 60</b>
<p><b>Course Objectives</b></p> <ol style="list-style-type: none"> <li>1. To study importance of classification in Angiosperms.</li> <li>2. To study primitive and advanced groups of Angiosperm.</li> <li>3. To study taxonomic structure of Angiosperms.</li> <li>4. To study orders of Engler and Prantl's system of classification.</li> <li>5. To study botanical nomenclature of Angiosperms.</li> </ol> <p><b>Course Outcomes</b></p> <ol style="list-style-type: none"> <li>1. Able to differentiate and identify various Angiospermic plants</li> <li>2. Able to classify flowering plants.</li> <li>3. Expertise taxonomic structure and nomenclature of Angiosperm.</li> </ol>		
<b>Unit-1</b>	<p><b>Classification</b></p> <ol style="list-style-type: none"> <li>1. Need for classification, (ii) Process of classification, (iii) Classification and Aesthetics, (iv) Hierarchical classification, (v) General and special purpose classification, (vi) Horizontal and Vertical classification, (vii) Polythetic and Monothetic classification, (viii) Folk classification, (ix) Phase of Classification.</li> </ol>	<b>08</b>
<b>Unit -2</b>	<p><b>Discussion of the following with respect to</b></p> <ol style="list-style-type: none"> <li><b>1. Ranales:</b> A group of most primitive dicotyledons, evolutionary trends.</li> <li><b>2. Amentiferae:</b> A heterogenous assemblage of moderately advanced dicotyledons, evolutionary trends</li> <li><b>3. Sympetalae:</b> Heptaphyletic in origin, evolutionary trends.</li> </ol>	<b>08</b>
<b>Unit-3</b>	<p><b>Taxonomic structure</b></p> <ol style="list-style-type: none"> <li>1. Taxonomic categories</li> <li>2. Major categories</li> <li>3. Minor categories</li> <li>4. Historical development of concept of species</li> <li>5. Concept of species</li> <li>6. Intraspecific categories.</li> </ol>	<b>08</b>
<b>Unit-4</b>	<p><b>Discussion of orders as defined in Engler and Prantl's system with reference to:</b></p> <ol style="list-style-type: none"> <li>1. Range of floral variation</li> <li>2. Taxonomy, phylogeny and evolutionary trends in the</li> </ol> <p><b>Orders:</b> Helobiae, Liliflorae, Glumiflorae, Scitaminae, Microspermae, Rosales, Contortae, Tubiflorae and Centrospermae</p>	<b>25</b>
<b>Unit-5</b>	<p><b>Study of Botanical Nomenclature with respect to:</b></p> <ol style="list-style-type: none"> <li>1. Scientific names and Common names</li> <li>2. International Code of Botanical Nomenclature (ICBN)</li> <li>3. Review of Various codes: i) Paris Code (1867), ii) Rochester Code (1892), iii) Vienna Code (1905), iv) American Code (1907), v) Cambridge Code (1935), vi) Edinburgh Code (1966) vii) Leningrad Code (1978), viii) St. Louis Code (1999).</li> <li>4. Principles of the code I-V</li> <li>5. Type method (Typification) and working of Type method</li> <li>6. Author citation</li> <li>7. Rejection of names</li> <li>8. Retention of names</li> <li>9. Conservation of names</li> <li>10. New Names</li> <li>11. Names of cultivated and hybrid plants</li> </ol>	<b>11</b>



### Suggested Readings

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2. Cronquist A. 1988. The Evolution and Classification of Flowering Plants (2nd ed.) Allen Press, U.S.A.
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**Bot.303**  
**Practical- (Core Course)**  
**Practical Based on Bot-301**

**Practicals 1-2:** Study of stomatal types by peeling method

- a. Types in Dicotyledones
- b. Types in Monocotyledones

**Practical 3 :** Study of Trichomes locally available plants

**Practicals 4 & 5:** Isolation and study of wood elements by acid maceration method.

(Preparation of permanent slides by students)

**Practical 6, 7 & 8:** Study of different types of woods by double stained preparation of:

- a. Dicot woods (Covering different types)
- b. Gymnospermous wood (Any two coniferous woods)

**Practicals 9 & 10 :** Study of anomalous structures in stem from permanent or prepared slides

- i) *Bignonia*
- ii) *Aristolochia, Tinospora* (Any one)
- iii) *Boerhavia, Mirabilis, Chenopodium* and *Amaranthus*(Anytwo)
- iv) *Achyranthes*
- v) *Salvadora* and *Combretum* (Any one)
- vi) *Dracaena*

**Practicals 11 & 12:** Double stained preparation of permanent slides using microtomy. (Using any suitable plant parts like leaf, stem, root, flower, etc.)

**Practical 13 :** Types of flowers (P.S.).

**Practicals 14 and 15:** Study of development of microsporangium, microsporogenesis, microspores, male gametophyte of angiosperms with the help of permanent slides

**Practical's 16 & 17:** Study of megasporogenesis and types of female gametophytes (embryosacs) of angiosperms from permanent slides

**Practical 18 :** Study of endosperm types (P.S.)

**Practical 19 :** Study of stages of embryo development (P.S.)

**Practical's 20 & 21:** Dissection and mounting of different stages of embryo development using suitable materials (e.g. *Cyamopsis tetragonaloba* and *Cucumis* and multiple embryos in *Citrus* seeds.)

**Practical 22:** Study of pollen units: monads, dyads, tetrads, polyads, pollinia

**Practicals 23 & 24:** Pollen/ Spore preparation of the following using acetolysis or any other suitable method:

- i. Angiosperm pollens
- ii. Gymnosperm pollens
- iii. Bryophytes types
- iv. Pteridophytes types

Note:

- i) Submission of permanent slide preparation at least two dicot woods and Two Gymnosperm woods and two whole mounts of wood maceration is necessary.
- ii) Submission of permanent slides at least one vegetative/ floral part.
- iii) Submission of five palynological slides is compulsory.

## BOT.304

### PRACTICAL-II (Core course)

#### (Based on BOT. 302 A Phycology Special Paper I)

##### Practical 1-8: Chlorophyceae

**A) Volvocales:**

*Chlamydomonas, Dunaliella, Pandorina, Eudorina, Volvox, and Gonium* (Any locally available forms)

**B) Chlorococcales:**

*Chlorococcum, Chlorella, Trebauxia, Tetraedron, Characium, Charasiophon, Ankistrodesmus, Selenestrum, Oocystis, Botryococcus, Coelastrum, Scenedesmus, Pediastrum, Hydrodictyon, Protosiphon* and *Crucigenia*. (Any locally available forms)

**C) Ulotrichales:** *Ulothrix, Uronema, Microspora, Sphaeroplea, Cyliandrocapsum, Ulva, Enteromorpha, Schizomeris* and *Monostroma*, (Any locally available forms)

**D) Chaetophorales:**

*Stigeoclonium, Chaetophora, Draparnaldia, Draparnaldiopsis, Fritschiella, Coleochaete, Trentepohlia*, and *Cephaleuros* (Any locally available forms)

**E) Cladophorales:**

*Cladophora, Rhizoclonium, Pithophora, Chaetomorpha*, and *Sponogomarpha* (Any locally available forms)

**F) Oedogoniales:**

*Oedogonium, Bulbochaete* and *Oedocladium* (Any locally available forms)

**G) Conjugales:**

*Spirogyra, Zygnema, Mougeotia, Sirogonium, Sirocladium, Cosmarium, Euastrum, Pleurotaenium, Closterium* and *Cylindrocystis* (Any locally available forms)

**H) Siphonales:**

*Caulerpa, Bryopsis, Dichotomosita, Codium, Halimeda, Udotea, Chaetomorpha, Boergesenia, Valonia, Valoniopsis, Neomeris, Acetabularia* and *Tydemania* (Any locally available forms)

**I) Charales:** *Chara* and *Nitella* (Any locally available forms)

##### Practical 9-10:

**A) Xanthophyceae:** *Vaucheria* and *Botrydium* (Any locally available forms)

**B) Chrysophyceae:** *Dinobryon* and *Synura* (Any locally available forms)

**C) Bacillariophyceae:** *Coscinodiscus, Melosira, Cyclotella, Chaetoceros, Cymbella, Cocconeis, Biddulphia, Navicula, Nitzschia, Synedra, Pinnularia, Fragilaria, Gyrosigma, Pleurosigma, Gomphonema* and *Surirella*. (Any locally available forms)

**D) Euglenophyceae:** *Euglena, Phacus, Lepocinclis* and *Trachelomonas* (Any locally available forms)

##### Practical 11-13: Phaeophyceae:

*Ectocarpus, Giffordia, Sphacelaria, Dictyota, Padina, Stoechospermum, Spatoglossum, Dictyopteris, Iyengaria, Colpomenia, Hydroclathrus, Sargassum, Turbinaria, Zonaria, Rosenvingeia, Laminaria, Fucus, Cystoseria, Chnoospora, Macrocystis, Nereocystis* and *Postelsia* (Any locally available forms)

##### Practical 14-16: Rhodophyceae:

*Porphyra, Compsopogon, Batrachospermum, Liagora, Scinia, Gelidium, Gelidiella, Grateloupia, Gracilaria, Hypnea, Rhodymenia, Champia, Ceramium, Caloglossa, Acanthophora, Chondrus, Laurencia, Polysiphonia, Asparagopsis, Helminthocladia, Sebdenia, Halymenia, Botryocladia, Gastroclonium, Nemalion* and *Amphiroa* (Any locally available forms)

**Practical 17-21:** Cyanophyceae :

*Chroococcus, Gloeocapsa, Gloeotheca, Merismopedia, Aphanothece, Coelosphaerium, Microcystis, Oscillatoria, Phormidium, Lyngbya, Arthrospira, Spirulina, Gloeothrichia, Cyndrospermum, Nostoc, Anabaena, Nostochopsis, Hapalosiphon, Stigonema, Tolypothrix, Rivularia, Calothrix and Dichothrix* (Any locally available forms)

**Practical 22 – 23:** Artificial key of the genera based on Morphology and Reproductive Characters.

**Practical 24:** Field work Surveys and collection of algae from local water reservoir as ponds, rivers, lakes and polluted habitats.

Notes:

(i) Classification of algae should be followed according to F. E. Fritsch

(ii) Students will submit their scientific survey reports and algal collection at the time of examination.

**BOT.304**  
**PRACTICAL-II (Core course)**  
**(Based on BOT. 302 B Mycology Special Paper I)**

Study of the representative genera belonging to following groups with respect to observations made based on accessory organs, asexual and sexual structures, fruiting body ascocarp/ basidiocarp/ Pycnidia. (Study should be based on genera collected from the regular field trips and outside tours.)

Practical: 01-03	Myxomycota (Any 10 Genera)
Practical: 04-05	Mastigomycotina (Any 08 Genera)
Practical: 06	Zygomycotina (Any 04 Genera)
Practical :07-12	Ascomycotina (Any 20 Genera)
Practical: 13-18	Basidiomycotina (Any 20 Genera)
Practical: 19-20	Deuteromycotina (Any 08 Genera)
Practical: 21-22	Preparation of artificial key based on appropriate characters
Practical: 23	Isolation of aquatic fungi by baiting in the laboratory
Practical: 24	Botanical Excursion

**Note:** Botanical excursion, collection of fungal specimens, tour report and submission of fungal specimens/Photographs is compulsory.

