

**KAVAYITRI BAHINABAI CHAUDHARI
NORTH MAHARASHTRA UNIVERSITY,
JALGAON**

॥अंतरी पेटयू ज्ञानज्योत॥



1990
'A' Grade
NAAC Re-Accredited
(4th Cycle)

National Education Policy 2020

SYLLABUS

For

**M. Sc. (BOTANY)
Part-II Semester- III & IV**

For

Affiliated Colleges

(With effect from - June 2024)

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

For

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

Abbreviations:

- **T:** Theory Course
- **DSC:** Discipline Specific Core Course
- **MIN:** Minor subject
- **VSC:** Vocational Skill Courses
- **GE/OE:** Generic/open elective
- **IKS:** Indian Knowledge System
- **CEP:** Community engagement and service
- **RP:** Research Project
- **MIL:** Modern Indian language
- **VSEC:** Vocational skill and Skill enhancement courses
- **OJT:** On Job Training: Internship/ Apprenticeship
- **Co-curricular Course (CC)**
 - a) **CC-1: CC-120: Sports and Yoga**
 - b) **CC-2: CC-130: Cyber Security**
 - c) **CC-3: CC-220: Human Rights and Environment Law**
 - d) **CC-4: CC-229: Communication Skills and Personality Development**
- **Value Education Courses (VEC)**
 - a) **VEC1: ES-118: Environmental Science**
 - b) **VEC2: CI-129: Constitution of India**
- **Indian Knowledge System (IKS): a)**
IK: 119: Ayurvedic Medicine in Ancient India
- **Ability Enhancement Courses (AEC)**
 - a) **AEC-1: EG: 101 – English -1**
 - b) **AEC-2: EG: 102 – English -2**
 - c) **AEC-3: MR: 201 – Marathi -1**
 - d) **AEC-3: HN: 201 – Hindi -1**
 - e) **AEC-3: MR: 202 – Marathi -2**
 - f) **AEC-3: HN: 202 – Hindi -2**
- **P:** Practical course
- **DSE:** Discipline Specific Elective Course
- **ES:** Environment studies
- **SEC:** Skill Enhancement Courses
- **CI:** Constitution of India
- **ENG:** English
- **RM:** Research methodology

**Semester-wise Course Structure, Course Code and Credit distribution of
Two Years/ One Year **M. Sc BOTANY** Programme as per NEP 2020, for Affiliated Colleges
w.e.f - June 2023.**

SEMESTER - I, Level - 6.0

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

SEMESTER - II, Level - 6.0

DSC-30	DSC	BO-421	Plant Systematics II (Pteridophytes, Gymnosperm and Paleobotany)	4	4	--	4	40	--	60	-
DSC-31	DSC	BO-422	Genetics	2	2	--	2	20	--	30	-
DSC-32	DSC	BO-423	Plant Physiology	4	4	--	4	40	--	60	-
DSC-33	DSC	BO-424	Practical based on BO-421	2	--	4	4	--	20	--	30
DSC-34	DSC	BO-425	Practical based on BO-422 & BO-423	2	--	4	4	--	20	--	30
DSE-6	DSE	BO-426(A)	Techniques in Plant Science	4	4	--	4	40	--	60	-
		BO-426(B)	Plant Ecology and Phytogeography	4	4	--	4	40	--	60	-
		BO-426(C)	Agriculture Botany	4	4	--	4	40	--	60	-
OJT	*OJT/ Int.	BO-427	On Job Training	4	--	8	8	--	40	--	60

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

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

SEMESTER – III, Level – 6.5

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

SEMESTER – IV, Level – 6.5

DSC-40	DSC	BO-521	Sp. Paper- II A. Phycology Sp. Paper- II B. Mycology Sp. Paper- II C. Angiosperm Taxonomy Sp. Paper- II D. Plant Physiology	4	4	--	4	40	--	60	--
DSC-41	DSC	BO-522	Sp. Paper- III A. Phycology Sp. Paper- III B. Mycology Sp. Paper- III C. Angiosperm Taxonomy Sp. Paper- III D. Plant Physiology	4	4	--	4	40	--	60	--
DSC-42	DSC	BO-523	Practical based on Sp. Paper BO-521 (A/B/C/D)	2	-	4	4	--	20	--	30
DSC-43	DSC	BO-524	Practical based on Sp. Paper BO-522 (A/B/C/D)	2	-	4	4	--	20	--	30
		BO-525(A)	Post Harvest Technology	4	4	--	4	40	--	60	--