**BOT.304**  
**PRACTICAL-II (Core course)**  
**(Based on BOT. 302 C Angiosperm Special Paper I)**

**Practical 1-17:** Study of Angiospermic families locally available in the region covering all orders/series (*Sensu* Bentham and Hooker, at least 30 families).

**Practical 18-19:** Preparation of artificial dichotomous keys of (i) indented (ii) bracketed type based on vegetative and floral characters.

**Practical 20-23:** Identification of plant specimens up to species level with help of flora's

**Practical 24:** To study the herbarium techniques

**Note:**

Botanical excursion is compulsory and students should submit botanical excursion report and digital herbarium/photograph of the plants.

Core Course	<p style="text-align: center;"><b>BOT-305 A</b> <b>BIostatISTICS AND BIOinformatics</b></p>	<p style="text-align: center;"><b>Lectures</b> <b>60</b></p>
<p><b>Course Objectives</b></p> <ol style="list-style-type: none"> <li>To understand the ways to report the results in a scientific way.</li> <li>Explain the concept of a random, representative sample from population.</li> <li>To recognize importance of Biostatistics in interpreting the biological data and design suitable experiments.</li> <li>Compare two (or more) groups based on continuous, categorical data using comparative measures and hypothesis tests.</li> <li>To use Bioinformatic tools to analyze different protein or nucleotide sequences to reach meaningful conclusions.</li> </ol> <p><b>Course Outcomes</b></p> <ol style="list-style-type: none"> <li>Able to understand the ways to report the results in a scientific way.</li> <li>Able to recognize importance of Biostatistics in interpreting the biological data</li> <li>Expertise in Bioinformatic stools to analyze different protein or nucleotide sequences</li> </ol>		
<p style="text-align: center;"><b>Unit-1</b></p>	<p><b>Fundamental of biostatistics:</b> Introduction to Biostatistics, Definition, Population, Sample and Samplings, Variables in biology, Types of variables, Collection of data, Types of data, Classification of data, Tabulation of data, Graphic representation of data (Histogram, Frequency Polygon, Frequency curve, Cumulative frequency curve), Significance and limitation of graphic representation.</p>	<p style="text-align: center;"><b>10</b></p>
<p style="text-align: center;"><b>Unit-2</b></p>	<p><b>Statistical Methods I:</b> A- Measure of Central tendency: Mean, Median, Mode; Merits and Demerits of central tendency B- Measure of Dispersion: Range, Mean Deviation/ Average Deviation, Standard Deviation, Coefficient of Variation; Merits and Demerits of Measure of Dispersion. C- Probability: Addition rule, Multiplication rule; Probability Distribution: Normal, Binomial and Poisson.</p>	<p style="text-align: center;"><b>10</b></p>
<p style="text-align: center;"><b>Unit-3</b></p>	<p><b>Statistical Methods II:</b> Chi-Square test (<math>X^2</math>- test), Test of Significance (t-test/Student test), Analysis of Variance (ANOVA) Correlation and Regression: Correlation analysis, Types of correlation, Methods of studying of correlation, Degree of correlation, significance test of correlation coefficient. Regression Analysis: Linear regression analysis.</p>	<p style="text-align: center;"><b>10</b></p>
<p style="text-align: center;"><b>Unit-4</b></p>	<p><b>Introduction to Bioinformatics:</b> Definition of Bioinformatics- History of Bioinformatics, scope and application of Bioinformatics. Fundamentals of Internet, www, HTML, URLs, Role of internet and www in bioinformatics. Biological Data Acquisition- The form of biological information; DNA sequencing methods – basic DNA sequencing, Types of DNA sequences – genomic DNA, cDNA, Expressed sequence tags (ESTs), Genomic survey sequences (GSSs); Databases: Format and Annotation Common sequencing file formats – NBRF/ PIR, FASTA, Files for multiple sequence alignment – multiple sequence format (MSF), ALN format; Files for structural data – PDB format. Bioinformatics Databases: -</p>	<p style="text-align: center;"><b>10</b></p>

	<p>Primary sequence databases (GenBank-NCBI, the nucleotide sequence database-EMBL, DNA sequence databank of Japan-DDBJ; Protein sequence and structure databases (PDB, SWISS-PROT and TrEMBL); Derived (Secondary) Databases of Sequences and Structure: Posited, PRODOM, PRINTS, Pfam, BLOCK, SSOP, and CATH. Enzyme Database, Biodiversity Database.</p>	
<p><b>Unit-5</b></p>	<p><b>Technique's in Bioinformatics:</b>  Sequence alignment, database searching and structure prediction Pairwise sequence alignment, database similarity searching, FASTA, and BLAST. Multiple sequence alignment and analysis with CLUSTAL X and CLUSTAL W. Measurement of sequence similarity; Similarity and homology. Phylogenetic tree. Phylogenetic data analysis, tree building methods, tree evaluation &amp; interpretation methods. Phylogenetic analysis with PHYLIP software. Prediction of secondary and tertiary structures with different software's and tools. Structure visualization software's.</p> <p>Introduction to Genomics and Proteomics: -  Introduction to genomics- scope and application, Computational genomics, Organization of the prokaryotic and eukaryotic genomes, Human Genome Project. Genome maps and types, current sequencing technologies, partial sequencing, gene identification, gene prediction rules and software, Genome databases; Annotation of genome, Genome diversity: taxonomy and significance of genomes –bacteria, yeast, Homo sapiens, Arabidopsis, etc. Functional Genomics - Microarray - Gene Expression, methods for gene expression analysis; Applications of DNA microarray.</p>	<p><b>20</b></p>
<p><b>Suggested Readings</b></p> <ol style="list-style-type: none"> <li>1. Arora, P. N. and P. K. Malhan (2006) Biostatistics: Himalaya Publishing House, Girgaon Mumbai-400004. Pp. 578.</li> <li>2. Baxevanis, A.D. and Francis Ouellette, B.F. (1998) "Bioinformatics– a practical guide to the analysis of genes and proteins" John Wiley and Sons</li> <li>3. Cantor C.R., Smith C.L., (1993) "Genomics: the science and technology behind the Human Genome Project" John Wiley and Sons</li> <li>4. Choudhuri S., Carlson D. B. (2008), "Genomics: fundamentals and applications" Informa Healthcare</li> <li>5. Griffiths A. J. F., Miller J.H., Suzuki D.T., (2000) "An Introduction to Genetic Analysis" W.H. Freeman and Co., Publishers.</li> <li>6. Khan Irfan Ali and Atiya Khanum (2004): Fundamental of Biostatistics. Ukaaz Publication, Hyderabad- 500036 (Andhra Pradesh). Pp. 498.</li> <li>7. Mount, D. (2004) "Bioinformatics: Sequence and Genome Analysis"; Cold Spring Harbor Laboratory Press, New York. (ISBN 0-87969-712-1)</li> <li>8. N. Gurumani (2005) An Introduction to Biostatistics. MJP Publishers, Chennai- 600005.Pp. 407.</li> <li>9. Pevsner J (2009), "Bioinformatics and functional genomics", Edition 2, John Wiley and Sons</li> <li>10. Primrose S. B., Twyman R. M. (2004), "Genomics: applications in human biology" Wiley-Blackwell</li> <li>11. Primrose S. B., Twyman R. M. (2006), "Principles of gene manipulation and genomics" WileyBlackwell</li> <li>12. Saccone C., Pesole G., (2003), "Handbook of comparative genomics: principle and methodology" John Wiley and Sons</li> <li>12. Sharma, V. Munjal, A. and Shankar, A. (2008) "A text book of Bioinformatics" first edition, Rastogi Publication, Meerut – India.</li> <li>13. Suhai S (2000), "Genomics and proteomics: functional and computational aspects" Springer</li> <li>14. Bergman N. H. (2007), "Comparative genomics" Volume 2, Humana Press</li> </ol>		



Core Course	<b>BOT-305 B TECHNIQUES IN PLANT SCIENCES</b>	<b>Lectures 60</b>
<p><b>Course Objectives</b></p> <ol style="list-style-type: none"> <li>1. To study principles and applications of technique used in life science</li> <li>2. To know the principles and application of Microscopy</li> <li>3. To know the principles and application of Microtomy, Histochemical and Cytochemical techniques</li> <li>4. To know the principles and application of Chromatography and Centrifugation techniques</li> <li>5. To know the principles and application of Electrophoretic and Molecular biology techniques</li> <li>6. To know the principles and application of Spectroscopic techniques.</li> </ol> <p><b>Course Outcome</b></p> <ol style="list-style-type: none"> <li>1. Able to operate all the instruments.</li> <li>2. Expertize in instrumentation calibration and Practical application.</li> </ol>		
<b>Unit-1</b>	<p><b>Microscopy</b></p> <ol style="list-style-type: none"> <li>1.1 Image formation (properties of light), Lens- refraction, dispersion of light, objects, images, image quality, magnification concept, resolution</li> <li>1.2 Light microscopy, Confocal microscopy, Phase Contrast microscopy, Fluorescence microscopy, Electron microscopy (SEM and TEM), Flow cytometry.</li> </ol>	<b>12</b>
<b>Unit-2</b>	<p><b>Microtomy, Histochemical and Cytochemical technique</b></p> <ol style="list-style-type: none"> <li>2.1 Dissection, maceration, squash, peeling and whole mount pre-treatment and procedures</li> <li>2.2 Serial sectioning, double or multiple staining, lesser assisted Microtomy</li> <li>2.3 Localization of specific Compounds/reactions/ activities in tissues and cells</li> </ol>	<b>12</b>
<b>Unit-3</b>	<p><b>Chromatography techniques and Centrifugation techniques</b></p> <ol style="list-style-type: none"> <li>3.1 Introduction, concept of partition coefficient, Paper, TLC, Column, Gel filtration</li> <li>3.2 Affinity, Ion exchange, HPLC</li> <li>3.3 Gas Chromatography techniques</li> <li>3.4 Principles, Rotors, Factors affecting centrifugation, Ultracentrifugation,</li> <li>3.5 Density Gradient Centrifugation, High speed centrifuges</li> </ol>	<b>12</b>
<b>Unit-4</b>	<p><b>Electrophoretic and Molecular biology techniques</b></p> <ol style="list-style-type: none"> <li>4.1 History, Principles, Agarose gel electrophoresis, Pulsed Field Gel Electrophoresis, Polyacrylamide Gel Electrophoresis (PAGE/ Native)</li> <li>4.2 Sodium Dodecyl Sulphate polyacrylamide gel electrophoresis (SDS-PAGE/ Denaturing),</li> <li>4.3 Isoelectric focusing, 2 Dimensional Gel Electrophoresis (2-D method), Blotting techniques</li> <li>4.4 DNA sequencing techniques- Sanger's method, Maxam- Gilbert's method, Automated DNA sequences, Pyrosequencing</li> <li>4.5 Sequencing of proteins and PCR</li> <li>4.6 DNA microarray</li> </ol>	<b>12</b>
<b>Unit-5</b>	<p><b>Spectroscopic techniques</b></p> <ol style="list-style-type: none"> <li>5.1 General principles, Beer and Lambert's Law, Molar extinction coefficient, Spectrophotometer (working and application)</li> <li>5.2 UV-Visible spectroscopy, Nuclear Magnetic</li> <li>5.3 Resonance (NMR) spectroscopy,</li> <li>5.4 X-ray crystallography, Spectro-fluometry</li> <li>5.5 AAS, MS, IR Spectroscopy</li> </ol>	<b>12</b>

### Suggested Readings

1. Annie and Arumugam (2000). Biochemistry and Biophysics, Saras Publishing, Tamilnadu.
2. Bisen P.S. Mathur S. (2006). Life Science in Tools and Techniques. CBS Publishers, Delhi.
3. Egerton R.F. Physical Principle of Electron Microscopy: an Introduction to TEM, SEM and AEM.
4. Gamborg O.L., Philips G.C. (Eds.) (1995). Plant Cell, Tissue and Organ Culture fundamental Methods. Narosa Publishing House (P) Ltd.
5. Gunadegaram P. (1995). Laboratory Manual in Microbiology. New Age International (P) Ltd.
6. Harborne J.B. (1998). Phytochemical Methods. Springer (I) Pvt. Ltd.
7. Khasim S.M. (2002). Botanical Micro techniques: Principles and Practice. Capital Publishing Company.
8. Krishnamurthy K.V. (1999). Methods in Cell Wall Cytochemistry. CRC Press. LLC.
9. Marimuthu R. (2008). Microscopy and Microtechnique. MJP Publishers, Chennai.
10. Pal and Ghaskadabi (2009). Fundamentals of Molecular Biology. Oxford Publishing Co.
11. Plummer David (1987). An Introduction to Practical Biochemistry. 3rd Eds. Tata Mc Graw-Hill Publishing Company Ltd.
12. Prasad and Prasad (1984). Outline of Microtechnique. Emkay Publications, Delhi.
13. Sadasivam S., Manickam A. (1996). Biochemical Methods. 2nd Edn. New Age International (P) Ltd.
14. Sass John E. (1984). Botanical Microtechniques. Tata McGraw-Hill Publishing Company Ltd.
15. Sharma V.K. (1991). Techniques in Microscopy and Cell Biology. Tata McGraw-Hill Publishing Company Ltd.
16. Srivastava S. and Singhal V. (1995). Laboratory Methods in Microbiology. Anmol Publication Pvt. Ltd. Delhi.
17. Srivistava M.L. (2008). Bioanalytical Techniques. Narosa Publishing House (P) Ltd.
18. Wilson K., Walker J. (2000). Practical Biochemistry Principles and Techniques. Cambridge University Press.
19. Wilson K., Walker J. (2005). Principles and Techniques in Biochemistry and Molecular Biology. Cambridge University Press.

## M.Sc. Part-II Semester-III Botany: Audit Courses

<b>AC-301 A: Computer Skills (2 Credits)</b>	
<b>Unit 1</b>	<p><b>Elements of Information Technology</b></p> <p>1.1 Information Types: Text, Audio, Video, and Image, storage formats</p> <p>1.2 Components: Operating System, Hardware and Software, firmware</p> <p>1.3 Devices: Computer, Mobile Phones, Tablet, Touch Screen, Scanner, Printer, Projector, smart boards.</p> <p>1.4 Processor &amp; Memory: Processor functions, speed, Memory types: RAM/ROM/HDD/DVDROM/Flash drives, memory measurement metrics</p>
<b>Unit 2</b>	<p><b>Office Automation- Text Processing</b></p> <p>2.1 Views: Normal View, Web Layout View, Print Layout View, Outline View, ReadingLayout View</p> <p>2.2 Working with Files: Create New Documents, Open Existing Documents, Save Documents to different formats, Rename Documents, Close Documents</p> <p>2.3 Working with Text: Type and Insert Text, Highlight Text, Formatting Text, Delete Text, Spelling and Grammar, paragraphs, indentation, margins</p> <p>2.4 Lists: Bulleted and Numbered Lists,</p> <p>2.5 Tables: Insert Tables, Draw Tables, Nested Tables, Insert Rows and Columns, Move and Resize Tables, Moving the order of the column and/or rows inside a table, Table Properties</p> <p>2.6 Page Margins, Gutter Margins, Indentations, Columns, Graphics, Print Documents,</p> <p>2.7 Paragraph Formatting, Paragraph Attributes, Non-printing characters</p> <p>2.8 Types of document files: RTF, PDF, DOCX etc</p>
<b>Unit 3</b>	<p><b>Office Automation-Worksheet Data Processing</b></p> <p>3.1 Spreadsheet Basics: Adding and Renaming Worksheets, Modifying Worksheets,</p> <p>3.2 Moving Through Cells, Adding Rows, Columns, and Cells, Resizing Rows and Columns, Selecting Cells, Moving and Copying Cells</p> <p>3.3 Formulas and Functions: Formulas, Linking Worksheets, Basic Functions, AutoSum, Sorting and Filtering: Basic Sorts, Complex Sorts, Auto-fill, Deleting Rows, Columns, and Cells</p> <p>3.4 Charting: Chart Types, drawing charts, Ranges, formatting charts</p>
<b>Unit 4</b>	<p><b>Office Automation-Presentation Techniques and slide shows</b></p> <p>4.1 Create a new presentation, AutoContent Wizard, Design Template, Blank Presentation, Open an Existing Presentation, PowerPoint screen, Screen Layout</p> <p>4.2 Working with slides: Insert a new slide, Notes, Slide layout, Apply a design template, Reorder Slides, Hide Slides, Hide Slide text, Add content, resize a placeholder or textbox, Move a placeholder or text box, Delete a placeholder or text box, Placeholder or Text box properties, Bulleted and numbered lists, Adding notes</p> <p>4.3 Work with text: Add text and edit options, Format text, copy text formatting, Replace fonts, Line spacing, Change case, spelling check, Spelling options</p> <p>4.4 Working with tables: Adding a table, Entering text, Deleting a table, Changing row width, Adding a row/column, Deleting a row/column, Combining cells, Splitting a cell, Adding color to cells, To align text vertically in cells, To change table borders, Graphics, Add clip art, Add an image from a file, Save &amp; Print, slide shows, slide animation/transitions.</p>
<b>Unit 5</b>	<p><b>Internet &amp; Applications:</b></p> <p>5.1 Computer Network Types: LAN, PAN, MAN, CAN, WAN, Defining and describing the Internet, Brief history, Browsing the Web, Hypertext and hyperlinks, browsers, Uniform resource locator</p> <p>5.2 Internet Resources: Email, Parts of email,</p> <p>5.3 Protecting the computer: Password protection, Viruses, Virus protection software, Updating the software, Scanning files, Net banking precautions.</p>

	<p>5.4 Social Networking: Features, Social impact, emerging trends, issues, Social Networking sites: Facebook, Twitter, linkedin, orkut, online booking services</p> <p>5.5 Online Resources: Wikipedia, Blog, Job portals, C.V. writing</p> <p>5.6 e-learning: e-Books, e-Magazines, e-Newspapers, OCW(open course wares): Sakshat(NPTEL) portal, MIT courseware</p>
<p><b>Unit 6</b></p>	<p><b>Cloud Computing Basics</b></p> <p>6.1 Introduction to cloud computing</p> <p>6.2 Cloud computing models: SAS, AAS, PAS</p> <p>6.3 Examples of SAS, AAS, PAS (DropBox, Google Drive, Google Docs, Office 365 Prezi, etc.)</p>

<b>AC-301 B: Cyber Security(2 Credits)</b>	
<b>Unit 1</b>	<p><b>Networking Concepts Overview</b>  Basics of Communication Systems, Transmission Media, ISO/OSI and TCP/IP models, Network types: Local Area Networks, Wide Area Networks, Internetworking, Packet Formats, Wireless Networks: Wireless concepts, Advantages of Wireless, Wireless network architecture, Reasons to use wireless, Internet.</p>
<b>Unit 2</b>	<p><b>Security Concepts</b>  Information Security Overview, Information Security Services, Types of Attacks, Goals for Security, E-commerce Security, Computer Forensics, Steganography. Importance of Physical Security, Biometric security &amp; its types, Risk associated with improper physical access, Physical Security equipments. Passwords: Define passwords, Types of passwords, Passwords Storage – Windows &amp; Linux.</p>
<b>Unit 3</b>	<p><b>Security Threats and vulnerabilities</b>  Overview of Security threats, Hacking Techniques, Password Cracking, Types of password attacks, Insecure Network connections, Wi-Fi attacks &amp; countermeasures, Information Warfare and Surveillance. Cyber crime: e-mail related cyber crimes, Social network related cyber crimes, Desktop related cyber crimes, Social Engineering related cyber crimes, Network related cyber crimes, Cyber terrorism, Banking crimes,</p>
<b>Unit 4</b>	<p><b>Cryptography</b>  Understanding cryptography, Goals of cryptography, Types of cryptography, Applications of Cryptography, Use of Hash function in cryptography, Digital signature in cryptography, Public Key infrastructure,</p>
<b>Unit 5</b>	<p><b>System &amp; Network Security</b>  System Security: Desktop Security, email security: PGP and SMIME, Web Security: web authentication, Security certificates, SSL and SET, Network Security: Overview of IDS, Intrusion Detection Systems and Intrusion Prevention Systems, Overview of Firewalls, Types of Firewalls, VPN Security, Security in Multimedia Networks, Fax Security.</p>
<b>Unit 6</b>	<p><b>OS Security</b>  OS Security Vulnerabilities updates and patches, OS integrity checks, Anti-virus software, Design of secure OS and OS hardening, configuring the OS for security, Trusted OS.</p>
<b>Unit 7</b>	<p><b>Security Laws and Standards</b>  Security laws genesis, International Scenario, Security Audit, IT Act 2000 and its amendments.</p>