DSE-8	DSE	BO-525(B)	Green House Technology	4	4	--	4	40	--	60	--
		BO-525(C)	Green Belt and Green Credit	4	4	--	4	40	--	60	--
RP	RP	BO-526	Research Project	6	-	12	12	--	60	--	90

Cumulative Credits For Second Year - 44

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

Course Code: BO-511		
Course Title: Plant Development and Reproduction		
Course Code: BO-511	Course Category: Core Course (DSC-35)	
Course Title: Plant Development and Reproduction	Type: Theory	
Total Contact Hours: 60	Course Credits: 04 (60 L)	
College Assessment (CA) Marks: 40	University Assessment (UA): 60	
Course Objectives:		
<ol style="list-style-type: none"> 1. To study vascular tissues, structure of woods and anomalous secondary growth 2. To study historical development of embryology. 3. To study structure and development of microsporangium, megasporangium and endosperm. 4. To study methods of pollination and fertilization. 5. To study applications of embryology in plant tissue culture. 6. To study development and structure of pollen grains. 7. To study applications of palynological science. 		
Course Outcomes:		
<ol style="list-style-type: none"> 1. Able to differentiate vascular tissues. 2. Able to identify embryological stages. 3. Expertise in tissue culture techniques. 4. Able to identify scope and applications of pollen grains 		
Course Content		
Unit: 1	Plant Anatomy	12 L
	<ol style="list-style-type: none"> 1.1 Meristems: Classification based on <ol style="list-style-type: none"> a) Origin and development b) Plane of division c) Function and position 1.2 Theories of zonation and differentiation <ol style="list-style-type: none"> a) Apical cell theory b) Histogen theory c) Tunica-carpus theory d) Korper- Koppe theory e) Cytohistological zonation 1.3 Study of stomata and Trichomes <ol style="list-style-type: none"> a) Introduction b) Classification of stomata by Metcalfe and Chalk c) Classification of Trichomes by Ramayya's 	
Unit: 2	Vascular Tissues	12 L

	<p>2.1 Cambium: Origin, Structure and Types</p> <p>2.2 Differentiation of xylem and Phloem elements and their phylogeny</p> <p>2.3 Study of Woods:</p> <p style="padding-left: 20px;">a) Dicotyledonous woods</p> <p style="padding-left: 20px;">b) Gymnospermous woods</p> <p style="padding-left: 20px;">c) Reaction woods</p> <p style="padding-left: 20px;">d) Sap and Heart wood</p> <p>2.5 Anomalous Secondary Growth in Plants:</p> <p style="padding-left: 20px;">a) Dicot stem:</p> <p style="padding-left: 40px;">i. Normal cambium with abnormal activity</p> <p style="padding-left: 40px;">ii. Abnormal cambium with abnormal activity</p> <p style="padding-left: 20px;">b) Monocot stem: <i>Dracaena</i></p>	
Unit: 3	<p>Embryology of Angiosperms</p> <p>3.1 Introduction</p> <p>3.2 Contribution of Strasburger and P. Maheshwari to embryology</p> <p>3.3 Study of Microsporangium: Development and structure, Wall layers, Tapetum types, Pollen kitt and sporopollenin, microsporogenesis, pollen units</p> <p>3.4 Male gametophyte: Structure, development and spermatogenesis</p> <p>3.5 Study of Megasporangium: Development, Structure, Megasporogenesis</p> <p>3.6 Types of female gametophytes (embryo sacs)</p> <p>3.7 Pollination and Fertilization: Pollination methods</p> <p>3.8 Pollen germination: Pollen-tube formation, sperm-cells</p> <p>3.9 Entry of pollen tube: Through stigma, style and embryo sac, transfer of pollen tube contents into embryo sac, fusion of gametes and fusion of nuclei.</p>	12 L
Unit: 4	<p>Endosperms, Polyembryony and Experimental Embryology</p> <p>4.1 Endosperms: Introduction, development and structure of endosperms, types of endosperms, functions of endosperms</p> <p>4.2 Polyembryony: Introduction, Classification, Causes and types (nucellar, integumentary, zygotic, synangial polyembryony)</p> <p>4.3 Experimental Embryology: Introduction, culture of Anther, ovary, ovule, endosperm and embryo</p>	12 L
Unit 5	<p>Palynology</p> <p>5.1 Introduction, Scope and Importance</p> <p>5.2 Pollen grains: Development, Differentiation of wall layers, Exine Stratification (ornamentation), Polarity and Symmetry</p> <p>5.3 Structure of mature pollen grain</p> <p>5.4 Pollen polymorphism</p> <p>5.5 Applied Palynology: Geopalynology, Melittopalynology, Forensic palynology and Palynotaxonomy</p>	12 L