**M.Sc. Part II Semester IV Botany: Core Special Paper**

Core Course	<p align="center"><b>BOT-401 A</b></p> <p align="center"><b>PHYCOLOGY SPECIAL PAPER-II</b></p>	Lectures <b>60</b>
<p><b>Course Objectives:</b></p> <ol style="list-style-type: none"> <li>1. To know cellular details of prokaryotic and eukaryotic algae.</li> <li>2. To understand algal physiology, biochemistry and genetics.</li> <li>3. To know about cultivation of algae and its application.</li> <li>4. To aware about commercial utilization of algae.</li> <li>5. Role of algae in industries.</li> </ol> <p><b>Course Outcomes:</b></p> <ol style="list-style-type: none"> <li>1. Able to understand algal physiology, biochemistry</li> <li>2. Able to cultivate algae for its utilization</li> </ol>		
<b>Unit I</b>	<p><b>Algal Cell Biology and Genetics:</b></p> <ol style="list-style-type: none"> <li>1. Prokaryotic, Mesokaryotic, Eukaryotic Cell structure and cellular organelles</li> <li>2. Cell wall, Flagella, Cell division in algae</li> <li>3. Type of Chloroplast / Plastids, Structure and arrangement of Thylakoid, Stroma.</li> <li>4. Endoplasmic Reticulum, Gas vacuoles, Golgi bodies, Mitochondria</li> <li>5. The nucleus and nuclear divisions, Cell Division and Chromosomes in algae</li> <li>6. Extra chromosomal Inheritance</li> <li>7. Plastid DNA</li> <li>8. Cyanophages</li> <li>9. Sexuality (All three types)</li> </ol>	<b>15 L</b>
<b>Unit II</b>	<p><b>Algal Physiology and Biochemistry:</b></p> <ol style="list-style-type: none"> <li>1. Biochemical characteristics of Algal pigments and Extracellular products</li> <li>2. Biochemicals from algae:               <ol style="list-style-type: none"> <li>a) Carbohydrates and Proteins in Algae</li> <li>b) Essential fatty Acids</li> <li>c) Plant growth regulators</li> </ol> </li> <li>3. Algal toxins: Effect of toxins, mode of action, problems and prospects.</li> <li>4. Nutrition in algae:               <ol style="list-style-type: none"> <li>a) Mineral nutrition: Macronutrients and Micronutrients</li> <li>b) Types of Nutrition: Phototropic, Chemotropic.</li> </ol> </li> <li>5. Biological nitrogen fixation:               <ol style="list-style-type: none"> <li>a) Role of enzyme nitrogenase, hydrogenase</li> <li>b) Mechanism of nitrogen fixation</li> <li>c) Nitrogen fixing blue green algae</li> <li>d) Heterocyst development and site of nitrogen fixation</li> <li>e) Factors affecting on nitrogen fixation</li> <li>f) Calcification and Silicification.</li> </ol> </li> </ol>	<b>15 L</b>
<b>Unit III</b>	<p><b>Algal Cultivation</b></p> <ol style="list-style-type: none"> <li>1. Definition, General requirements for culturing of algae, types of culture media</li> <li>2. Preparatory culture, isolation of algae, streak culture, nutritive solution, dilution culture</li> <li>3. Types of cultures: Enrichment culture synchronous culture, continuous culture, mass culture.</li> <li>4. Cultivation of algae in waste water</li> <li>5. Current status of the large-scale culture of algae in India</li> </ol>	<b>12 L</b>

<b>Unit IV</b>	<p><b>Marine Algal Cultivation</b></p> <ol style="list-style-type: none"> <li>1. Introduction, Necessity of marine algal cultivation.</li> <li>2. Principle methods of cultivation :             <ol style="list-style-type: none"> <li>a) Vegetative propagation / <i>Eucheuma</i> type mariculture</li> <li>b) Nonmotile spore type / <i>Porphyra</i> type mariculture</li> <li>c) Motile spore (Zoospore) type / The <i>Laminaria</i> type Mariculture.</li> </ol> </li> <li>3. Marine algal cultural status and utilization in India</li> </ol>	<b>08 L</b>
<b>Unit V</b>	<p><b>Algal Utilization</b></p> <ol style="list-style-type: none"> <li>1. Nutritional Value of Microscopic and Macroscopic algae</li> <li>2. Micro algae industrial raw material.</li> <li>3. Industrial uses: Agar Agar, Alginates, Carrageen and other by products of marine algae.</li> <li>4. Algal fuel: Biogas from algae, algal energy products, Hydrocarbons from algae</li> <li>5. Cyanobacteria in human welfare: Production of fine chemicals, polysaccharides, bioactive molecules, pigments, antioxidants, and biofertilizer, Reclamations of Usar soils</li> <li>6. Algae in Pharmacy Iodine, Vitamins, Proteins, Antibiotics.</li> <li>7. Human food: Role of algae as nutrients supplement.</li> </ol>	<b>10 L</b>
<p><b>Suggested Readings:</b></p> <ol style="list-style-type: none"> <li>1. C. Van den Hoke, D. G. Mann &amp; H.M. Jahns (1995) <i>Algae An Introduction to Phycology</i>, Cambridge University Press</li> <li>2. Carr N.G. &amp; B. A. Whitton (1982) <i>The Biology of Cyanobacteria Botanical Monograph Vol-II</i> Blackwell Scientific Publication, London, UK.</li> <li>3. Janet R. Stein (1975) <i>Phycological methods</i>, Cambridge University Press.</li> <li>4. John D. Dodge ( 1973 ) <i>The Fine Structure of algal cells</i>, Academic Press, New York, USA.</li> <li>5. John S. Burlew (1976) <i>Algal Culture from Laboratory to Pilot Plant</i>, Crnegie Institution of Washington Publication 600, Washington, D. C., USA.</li> <li>6. Peter S. Dixon ( 1973) <i>Biology of the Rhodophyta</i>, Oliver &amp; Boyd Croythorn House, 23 Ravelston Terrace, Edinburgh</li> <li>7. Ralph A. Lewin. (1976) <i>The Genetics of Algae (Botanical Monographs Vol. 12)</i>, Blackwell Scientific Publications, Oxford.</li> <li>8. Tilden J. E. (1968) <i>The Algae and Their life relations (Fundamentals of Phycology)</i> Hafner Publishing Co, London, UK.</li> <li>9. Alan J. Brook (1981) <i>The Biology of Desmids</i>. University of California Press , Berkeley.</li> </ol>		

**M.Sc. Part II Semester IV Botany: Core Special Paper**

Core Course	<p align="center"><b>BOT-401 B</b></p> <p align="center"><b>MYCOLOGY SPECIAL PAPER-II</b></p>	Lecture 60
<p><b>Course Objectives:</b></p> <ol style="list-style-type: none"> <li>1) Identify, characterize, maintain industrially important moulds</li> <li>2) To learn possibilities for fungal growth, fermentation technology, production of alcohol, antibiotics, enzymes, organic acid.</li> <li>3) To study mushroom technology, fungal toxins.</li> <li>4) To provide students with knowledge of harmful and beneficial soil microflora.</li> <li>5) To learn role of soil microorganism, environmental aspects, symbiosis, nitrogen fixation.</li> <li>6) To study the fungal ecology, make students aware about fungal biotechnology.</li> <li>7) To learn the fungal genetics, improvement of fungal strains.</li> </ol> <p><b>Course Outcomes:</b></p> <ol style="list-style-type: none"> <li>1) This paper acquaints students with maintenance and preservation industrial important fungi.</li> <li>2) Able to know fermentation technology, mushroom technology, fungal toxins, soil microflora, importance of soil microflora, nitrogen fixation, fungal ecology, fungal genetics and fungal biotechnology.</li> </ol>		
Unit I	<p><b>Industrial Mycology:A</b></p> <ol style="list-style-type: none"> <li>i) Maintenance and Preservation of Cultures</li> <li>ii) Methods of Sterilization: Physical, Chemical, Radiations</li> <li>iii) Principals of Microbial Growth: Batch Cultures, Continuous Culture, Synchronous Culture</li> <li>iv) Assay Methods for Fermentation Products: Physical, Chemical and Biological Methods</li> <li>v) Mushroom Cultivation: Important steps involved in cultivation of <i>Agaricus</i> (Button) and <i>Pleurotus</i> (Dhingri) mushrooms on large Scale.</li> </ol>	12 L
Unit II	<p><b>Industrial Mycology: B</b></p> <ol style="list-style-type: none"> <li>i) Fermentation Methods for- Alcohol Production, Citric acid Production, Antibiotic (Penicillin) Production, Vitamins (Vitamin B12, Vitamin A B-Carotene, Riboflavin and Gibberellin ) Production, Enzymes Production</li> <li>ii) Non Alcoholic Beverages: Tea, Coffee, Cocoa</li> <li>iii) Retting/Rotting of Fibres</li> <li>iv) Fungal Toxins: Fungal toxins affecting animals and man- Mycotoxins of Food and Feed, Ergot toxins, Mushroom toxins.</li> </ol>	12 L
Unit III	<p><b>Soil Microbiology:</b></p> <ol style="list-style-type: none"> <li>i) Structure of soil, Types of soil, Microbial distribution in soil</li> <li>ii) Role of microbes in soil and their effect on plant growth.</li> <li>iii) Humus and its role in agriculture</li> <li>iv) Rhizosphere and Rhizoplane</li> <li>v) Microbial association in soil, Nitrogen fixation</li> </ol>	14 L
Unit IV	<p><b>Fungal Ecology:</b></p> <ol style="list-style-type: none"> <li>i) Fungi in extreme environment- Thermophilic and Psychrophilic fungi</li> <li>ii) Heterotrophy and consequences, practical exploitation of saprotrophy</li> <li>iii) Fungi as control agents-Entomogenous, Nematophagus and Mycoparasites</li> </ol> <p><b>Fungi and Biotechnology:</b></p> <ol style="list-style-type: none"> <li>i) Fungi in Industry- Mycoprotein, Growth Hormone, Miscellaneous products as Zearalenone, Mycoinsecticides, Mycoweedicides.</li> <li>ii) Mycorrhiza- Mass cultivation and its uses in agriculture and forest.</li> </ol>	12 L



	<ul style="list-style-type: none"> <li>iii) Protoplast isolation and fission</li> <li>iv) Engineering plants for resistance to disease and pest</li> </ul>	
Unit V	<p>Fungal Genetics:</p> <ul style="list-style-type: none"> <li>i) Incompatibility System, Tetrad analysis</li> <li>ii) Sexual reproductive structures in Ascomycetes and Basidiomycetes</li> <li>iii) Parasexual Cycle</li> <li>iv) Industrial strain improvement in Penicillium, Yeast and Mushroom</li> </ul>	<b>10 L</b>

**Suggested Readings:**

- Barron J. H. (1975) The nematodes destroying Fungi. Can. Biol. Pub. Ltd. Gulph Ontario
- Burnett J. H. (1975) Myogenetics: Introduction to General Genetics of Fungi Wiley- Blackwell, London.
- Casida L. F.JR. (1968) Industrial Microbiology New International Publishers, New Delhi.
- Dayal R. (2000) Predaceous Fungi Common wealth Publishers.
- Dubey R. C. (1995) A text Book of Biotechnology. S. Chand and Company Ltd. New Delhi
- Essar K E and R Kuenen (1967) Genetics of Fungi Sringer-Verzlag, Berline
- Funcham (1990) Fungal Genetics Oxfort and Edinburgh, Blackwell Scientific Publication
- Griffin (1973) Ecology of Fungi, Chapman and Hall, London
- Hudson H J (1961) Fungal Sporophytism. Edward Arnold Ltd. London
- Martin A (1961) An introduction to soil microbiology Vol. I, II, III Rastogi Publication, Meerut.
- Nair M C and Balakrishinan (1986) (Eds.)Benificial Fungi and Their Utilization, Scientific Pub. Jodhpur.
- Pathak Y B (1998) Mushroom Production and Processing Technology Vol III Himalaya Publishing Bombay
- Purkyastha and Chanda (1976) Indian Edible Mushroom, Firma Klam Pvt. Ltd. Calcutta
- Singh B D (1998) Biotechnology Kalyani Pub. New Delhi
- Smith G (1969) An Introduction to Industrial Mycology, Edward Arnold London

**M.Sc. Part II Semester IV Botany: Core Special Paper**

Core Course	<b>BOT-401 C ANGIOSPERM SPECIAL PAPER II</b>	<b>Lecture 60</b>												
<p><b>Objectives:</b></p> <ol style="list-style-type: none"> <li>To study Cronquist's system of classification of angiosperms.</li> <li>To study phylogeny and interrelationship of different orders.</li> <li>To study biosystematics and ultra structural systematic.</li> <li>To study the numerical taxonomy of angiosperms.</li> <li>To study chemotaxonomy of Angiospermic plants.</li> </ol> <p><b>Course outcomes:</b></p> <ol style="list-style-type: none"> <li>Able to know Cronquist's system of classification.</li> <li>Able to know phylogeny and interrelationship of different orders and taxa.</li> <li>Able to understand biosystematics and ultra structural systematic.</li> <li>Able to understand the numerical taxonomy of angiosperms.</li> <li>Able to understand chemotaxonomy of Angiospermic plants.</li> </ol>														
<b>Unit 1</b>	<p><b>Cronquist's system of classification (1968, 1988) w.r.t.</b></p> <ol style="list-style-type: none"> <li>Outline of the system.</li> <li>Refinements over his earlier system of 1968.</li> <li>Salient features of the system.</li> <li>Merits and demerits of system.</li> <li>Description, characterization and critical tendencies of the subclasses.</li> </ol>	<b>12 L</b>												
<b>Unit 2</b>	<p><b>Discussion on the orders (Sensu Cronquist):w.r.t. Morphological characters, floral variation, phylogeny and interrelationship.</b></p> <table border="0"> <tr> <td>2.1 Piperales</td> <td>2.2 Hamamelidales</td> <td>2.3 Caryophyllales</td> </tr> <tr> <td>2.4 Dilleniales</td> <td>2.5 Euphorbiales</td> <td>2.6 Asterales</td> </tr> <tr> <td>2.7 Najadales</td> <td>2.8 Arales</td> <td>2.9 Cyperales</td> </tr> <tr> <td>2.10 Zingiberales</td> <td>2.11 Liliales</td> <td></td> </tr> </table>	2.1 Piperales	2.2 Hamamelidales	2.3 Caryophyllales	2.4 Dilleniales	2.5 Euphorbiales	2.6 Asterales	2.7 Najadales	2.8 Arales	2.9 Cyperales	2.10 Zingiberales	2.11 Liliales		<b>12 L</b>
2.1 Piperales	2.2 Hamamelidales	2.3 Caryophyllales												
2.4 Dilleniales	2.5 Euphorbiales	2.6 Asterales												
2.7 Najadales	2.8 Arales	2.9 Cyperales												
2.10 Zingiberales	2.11 Liliales													
<b>Unit 3</b>	<p><b>Systematics</b></p> <p><b>3.1 Biosystematics</b></p> <ol style="list-style-type: none"> <li>Concept, aims and objectives, categories.</li> <li>Methods in biosystematics, ecotypic variations, scope and limitations.</li> <li>Comparison of classical taxonomy and biosystematics.</li> </ol> <p><b>3.2 Ultra structural Systematics</b></p> <ol style="list-style-type: none"> <li>SEM and TEM studies and plant systematic</li> <li>SEM and plant surface structure.</li> <li>TEM and dilated cisterneae of endoplasmic reticulum and sieve element plastids.</li> <li>Applications of data in the classification of higher taxa</li> </ol>	<b>12L</b>												
<b>Unit 4</b>	<p><b>Numerical Taxonomy</b></p> <ol style="list-style-type: none"> <li>Phenetic methods in taxonomy (taxometris)</li> <li>Principles, construction of taxonomic groups</li> <li>OTUs, unit character, measurement of resemblances, cluster analysis</li> <li>Phenons and ranks, discrimination, nomenclature and numerical taxonomy.</li> <li>Applications, merits and demerits, cladistics and cladogram, parsimony analysis, cladistics and classification.</li> </ol>	<b>12 L</b>												
<b>Unit 5</b>	<p><b>Chemotaxonomy</b></p> <ol style="list-style-type: none"> <li>Origin of chemotaxonomy, classes of compounds and their biological significance.</li> <li>Stages in chemotaxonomic investigations, techniques.</li> <li>Uses of chemical criteria in plant taxonomy, protein and taxonomy, seed proteins, techniques of protein electrophoresis,</li> <li>Chemical protein analysis procedures, analysis of amino acid</li> </ol>	<b>12L</b>												

sequence and its significance in systematics, 5.5 Serology and taxonomy, history, precipitation reaction, techniques, antigen, antisera antibody, application of serological data in systematics	
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**Suggested readings:**

1. Cronquist, A. 1981. An Integrated System of Classification of Flowering Plants. Columbia University Press, New York, USA.
2. Cronquist, A. 1988. The Evolution and Classification of Flowering Plants (2nd ed.), Allen Press, U.S.A.
3. Davis, P. H. and V. H. Heywood 1991. Principles of Angiosperm Taxonomy. Today and Tomorrow Publications, New Delhi, India.
4. Endress Peter, K. 1994. Diversity and Evolutionary Biology of Tropical Flowers. Cambridge.
5. Judd Walter S., Campbell C. S., Kollogg, E. A., Stevens P. F. and M. J. Donoghue 2008. Plant Systematics. Sinauer Associates, INC, Publisher. Sunderland, Massachusetts, USA.
6. Judd Walter S., Campbell C. S., Kollogg, E. A., Stevens P.F. and M. J. Donoghue 2008. Plant Systematics. Sinauer Associates, INC, Publishers. Sunderland, Massachusetts, USA.
7. Lawrence George H. M. 1951. Taxonomy of Vascular Plants. Oxford and IBH Publ. Co. Pvt. Ltd. New Delhi, India.
8. Naik, V. N. 1984. Taxonomy of Angiosperms Tata McGraw-Hill Publication Com. Ltd. New Delhi, India.
9. Quicke, Donald, L. J. 1993. Principles and Techniques of Contemporary Taxonomy. Blakie Academic & Professional, London, UK.
10. Rao, R. R. 1994. Biodiversity of India (Floristic Aspects). Bishen Singh Mahendra Pal Singh, Dehradun, India.
11. Richard, A. J. 1997. Plant Breeding Systems. (2ed.) Chapman and Hall.
12. Shivanna, k. R. and B. M. Johri 1985. The Angiosperm Pollen: structure and Function. Wiley Eastern limited, New Delhi, India.
13. Stace, C. A. 1989 Plant Taxonomy and Biosystematics. Edward Arnold, London, U.K.
14. Stuessy, T. F. 2002. Plant Taxonomy. The Systematics Evaluation of Comparative data. Bishen Singh Mahendra Pal Singh, Deheradun, India.
15. Taylor, D. V. and L. J. Hickey 1997. Flowering Plants: Origin, Evolution and Phylogeny. CBS Publishers & Distributers, New Delhi, India.

**M.Sc. Part II Semester IV Botany: Core Special Paper**

<b>Core Course</b>	<b>BOT 402: A PHYCOLOGY SPECIAL PAPER - III</b>	<b>Lecture 60</b>
	<p><b>Course Objectives:</b></p> <ol style="list-style-type: none"> <li>1. To study ecological classification of algae.</li> <li>2. To understand those environmental factors which control their survival growth, distribution and causal mechanisms</li> <li>3. To helps in bio-monitoring the water bodies and pollution control.</li> <li>4. To know phycological techniques, for water supplies.</li> <li>5. To study the role of algae in sewage disposal.</li> </ol> <p><b>Course Outcomes:</b></p> <ol style="list-style-type: none"> <li>1. Able to understand ecological classification of algae , Habitats of algae.</li> <li>2. Able to know algae and sewage disposal and eutrophication.</li> </ol>	
<b>Unit I</b>	<p><b>Ecological Classification of Algae</b></p> <ol style="list-style-type: none"> <li>1. Phytoplankton</li> <li>2. Benthic algae</li> <li>3. Cryophilic algae</li> <li>4. Thermophilic algae</li> <li>5. Soil Algae</li> <li>6. Epiphytic algae</li> <li>7. Lithophytes</li> <li>8. Endophytic algae</li> <li>9. Symbiotic algae</li> <li>10. Parasitic algae</li> <li>11. Epizooic Algae</li> </ol>	<b>08 L</b>
<b>Unit II</b>	<p><b>A) Fresh Water Bodies</b></p> <ol style="list-style-type: none"> <li>1. Lentic and Lotic environment: - General considerations physical and chemical factor and their influence, Types of Lakes, Zonation types of Lentic and Lotic water bodies, phytoplankton nature, adaptation, periodicity and succession.</li> <li>2. Flora of Lentic and Lotic series and its feature</li> </ol> <p><b>B) Marine Environment</b></p> <ol style="list-style-type: none"> <li>1. General considerations, physical and chemical factors, marine phytoplankton nature, seasonal growth cycles, productivity.</li> <li>2. Marine benthic algae, shore type Zonation patterns and factors governing them, Zonation pattern of East and west Coast of India.</li> </ol>	<b>15 L</b>
<b>Unit III</b>	<p><b>Algae and Sewage Disposal</b></p> <ol style="list-style-type: none"> <li>1. Necessity of sewage disposal</li> <li>2. Composition of sewage (Physical, chemical biological)</li> <li>3. Treatment of waste water: Pretreatment, secondary biological treatment.</li> <li>4. Types of algal stabilization ponds</li> <li>5. Algal flora their periodicity and succession in sewage stabilization ponds.</li> </ol>	<b>10 L</b>
<b>Unit IV</b>	<p><b>Eutrophication and Biomonitoring of Water Quality (17 L)</b></p> <ol style="list-style-type: none"> <li>1. Definition of Water pollution</li> <li>2. Types of water pollutants</li> <li>3. Eutrophication Definition, Process of eutrophication, Effects of eutrophication and algal bloom, Controls of water blooms, pollution tolerant genera.</li> <li>4. Saprobic zones (Kolwewitz and marson 1909); Saprobic zones (Partick 1977)</li> </ol>	

	<p>5. Algae in organically polluted waters and home sewage</p> <p>6. Common algae in water supplies</p> <p>7. Diatoms as indicators of water pollutions</p> <p>8. Nygaard's tropic state indices.</p> <p>9. Palmer's pollution index</p> <p>10. Filter clogging algae; Algae causing odour, taste, colour, and slime in water.</p> <p>11. Uses of algae in water supplies; Control of algae in water supplies.</p> <p>12. Water pollution monitoring and management bodies</p>	<b>17 L</b>
<b>Unit V</b>	<p><b>: Phycological Techniques</b></p> <p>1. Field Collection procedure for marine and freshwater algae, phytoplankton Phytoplankton counts methods.</p> <p>2. Ecological Field Methods: Macro algae</p> <p>3. Preservation, preparation of herbarium and permanent slides</p> <p>4. Histochemical and general methods, stains and fixatives</p> <p>5. Important organizations involved in water pollution control and monitoring in India and role of NGO's in water pollution management</p> <p>6. Some international phycological societies and journals</p>	<b>10 L</b>

**Suggested Readings:**

1. Abbasi, S.A. (1998) Water Quality Sampling and Analysis. Discovery Publishing House New Delhi, India.
2. Agrawal, S.C. (1999) Limnology. APH Publishing Corporation, New Delhi, India.
3. Anand, N. (1989) Handbook of Blue Green Algae. Bishen Singh Mahendra Pal Singh, Dehradun, India.
4. Anonymous, (1971) Algal Assay Procedure Bottle Test. Nat. Eut. Res. Prog. EPA.
5. APHA, (2017) Standard Method for the Examination of Water and Waste Water. 23rd Edition American Public Health Association, New York, U.S.A.
6. Fatma, T. (1999) Cyanobacterial And Algal Metabolism and Environmental Biotechnology. Narosa Pub. House, New Delhi, India.
7. Kachroo, P. Aquatic Biology in India. Bishen Singh Mahendra Pal Singh Dehradun, India.
8. Mark M. Littler & Diane S. Litter (1985) Hand book of Phycological Methods, Cambridge University Press.
9. Palmer, C. Wervin (1980) Algae and Water Pollution. Castle House Publications Ltd. , London, U.K.
10. R. Ramesh, M. Anbu (1996) Chemical Methods for Environmental Analysis. McMillan India Ltd., Mumbai, India.
11. Sambamurty, A.V.S.S. (2005) A Text Book of Algae. I.K. International, Mumbai, India.
12. Sharma, O.P. (2003) A Text Book of Algae. Tata Mc. Grew Hill Pub. Mumbai, India.
13. Trivedi, P.C. (2001) Algal Biotechnology. Pionter Pub., Jaipur, India.