Suggested reading:

1. Carlquist, S. (1961) Comparative Plant Anatomy, Hold, Rinehart and Winston, New York, U.S.A.
2. Carlquist, S. (1988) Comparative Wood Anatomy: Systematic, Ecological and Evolutionary Aspects of Dicotyledonous Wood. Springer-Verlag, Berlin, Germany
3. Cutter, D.F. (1978) Applied Plant Anatomy, Longman, London and New York, USA
4. Cutter, E. G. (1969) Plant Anatomy: Experiment and Interpretation. Part-I : Cell and Tissues, Edward Arnold, London, UK.
5. Eames, A.J. (1961) Morphology of Angiosperms, McGraw Hill, New York, U.S.A.
6. Eames, A.J. and McDaniels, L.H. (1974) An Introduction to Plant Anatomy, II Ed. McGrawHill, New York and London, UK.
7. Easu, K. (1960) Anatomy of the Seed Plants, Wiley, New York, U.S.A.
8. Easu, K. (1965) Vascular Differentiation in Plants. Hold, Rinehart and Winston, New York, U.S.A.
9. Easu, K. (1977) Anatomy of Seed Plants, (II Ed.) John, Wiley and Sons, New York, U.S.A.
10. Fahh, A. (1982) Plant Anatomy, III Ed. Pergamon Press, Oxford U.K.
11. Fahh, A. (1995) Secretory Tissues in Plants. Academic Press. London, U.K.
12. Foster, A.S. (1949) Practical Plant Anatomy, II Ed. Van Nostrand, New York, U.S.A.
13. Lyndon, R.F. (1990) Plant Development. The Cellular Basis. Unwin Hyman, London, U.K.
14. M.N.B. (1998) Wood Anatomy and Major Uses of Wood. Faculty of Forestry, University Putra Malaysia, Malaysia.
15. Mauseth, J.D. (1988) Plant Anatomy. The Benjamin / Cummings Publ. Co. In. Menlo Park, California, U.S.A.
16. Metcalfe, C.R. (1960) Anatomy of the Monocotyledons. I Graminae. Clarendon Press, Oxford, U.K.
17. Metcalfe, C.R. and Chalk, L. (1950) Anatomy of Dicotyledons Vol.I-II. Clarendon Press, Oxford, U.K.
18. Steeves, T. A. and I. M. Sussere (1989) Patterns in Plant Development (II Ed.) Cambridge University Press. Cambridge, U.S.A.
19. Tomlinson, P.B. (1961) Anatomy of the Monocotyledons-II. Palmae (Ed. C.R.Metcalfe), Clarendon Press, Oxford, U.K.
20. Bhojwani S.S. and S.P. Bhatnagar S.P. (1974) Embryology of Angiosperms Vikas Publishing House (P.) Ltd., New Delhi, India.
21. Davis, G.L. (1966) Systematic Embryology of Angiosperms, John, Wiley and Sons, New York, U.S.A.
22. Johri, B.M. (1984 Ed.) Embryology of Angiosperms. Springer-Verlag, Berlin, Heidelberg, New York, U.S.A.
23. Maheshwari, P. (1950) An Introduction To The Embryology of Angiosperms, McGraw Hill Book Co. New York, U.S.A.
24. 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. (1999) *Developmental Biology of Flowering Plants*, Springer-Verlag, New York, U.S.A
25. Raghavan, V. (1997) *Molecular Embryology of Flowering Plants*, Cambridge University Press. Cambridge, 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
30. Nair, P.K.K. (1970) *Pollen Morphology of Angiosperms: A Historical and Phylogenetic study*. 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*, WileyEastern 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.