**M.Sc. Part II Semester IV Botany: Core Special Paper**

Core Course	<p align="center"><b>BOT. 402 B</b> <b>MYCOLOGY SPECIAL PAPER-III</b></p>	Lectures <b>60</b>
<p><b>Course objectives:</b></p> <ol style="list-style-type: none"> <li>1. To know scope and significance and history of plant pathology.</li> <li>2. To study pathogenesis, defense mechanism and physiology of diseased plants.</li> <li>3. To make aware about Specific Plant diseases and disease management.</li> <li>4. To know seed pathology, Market pathology, Forest pathology and medical mycology.</li> </ol> <p><b>Course outcomes:</b></p> <ol style="list-style-type: none"> <li>1. Able to know concept, scope and importance of the plant pathology.</li> <li>2. Able to describe development of disease, pathogenesis, defense mechanism.</li> <li>3. Higher cognitive skills about abiotic and biotic diseases of plants will develop.</li> </ol>		
Unit 1	<p>Plant pathology:</p> <p>A) Definition, Objectives, Scope and significance of plant pathology. History of Plant Pathology in India.</p> <p>B) Concept of disease, Disease pyramid.</p> <p>C) Classification of Plant diseases</p> <p>D) Stages in development of disease (Disease cycle).</p>	<b>12 L</b>
Unit 2	<p>A) Pathogenesis (Mechanism of infection): penetration, invasion and growth.</p> <p>B) Plant-parasite relationship.</p> <p>C) Chemical Weapons of pathogen:</p> <ol style="list-style-type: none"> <li>i) Enzymes in plant diseases</li> <li>ii) Microbial toxins in plant diseases, Non-Host specific toxins and Host-specific toxins.</li> </ol>	<b>12 L</b>
Unit 3	<p>A) Effect of environment on disease development</p> <p>B) Defense mechanism:</p> <ol style="list-style-type: none"> <li>i) Structural defense mechanism</li> <li>ii) Biochemical defense mechanism</li> </ol> <p>C) Physiology of diseased plants</p>	<b>12 L</b>
Unit 4	<p>Specific Plant diseases and disease management:</p> <p>a) Abiotic: environmental factors that cause disease- temperature, moisture, oxygen, light and mineral deficiency.</p> <p>b) Biotic : Plant diseases caused by</p> <ol style="list-style-type: none"> <li>i) Viruses: Leaf curl of Tomato, Yellow vein mosaic of Bhendi.</li> <li>ii) Mycoplasmas: Little leaf of Brinjal, Grassy shoot of Sugarcane</li> <li>ii) Bacterial: Citrus canker, Angular leaf spot of Cotton.</li> <li>iv)Nematode: Root knot of vegetable, Soybean cyst nematode.</li> <li>v) Fungal: Downy mildew of crucifers, Downy mildew of Grapes, Powdery mildew of Grapes, Rust of Wheat, Smut of Jowar, Red rot of Sugarcane.</li> </ol> <p>c) Physical, Chemical and Biological Control measures</p>	<b>12L</b>
Unit 5	<p>A) Seed Pathology: Methods of study, external and internal seed born diseases, Quarantine laws and seed certification, storage mycoflora and toxins.</p> <p>B) Forest Pathology: Forest diseases, management and wood decay.</p> <p>C) Market pathology: Post harvest fungal diseases of fruits and vegetables.</p> <p>D) Medical Mycology: Mycotic infections, Dermatophytes and Deep mycoces.</p>	<b>12L</b>

**Suggested readings:**

1. Agrios G. N. (1969). Plant Pathology. Academic Press, New York, USA
2. Ainsworth G. C. 1952. Medical Mycology. Pitma Press, London, UK
3. Bakshi B. K. 1976 Forest pathology. Controller of Pub. New Dehli, India.
4. Billgrami and Dubey 1976 Modern plant Pathology. Vikas Publ House Pvt. Ltd., New Delhi, India.
5. Butler E. J. 1973 Fungi and plant diseases in plants Thecker Spinck and Co., Culcutta
6. Cochrane V. W. 1958 Physiology of Fungi Wiley Chapman and Hall, New York, USA
7. Daniel and Roberts, Carlw. Boothroyd (II nd Ed.) 1987. Fundamentals of plant pathology. CBS Publ and distributors. New Delhi, India.
8. Dugger B. M.1998 Fungus diseases of plants, Agro Bot. Pub., New Delhi, India.
9. Ellis M. B. 1976 Medical Mycology. Led and Febiger, Philadelphia
10. Harsfall and Diamond 1971 Plant pathology Vol I – V Academic press New Delhi, India.
11. Joshi K. R. 1966 Opportunetic mycosis. Scientific Publisher, New Dehli, India.
12. Kamat M. N. 1959 Introductory Plant Pathology. Prakash Publ., Pune, India.
13. Mehrotra 1994 Plant Pathology. International Pub House, New Delhi, India.
14. Merotra R. S. Ashok Agrawal 2003 Plant Pathology. Tata Mac Graw Hill Publ Co Ltd, New Delhi, India.
15. Mukherji and Bhasin 1986 Plant diseases of India Tata Mac Graw Hill Publ Co Ltd New Delhi, India.
16. Nene Y. L. 1976 Fungicides in plant diseases controls. Oxford and IBH Publ. Co. New Delhi, India.
17. Pathak V. R. 1972 Essentials of plant pathology. Prakash publishing, Jodhpur.
18. Pathak, Khatri and Pathak 1996 Fundamentals of Plant Pathology. Agro Bot. Publ Bikaner India
19. Robertis and Boothroyd 1972 Fundamentals Plant Pathology Toppan Co. Ltd. Tokya.
20. Sharma Rajni 2000 Plant Pathology Campus Books International New Delhi, India.
21. Singh R. S. 1982 Plant Pathology Oxford and IBH Publ. Co. New Delhi, India.
22. Singh R. S. 1990 Plant diseases 6 th edition Oxford and IBH Publ. Co. New Delhi, India.
23. Stakman and Harrar 1957 Principles of Plant pathology, Ronold Press Co., New Delhi, India.
24. Suryanarayana D. 1978 Seed Pathology. Vikas Pub. House Pvt . New Delhi, India.
25. S. A. J. 1972 Principles of Plant Pathology. The McMellian Press, India
26. Walker J. C. 1974 Plant Pathology. McGraw-Hill Book Co. Inc., New York, USA.

**M.Sc. Part II Semester IV Botany: Core Special Paper**

Core course	<p align="center"><b>BOT. 402 C</b> <b>ANGIOSPERM SPECIAL PAPER-III</b></p>	<p align="center"><b>Lectures</b> <b>60</b></p>
<p><b>Course objectives:</b></p> <ol style="list-style-type: none"> <li>1.To trace the origin of Angiosperms.</li> <li>2.To study embryology of Angiosperm plant.</li> <li>3.To study palynology of Angiosperm plant.</li> <li>4.To study wood anatomy of Angiosperm plant.</li> <li>5.To study ecological anatomy of Angiosperms.</li> </ol>		
Unit: 1	<p><b>Origin of Angiosperms :</b></p> <ol style="list-style-type: none"> <li>1. Time of origin of angiosperms</li> <li>2. Cradle of angiosperms</li> <li>3. Theories of origin of Angiosperms with respect to time, place, and possible ancestors:               <ol style="list-style-type: none"> <li>a. The <i>Isoetes</i>– monocotyledons theory,</li> <li>b. The Coniferales- Amentiferae theory,</li> <li>c. The Gnetales- Angiosperm theory,</li> <li>d. The Anthostrobilus- (Bennettitalean) theory,</li> <li>e. The CaytonialeanTheory,</li> <li>f. The Stachyosporo- Phyllospermae theory,</li> <li>g. The Pteridosperm theory,</li> <li>h. The Pentoxylales theory and The Durian theory</li> </ol> </li> </ol>	<b>(20 L)</b>
Unit: 2	<p><b>Embryology :</b></p> <ol style="list-style-type: none"> <li>1. Different schools of embryology and their contributions,</li> <li>2. Artificial pollination, fertilization,</li> <li>3. Sexual incompatibility,</li> <li>4. Endosperm, endosperm – ultra structure and histo-chemistry.</li> <li>5. Embryo as a reaction system, homologies, experimental embryogenesis,</li> <li>6. Embryo-endosperm relationship,</li> <li>7. Embryology in relation to taxonomy,</li> <li>8. Fertilization in <i>Tambourissa</i> and <i>Butomopsis</i> and their significance.</li> </ol>	<b>(10 L)</b>



Unit: 3	<p><b>Palynology:</b></p> <ol style="list-style-type: none"> <li>1. Pollen units, pollen biochemistry, and pollen physiology.</li> <li>2. Pollenkitt, sporopollenin, pollen wall proteins, pollen germination <i>in vivo</i> and <i>in vitro</i>.</li> <li>3. Pollen storage and viability, pollen sterility.</li> <li>4. Pollen polymorphism.</li> <li>5. Palynology in relation to angiosperm phylogeny.</li> </ol>	(15 L)
Unit: 4	<p><b>Wood Anatomy:</b></p> <ol style="list-style-type: none"> <li>1. Introduction</li> <li>2. Hard and softwood.</li> <li>3. Elements of wood, their structure and distribution.</li> <li>4. Properties and uses of wood in relation to structure and composition</li> <li>5. Anatomy and identification of important timbers.</li> </ol>	(07L)
Unit: 5	<p><b>Ecological Anatomy:</b></p> <ol style="list-style-type: none"> <li>1. Hydrophytes: (i) Submerged, (ii) Free floating, (iii) Anchored floating, (iv) Amphibious.</li> <li>2. Xerophytes: (i) Microphyllous, (ii) Sclerophyllous, (iii) Trichophyllous, (iv) Malacophyllous</li> <li>3. Halophytes</li> <li>4. Parasites</li> <li>5. Epiphytes</li> </ol>	(08 L)

**Suggested readings:**

vani, S. S. and Bhatnagar, S. P. 1984. Embryology of Angiosperms. Vikas Publ. House, New Delhi, India.

Bhojwani, S. S., Bhatnagar, S. P. and P. K. Dantu 2015. The Embryology of Angiosperms. Vikas Publ. House, New Delhi, India.

Carlquist, S. 1961 Comparative Plant anatomy, Hold, Rinehart and Winson, New York, USA.

Cronquist, A. 1981. An Integrated System of Classification of Flowering Plants. Columbia University Press, New York, USA.

quist A. 1988. The Evolution and Classification of Flowering Plants (2nd ed.) Allen Press, U.S.A.

P. H. and V. H. Heywood 1991. Principles of Angiosperm Taxonomy. Today and Tomorrow Publications, New Delhi, India.

an G. 1952. Pollen Morphology and Plant Taxonomy. Angiosperms. Alquist and Wiksell. Stockholm.

Erdman G. 1952. Pollen Morphology and Plant Taxonomy. Angiosperms. Hafner Publ. Co. New York, USA.

Esau K. 1960. Anatomy of Seed Plants, Wiley. New York, USA.

**M.Sc. Part II Semester IV Botany: Core Course**

<b>BOT-403</b> <b>Practical (Core Course)</b> <b>(Based on BOT. 401 A and 402 A)</b>	
Practical 1	Preparation of culture media (De's modified Beneck's medium for Blue Green Algae)
Practical 2	Isolation and cultivation of algae by dilution and streak culture technique
Practical 3	Mass culture of blue green algae as bio-fertilizer
Practical 4	Biomass estimation, total chlorophyll / fresh and dry weight
Practical 5-6	Extraction and separation of amino acids and carbohydrates of algae by chromatography methods
Practical 7-8	Algae of unusual habitats (a) Epiphytic algae, (b) Epizoic and Endozoic algae, (c) Symbiotic algae, (d) Endophytic algae, (e) Benthic algae, (f) Aerial algae (g) phytoplankton
Practical 9-10	Algae of east & west coast of India
Practical 11-12	Qualitative and quantitative studies of phytoplankton using standard Methods Lacky's simple drop method and haemo-cytometer method.
Practical 13	Study of Palmer's pollution index for assessing the water quality of any polluted habitat
Practical 14 -17	Water analysis pH, Turbidity, Total dissolved solids dissolved oxygen, Free CO <sub>2</sub> , BOD, COD, Carbonate, Bicarbonate, Total Alkalinity, Chlorides, Hardness, Calcium, Magnesium, Nitrate, Sulphate, Phosphate (any 6)
Practical 18	Cytological studies of <i>Chara</i> , <i>Hydrodictyon</i> , <i>Cladophora</i> , <i>Spirogyra</i> , <i>Oedogonium</i> (any 1)
Practical 19	Extraction of Mucilage from algal material.
Practical 20-21	Extraction of Agar-Agar, Extraction of Algenic acid from Marine algae
Practical - 22	Extraction and Estimation of algal proteins from unpolluted waters and polluted water bodies.
Practical 23	Extraction and Estimation of Photosynthetic pigments of algae from polluted and unpolluted waters using the method of Arnon (1949).
Practical 24	Culture and Test for oils of diatoms biomass.
Note:	1. Compulsory Botanical excursion of marine and fresh water habitats 2. Compulsory Botanical excursion Visit to nearby ponds rivers lakes and polluted habitats; Submission of algal photomicrograph and tour report is essential 3. Duly certified journals are compulsory at the time of practical examination.

**M.Sc. Part II Semester IV Botany: Core Course**

**BOT-403**

**Practical I (Core Course)**

**(Based on BOT. 401 B and 402 B)**

Practical 1	Basic Techniques in Plant Pathology
Practical 2	Isolation of Mycorrhiza from soil
Practical 3	Isolation of Fungal Pathogens
Practical 4 & 5	Isolation and enumeration of microorganism from soil by serial dilution plate method
Practical 6	Isolation of <i>Rhizobia</i> from root nodules
Practical 7	Study of seed pathology
Practical 8	Study of fruit pathology
Practical 9	Study of Forest plant pathogens
Practical 10	Study of diseases caused by bacteria and viruses (any two)
Practical 11	Study of diseases caused by Mastigomycotina and Plasmodiophorales (any three)
Practical 12	Study of diseases caused by Ascomycotina (any three)
Practical 13	Study of diseases caused by Basidiomycotina (any three)
Practical 14	Study of diseases caused by Deuteromycotina (any three)
Practical 15 & 16	Biochemical studies of diseased plants by paper chromatography (sugar/amino acid)
Practical 17	Biochemical studies of diseased plants (enzymes/proteins)
Practical 18 & 19	Citric acid fermentation and assay
Practical 20 & 21	Alcohol fermentation and Distillation
Practical 22 & 23	Spawn preparation and mushroom cultivation
Practical 24	Field Visit
	<b>Note:</b> Visit to fermentation industry, research institute, Agriculture University, tour for collection of Phytopathological organism is compulsory.

**M.Sc. Part II Semester IV Botany: Core Course**

<b>BOT-403</b> <b>Practical (Core Course)</b> <b>(Based on BOT. 401 C and 402 C)</b>	
Practical 1-6	Study of the families with respect to morphological characters using botanical terms, floral formula, floral diagram and classification. (Sensu. Bentham and Hooker`s system at least 12 families)
Practical 7-13	<p>Study of anatomical features of ecological interest of the following:</p> <p><b>Hydrophytic leaves (Any two) :</b> <i>Potamogeton, Ceratophyllum, Hydrilla, Ottelia, Vallisneria, Typha, Limnophila, Phylla nodiflora, Bacopa monieri, Nymphaea, Nelumbo.</i></p> <p><b>Hydrophytic stem or petiole (Any two):</b> <i>Limnophila, Hydrilla, Potamogeton, Bacopa monieri, Nymphaea, Nelumbo.</i></p> <p><b>Xerophytic leaves (Any two):</b> <i>Euphorbia nerifolia, Calotropis sp., Pentatropis sp., Nerium sp., Ficus bengalensis.</i></p> <p><b>Xerophytic stem (Any two):</b> <i>Casuarina equisetifolia, Tamarix sp., Capparis deciduas, Caralluma sp., Euphorbia tirucaulli, Sarcostemasp.</i></p> <p><b>Specialized structure:</b> (a) Cladode of <i>Asparagus sp.</i> (b) Phyllode of <i>Acacia auriculiformis</i></p> <p><b>Parasites:</b> <i>Striga gesneroides, Cuscuta chinensis.</i></p> <p><b>Epiphytes:</b> Study of velamen tissue (either from root material or permanent slide)</p>
Practical 14-15	Identification of six important timbers with the help of anatomical character and prepare an artificial key of timber wood on the basis of anatomical characters.
Practical 16-18	<p>Embryology:</p> <ol style="list-style-type: none"> <li>To study types of tetrads, pollen unit (Polyad and Pollinia) from locally available plant material.</li> <li>Dissection and mounting of stages of embryo development, multiple embryos.</li> <li>To study different types of endosperm from locally available materials</li> </ol>
Practical 19-22	<p>Palynology:</p> <ol style="list-style-type: none"> <li>To observe pollen fertility and sterility.</li> <li>To study pollen polymorphism.</li> <li>Palynotaxonomy of some selected taxa (either family or a genus).</li> <li>To study of pollen from honey by acetolysis or any other suitable method.</li> </ol>
Practical 23-24	Field tour.
Note:	<ol style="list-style-type: none"> <li>Excursion report is compulsory.</li> <li>Any five timber block submission is compulsory</li> <li>Submission of five permanent slide from embryology and palynology is compulsory.</li> <li>Duly certified journals are compulsory at the time of practical examination.</li> </ol>

**M.Sc. Part II Semester IV Botany: Core Course**

**BOT-404**

**Practical (Core Course)**

**Project Dissertation**

Submission of project work certified by Guide.

Presentation of project work using LCD.

Viva- voce.

**M.Sc. Part II Semester IV Botany: Elective Course**

Core course	<b>BOT. 405 A PLANT ECOLOGY AND PHYTOGEOGRAPHY</b>	<b>Lectures 60</b>
<p><b>Course objectives:</b></p> <ol style="list-style-type: none"> <li>1. To know concept, scope and importance of the discipline.</li> <li>2. To study ecosystem ecology and community ecology.</li> <li>3. To make aware about conservation of biodiversity, energy and Pollution.</li> <li>4. To study botanical regions of India and vegetation types of Maharashtra.</li> <li>5. To study Bioremediation, Global warming and climate change.</li> </ol> <p><b>Course outcomes:</b></p> <ol style="list-style-type: none"> <li>1. Able to know concept, scope and importance of the discipline.</li> <li>2. Able to describe ecosystem ecology and community ecology.</li> <li>3. Higher cognitive skills about conservation of biodiversity, energy and pollution will develop.</li> </ol>		
Unit 1	<p>A) Plant Ecology: Definition, Concept and Scope of Ecology, Branches of Ecology.</p> <p>B) Ecosystem Ecology:</p> <ol style="list-style-type: none"> <li>i) Introduction, kinds of ecosystems, structure and functions of ecosystem.</li> <li>ii) Productivity of ecosystem</li> <li>iii) Food chain and food web</li> <li>iv) Major ecosystems- Pond ecosystem, Ocean (Marine) ecosystem, Grassland ecosystem, Forest ecosystem, Desert ecosystem, Cropland ecosystem.</li> <li>v) Biogeochemical (Nutrient) cycles in ecosystem: Water cycle, Carbon cycle, Nitrogen cycle and impact of human activities on them.</li> </ol>	<b>12 L</b>
Unit 2	<p>C) Community Ecology:</p> <ol style="list-style-type: none"> <li>i) Definition and concept of community</li> <li>ii) Structure- Zonation and Stratification</li> <li>iii) Characters used to describe community structure: Quantitative and Qualitative characters</li> <li>iv) Methods of community studies</li> </ol> <p>D) Community Dynamics:</p> <ol style="list-style-type: none"> <li>i) Ecological succession- Definition causes and types.</li> <li>ii) Process of succession- Hydrosere and Xerosere</li> <li>iii) Climax concept- Monoclimax and Polyclimax</li> </ol>	<b>12 L</b>
Unit 3	<p>Conservation Ecology:</p> <p>A) Biodiversity and its Conservation:</p> <ol style="list-style-type: none"> <li>i) Definition and importance</li> <li>ii) Types of Biodiversity: Genetic, Species, Ecosystem.</li> <li>iii) Indian Hot spots of biodiversity: Eastern Himalayas and Western Himalayas.</li> <li>iv) Conservation of Biodiversity: In-situ and Ex-situ In-situ Conservation: Biosphere reserves, National parks, Wildlife Sanctuaries. Ex-situ Conservation: Botanical gardens/Herbal gardens, Seed (Germplasm) bank, Pollen bank.</li> </ol> <p>B) Energy Conservation:</p> <ol style="list-style-type: none"> <li>i) Sources of Energy: Conventional and non conventional</li> <li>ii) Non conventional sources: Solar energy, Tidal energy, Biomass energy.</li> <li>iii) Perspective alternatives for energy: Petroplants, Biogas energy.</li> </ol>	<b>12 L</b>

Unit 4	<p>A) Pollution:  i) Air pollution: Sources, types, effect of air pollution on plants, effect of air pollutants on human.  ii) Water pollution: causes, effects, control measures.  iii) Global warming and climate change: Greenhouse effect, Ozone depletion, El NINO and LA NINA.</p> <p>B) Bioremediation:  i) Definition, concept, need and scope.  ii) Phytoremediation: a) Recovery of heavy metals from soil  b) Reclamation of industrial waste and municipal waste water  c) Revegetation of industrial deserts.</p>	<b>12 L</b>
Unit 5	<p>A) Phytogeography:  i) Main Botanical Regions of India.  ii) Detailed study of vegetation types in Maharashtra</p> <p>B) Ecological Indicators:  i) Introduction  ii) Plants as indicators: Soil, pH, Ground water, Minerals. Metals and Pollution</p> <p>C) Endemism: Causes and types.</p> <p>D) Biogeography: Dispersal- Barriers and means of dispersal.</p>	<b>12L</b>

**Suggested readings:**

1. Agrawal, K.C. (1996). Environmental Biology, Agro-Botanical Publisher, Bikaner India
2. Ambasta, R.S.(1988).A Text of Plant Ecology, Student Friends &Co. Varanasi, India.
3. Ambasta,R.S.(1990).Environmental and Pollution, Student Friends & co. Varanasi,India.
4. Chapman, and Reiss, M.J.(1998). Ecology: Principles and Applications. Cambridge University Press, Cambridge
5. Dash, M.C. (1993). Fundamentals of Ecology, Tata McGraw Hill Publishing Co. Ltd. New Delhi, India.
6. Heywood, V.H. and Watson, R.T.(1995). Global Biodiversity Assessment, Cambridge University Press, Cambridge.
7. Hill, M. K. (1997). Understanding Environmental Pollution, Cambridge University Press, Cambridge.
8. Kapur, P. And Govil, S.R.(2000).Experimental Plant Ecology S.K.Jain for CBS Publishers and Distributors, New Delhi, India.
9. Kothari, A. (1997). Understanding Biodiversity: Life Sustainability and Equity Orient Longman.
10. Krebs, C.J.(1989). Ecological Methodology. Harper and Row, New York, USA.
11. Kumar, H.D. (1996). Modern Concept of Ecology (4th Ed.) Vikas Publishing House (P.)Ltd. New Delhi.
12. Kumar, H.D. (1997). General Ecology, Vikas Publishing House (P.) Ltd. New Delhi,
13. Kochhar, P. L. Plant Ecology. Genetics and Evolution, S. Nagin& Co. Ltd. New Delhi.
14. Moore,P.W. and Chapman,S.B. (1986).Method in Plant Ecology. Blackwell Scientific Publications.
15. Mukherjee B. Environmental Biology. Tata McGraw Hill Publishing Ltd.
16. Purohit S.S. and Ranjan R.(2007).Ecology, Environment and Pollution. Agrobios (India)
- 17.Sharma P.D.(2018)Ecology and Environment. Rastogi Publications, Meerut-New Delhi.

**M.Sc. Part II Semester IV Botany: Elective Course**

Core course	<p align="center"><b>BOT. 405 B</b></p> <p align="center"><b>INDUSTRIAL BOTANY</b></p>	<p align="center"><b>Lectures</b> <b>60</b></p>
<p><b>Course objectives:</b></p> <ol style="list-style-type: none"> <li>1) To study importance and production of SCP.</li> <li>2) To study the preservation canning and processing of fruits and vegetables.</li> <li>3) To learn mushroom technology.</li> <li>4) To acquire the knowledge of sugar production and fermentation technology.</li> <li>5) To study the paper production technology, production of essential oils.</li> </ol> <p><b>Course outcomes:</b></p> <p>This paper acquaints students with various plant materials and microbes viz. Algae, Fungi, Bacteria used on large scale for industrial purpose like food industry, Sugar industry, Paper industry, Oil industry, Medicine (Space food).</p>		
Unit 1	<ol style="list-style-type: none"> <li>i) Introduction, scope and importance of Industrial Botany</li> <li>ii) Production of Single Cell Protein (SCP): Introduction, Bacterial proteins, Yeast proteins, Fungal proteins, Algal proteins.</li> </ol>	<b>10L</b>
Unit 2	<p><b>Food processing Industry</b></p> <ol style="list-style-type: none"> <li>i) Principles of preservation: Canning and bottlings fruits and vegetables. Principle of food processing.</li> <li>ii) Commercial Canning: Factory site, factory building, water supply, and drainage. Machinery and equipment's, canning process, sorting and grading, washing, peelings, corning and pitting, can filling processing. Heat penetration in cans, processing methods, processing pressure and temperature. Testing for defects, labelling, sorting and packing.</li> <li>iii) Containers for packing: Tin and glass container, manufacture of cans, testing of cans, mechanical defects, size of cans.</li> <li>iv) Canning fruits: Apple, Mango, Banana, Grape, Orange, Papaya, Pineapple.</li> <li>v) Canning of vegetables: Cabbage, Beans, Potato, Tomato, Spinach</li> <li>vi) Preparation of Jams, Jellies and Squashes</li> </ol>	<b>14 L</b>
Unit 3	<p><b>Mushroom Industry</b></p> <ol style="list-style-type: none"> <li>i) Importance of mushrooms</li> <li>ii) Selections of mushrooms for cultivation, mushroom house design, spawn and spawning, preparation of mother spawn and planting spawn.</li> <li>iii) Cultivation method of white button mushroom (<i>Agaricus bisporus</i>): Compost preparation, methods of composting, spawning, crop management, maintenance, casing, harvesting, preservation.</li> <li>iv) Oyster mushroom (<i>Pleurotus</i> sp.): Materials and substrates, sterilization, spawning, incubation, crop maintenance, harvesting, preservation.</li> <li>v) Mushroom marketing, mushroom recipe.</li> </ol>	<b>12 L</b>
Unit 4	<p><b>Sugar and Fermentation Industry</b></p> <ol style="list-style-type: none"> <li>i) Sugar manufacture, machinery and equipment's</li> </ol>	



	<ul style="list-style-type: none"> <li>ii) Crushing of sugarcane, composition of juice, juice heating, liming and sulphuration.</li> <li>iii) Sedimentation, filtration of mud, evaporation, syrup sulphuration, crystallization, drying.</li> <li>iv) Grading, bagging, storage.</li> <li>v) Yeast and its uses: Production of Brewers Yeast, Production of Bakers Yeast, Production of food and fodder Yeast.</li> <li>vi) Production of Alcohol.</li> </ul>	<b>12 L</b>
Unit 5	<p><b>Paper and Oil Industry</b></p> <ul style="list-style-type: none"> <li>i) Sources of raw material for paper: Wood, chemistry of wood, Cellulose, hemicellulose, lignin.</li> <li>ii) Pulping: General principle of pulping. Types of pulping processes: mechanical, chemical, semi-chemical, sulphate process, Kraft process. Process calculations. Raw material utility requirements. Process flow sheet and description. Washing and bleaching. Common unit operation. Wood treatment, digestion, evaporation, drying with equipment used.</li> <li>iii) Treatment of Pulp: Screening, washing, refining, thickening of pulp. Bleaching- conventional and non-conventional bleaching techniques. Paper Making: Preliminary operations on pulp. Beating and refining of pulp. Non-fibrous materials. Fillers and loading material. Internal sizing. Wet and additive surface treatment. Paper coloring. Surface sizing.</li> <li>iv) Essential oil and their characteristics</li> <li>v) Production of essential oils.</li> </ul> <p><b>Suggested readings:</b></p> <ol style="list-style-type: none"> <li>1) A. H. Patel (1985) Industrial Microbiology. Published by MACMILLAN INDIA LTD. Ansari Road, Dariyaganj, New Delhi. 110002.</li> <li>2) Christopher Biermann (1996) Handbook of Pulping and Papermaking. Elsevier.</li> <li>3) D. P. Kulkarni (2015) Cane Sugar Manufacture in India. Published by The Sugar Technologists Association of India, 21 Community Center, East Kailash, New Delhi- 110005</li> <li>4) G. S. Siddappa ((1998) Preservation of Fruits and Vegetables. Indian Council of Agricultural Research, New Delhi</li> <li>5) Henry Kraemer (1997) Applied and Economic Botany (Vo. I and II) Ambey Publications, Tank Road, Karol Bagh, New Delhi- 110005</li> <li>6) L. E. Casida Jr. (2009) Industrial Microbiology. New Age International(P) Limited, Publishers, Ansari Road, Dariyaganj, New Delhi 110002.</li> <li>7) O. P. Sharma (1996) Hill's Economic Botany. Tata McGraw-Hill Publishing Company Limited, New Delhi.</li> <li>8) Pathak, Yadav, Gaur (1998) Mushroom Production and Processing Technology. Agrobios (India) Behind Nasrani Cinema, Chopasani Road, Jodhpur- 342002. P. Srinivasa (2013) Production Functions in Sugar Industry. Serials Publication.</li> </ol>	<b>12L</b>

**M.Sc.-II (Botany)**  
**Equivalence of Papers**

<b>Semester-III</b>			
Code	Title (Old)	Code	Title (New)
BOT. - 301	Gymnosperm and Palaeobotany	BOT-301	Plant Development & Reproduction
BOT. - 302	Plant Biotechnology and Bioinformatics	BOT-305A	Biostatistics and Bioinformatics
BOT. - 331	Algae special paper – I	BOT-302 A	Phycology Special Paper-I
BOT. - 332	Mycology and Plant Pathology Special paper - I	BOT-302 B	Mycology Special Paper-I
BOT. - 333	Genetics and Plant breeding Special paper - I	----	----
BOT. - 334	Angiosperm Taxonomy Special paper – I	BOT-302 C	Angiosperm Special Paper-I
BOT. - 304	Practical - I ( Based on Bot. - 301 & 302 )	BOT-303	Practical Based on BOT 301
BOT. - 305	Practical - II ( Based on Bot. - 331 / 332 / 333/ 334 )	BOT-304	Practical Based on BOT 302 (Special Paper)
<b>Semester-IV</b>			
BOT-401	Developmental Botany	BOT-405 A	Plant Ecology & Phytogeography
BOT-421	Algae special paper – II	BOT-401 A	Phycology Special Paper-II
BOT-422	Mycology and Plant Pathology Special paper - II	BOT-401 B	Mycology Special Paper-II
BOT-423	Genetics and Plant breeding Special paper - II	-----	-----
BOT-424	Angiosperm Taxonomy Special paper – II	BOT-401C	Angiosperm Special Paper-II
BOT-431	Algae special paper – III	BOT-402 A	Phycology Special Paper-III
BOT-432	Mycology and Plant Pathology Special paper – III	BOT-402 B	Mycology Special Paper-III
BOT-433	Genetics and Plant breeding Special paper - III	-----	-----
BOT-434	Angiosperm Taxonomy Special paper – III	BOT-402 C	Angiosperm Special Paper-III
BOT-404	Practical – I ( Based on Bot. – 401 )	-----	-----
BOT-405	Practical – II (Based on Bot. – 421 & 431 /Bot. – 422 & 432 / Bot. 423 &433/ Bot. – 424 &434 )	BOT-403	Practical based on BOT 401 & BOT 402
BOT-406	Project work	BOT-404	Practical: Project Dissertation