Course Code: BO-512		
Course Title: Plant Breeding and Evolution		
Course Code: BO-512	Course Category: Core Course (DSC-36)	
Course Title: Plant Breeding and Evolution	Type: Theory	
Total Contact Hours: 30	Course Credits: 02 (30 L)	
College Assessment (CA) Marks: 20	University Assessment (UA): 30	
Course Objectives:		
<ol style="list-style-type: none"> 1. To impart theoretical knowledge and practical skills about plant breeding objectives, modes of reproduction and breeding methods for crop improvement. 2. To provide understanding about Heterosis and Inbreeding depression. 3. To impart the knowledge about Polyploidy breeding., Role of Polyploidy in crop evolution. 		
Course Outcomes:		
<ol style="list-style-type: none"> 1. To learn breeding procedures in self- pollinated crops and cross-pollinated crops 2. The student will be able to know about importance of heterosis and Inbreeding depression. 3. The student will be able to know various kinds of male sterility and their utilization in hybrid seed production of important field crops. 4. The student will be able to know about the fundamentals of mutation, polyploidy, hybridization and their role in crop improvement 		
Course Content		
Unit: 1	Introduction of Plant Breeding <ol style="list-style-type: none"> 1.1 Definition, Aim, Objectives and Scope of Plant Breeding, History of Plant Breeding (Pre- and post-Mendelian era) 1.2 Plant Introduction: - History and types of plant introduction, Procedure, Merits & Demerits of plant introduction, Acclimatization, Plant introduction agencies in India. 1.3 Selection: -Introduction, History, Procedure, Merits & Demerits of Selection and types of Plant selection (Pure line selection, Mass selection) 1.4 Hybridization: - Introduction, types of hybridization (Intervarietal and Distant), procedure / steps involved in hybridization, procedure merits and demerits of crop improvement method through hybridization (Pedigree, Bulk and Backcross methods) 	14 L
Unit: 2	Male Sterility <ol style="list-style-type: none"> 2.1 Introduction, different types of male sterility (genetic, cytoplasmic and cytoplasmic genetic male sterility) utilization of male sterile lines in hybrid seed production. 	4 L
Unit: 3	Heterosis and Inbreeding <ol style="list-style-type: none"> 3.1 Heterosis, types of heterosis, heterosis and hybrid vigour, Dominance hypothesis, Over-dominance hypothesis 	4 L

	3.2 Introduction, History of inbreeding, effect of inbreeding depression and degree of inbreeding depression.	
Unit: 4	Mutation Breeding 4.1 Historical Background Classification of mutations (physical & chemical mutagens). 4.2 Characteristic feature of mutations, 4.3 Various steps involved in mutation breeding, Merits, Demerits and Achievements of Mutation breeding, Gama Garden.	4 L
Unit: 5	Origin and Evolution of Crop Plants 5.1 Centres of origin of cultivated crop plants 5.2 Patterns of Evolution (Mendelian variation, interspecific hybridization and polyploidy). 5.3. Evolution of Bread Wheat, Tobacco, Tetraploid Brassica, Rice and Potato.	4 L

Suggested reading:

1. Allard RW. 1981. Principles of Plant Breeding. John Wiley & Sons.
2. Chahal GS and Gossal, SS. 2002. Principles and Procedures of Plant Breeding Biotechnological and Conventional approaches. Narosa Publishing House.
3. Chopra, V.L. (2000). Plant Breeding: Theory and Practice 2nd Ed. Oxford & IBH, New Delhi.
4. George A. 2012. Principles of Plant Genetics and Breeding. John Wiley & Sons.
5. Jain HK and Kharakwal MC. 2004. Plant Breeding and–Mendelian to Molecular Approach, Narosa Publications, New Delhi
6. Pohlman JM & Bothakur DN. 1972. Breeding Asian Field Crops. Oxford & IBH.
7. Roy D. 2003. Plant Breeding, Analysis and Exploitation of Variation. Narosa Publ. House.
8. Sharma JR. 2001. Principles and Practice of Plant Breeding. Tata McGraw-Hill.
9. Simmonds NW.1990. Principles of Crop Improvement. English Language Book Society.
10. Singh BD. 2006. Plant Breeding. Kalyani Publishers, New Delhi.
11. Singh Phundan. (2014) Essentials of Plant Breeding Kalyani Publishers; 5th Edition.
12. Singh S & Pawar IS. 2006. Genetic Bases and Methods of Plant Breeding.
13. Singh, B. D. (2000) Plant breeding- Principles and methods. Kalyani Publishers, Ludhiana.
14. Sinha V and Sinha S: 1998 Cytogenetics plant Breeding and Evolution, Vikas Publishing house Pvt ltd, New Delhi.
15. Verma, Agarwal. (2005) Cell Biology, Genetics, Molecular Biology, Evolution and Ecology: S. Chand and Company, New Delhi, India.

Course Code: BO-513		
Course Title: Special Paper- I A. Phycology		
Course Code: BO-513	Course Category: Core Course (DSC-37)	
Course Title: Special Paper- I A. Phycology	Type: Theory	
Total Contact Hours: 60	Course Credits: 04 (60 L)	
College Assessment (CA) Marks: 40	University Assessment (UA): 60	
Course Objectives:		
<ol style="list-style-type: none"> 1. The main objective is to fulfil the knowledge of rapidly expanding branch Phycology in Botanical Science. 2. To know diversity of various algal groups. 3. To provide a clear and sound background knowledge in respect to morphology; reproduction and interrelationships of Algae. 4. To study different systems of classification of algae. 5. To study and understand the local Algal diversity from various habit and habitat. 		
Course Outcomes:		
<ol style="list-style-type: none"> 1. Able to identify and differentiate algae taxa up to Genus and species level. 2. Able to know algal systematics and phylogeny 3. Expertise in knowing algal diversity and distribution according to habitat. 		
Course Content		
Unit: 1	Introduction to Phycology	12 L
	<ol style="list-style-type: none"> 1.1 Introduction, a brief History of Phycology, contribution of Indian algologist. 1.2. Comparative account of general characters of different groups of algae. (According to F. E. Fritsch's classification). 1.3. Systems of classification of algae up to orders according to F. E. Fritsch, G. M. Smith, 1.4. Modern trends in algal systematics. 	
Unit: 2	Discussion of algae with reference to Reproduction, Life Cycle, Evolution, Phylogeny and interrelationships of belonging to the following algal classes (sensu F. E. Fritsch).	12 L
	<ol style="list-style-type: none"> 1. Cyanophyceae. 2. Chlorophyceae. 	
Unit: 3	Discussion of algae with reference to Reproduction, Life Cycle, Evolution, Phylogeny and interrelationships of belonging to the following algal classes (sensu F. E. Fritsch).	12 L
	<ol style="list-style-type: none"> 1. Phaeophyceae. 2. Rhodophyceae 	
Unit: 4	Discussion of algae with reference to Reproduction, Life Cycle, Evolution, Phylogeny and interrelationships of belonging to the following algal classes (sensu F. E. Fritsch).	12 L

	1. Euglenophyceae 2. Xanthophyceae 3. Bacillariophyceae	
Unit: 5	Brief discussion in relation to the Characteristics and systematic position of the following groups. 1. Chrysophyceae. 2. Dinophyceae. 3. Desmophyceae. 5. Cryptophyceae.	12 L

Suggested reading:

1. Anand, N. (1998). Indian Freshwater Microalgae, Bishen Singh Mahendra Pal Singh, Dehradun, India.
2. Bold, H and Wynne. M. J (1978) Algal structure and reproduction. Prentice Hall of India pvt. Ltd. New Delhi, India.
3. Bony, A.D. (1978). Phytoplankton. Edward Arnold pub. Ltd. London, U.K.
4. Chapman, V.J. and Chapman D.J. (1979). The Algae. English Language Book Society and Mc. Millan, Co, London, U.K.
5. Daws, C. J. (1981). Marine Botany. Wiley Publication Com. New York, USA.
6. Desikachary, T.V. (1959). Cyanophyta. ICAR, New Delhi, India.
7. Fritsch, F.E. (1959-1961). The Structure and Reproduction of the Algae. Vol. 1 & 2 Cambridge University Press, U.K.
8. Ghandi, H.P. Fresh Water Diatoms of Central Gujrat, Bishen Singh Mahendra Pal Singh Dehradun, India.
9. Gonzalves, E. (1981). Oedogoniales. ICAR, New Delhi, India.
10. Gordon, F. Leedale (1969). Euglenoid Flagellates Biological techniques series Prentice-Hall, Inc, Englewood, London, U.K.
11. Irvine D. E. G. & D. M. John (1984). Systematics of Green Algae (The systematic association special vol. 27), Academic Press, London
12. Iyengar, M.O.P. and Desikachary, T.V. (1981). Volvocales. ICAR, New Delhi, India.
13. Lee, R.E. (1989). Phycoogy. Cambridge University Press, Cambridge, U.K.
14. Misra, J.N. (1966). Pheohyceae in India. ICAR, New Delhi, India.
15. Morris, I (1967). An Introduction To The Algae Hutchinson University Press
16. Pal, B.P. and Sunderlingam et al. (1962). Characeae. ICAR, New Delhi, India.
17. Philipose, M.T. (1960). Chrococcales. ICAR, New Delhi, India.
18. Prescott, G.W. (1968). The Algae : A Review. Houghton-Mifflin Co. Boston.
19. Ramanathan, M.S. (1964). Ulotrichales. ICAR, New Delhi, India.
20. Randhawa, M.S. (1959). Zygnemataceae. ICAR, New Delhi, India.
21. Round, F.E. (1973). The Biology of the Algae. Edward Arnold, London, U.K.
22. Sahoo, Dinabandhu and Debasish Nivedita (2001). The Checklist of Seaweeds of Indian Coast APH Publishing Corporation, Delhi, India.
23. Sarode, P.T. and Kamat N.D. (1984). Freshwater Diatoms of Maharashtra. Saikrupa Pub. Aurangbad (M.S.), India. (12)
24. Smith, G.M. (1950). Freshwater Algae of the United States. Mc.Graw Hill, New York, U.S.A.
25. Srinivasan, K.S. (1969). Phycologia Indica. Icones of Indian Marine Algae. Vol. 1 and 2. Botanical Survey of India, India.
26. Venkatraman, G.S. (1969). Vaucheriaceae ICAR, New Delhi, India

Course Code: BO-513		
Course Title: Special Paper- I B. Mycology		
Course Code: BO-513	Course Category: Core Course (DSC-37)	
Course Title: Special Paper- I B. Mycology	Type: Theory	
Total Contact Hours: 60	Course Credits: 04 (60 L)	
College Assessment (CA) Marks: 40	University Assessment (UA): 60	
<p>Course Objectives:</p> <ol style="list-style-type: none"> 1. To reveal historical development in mycology. 2. To make aware principles, rules and regulations of ICBN. 3. To know ultra-structure of fungal cells. 4. To study different classifications for fungal organisms. 5. To study vegetative structure of various groups of fungi. 6. To study reproductive structure phylogeny, interrelationship and life cycle pattern of various groups of fungi. 		
<p>Course Outcomes:</p> <ol style="list-style-type: none"> 1. Able to know history of Mycology and Nomenclature of fungi. 2. Able to describe life cycle patterns of various groups of fungi. 3. Higher cognitive skills about taxonomy of fungi will develop. 		
Course Content		
Unit: 1	<p>Introduction</p> <ol style="list-style-type: none"> 1.1 History of Mycology 1.2 International code of Nomenclature for Fungi, Principles, major rules, Revisions and recommendations, effective and valid publications, typification, starting date point, authority. 1.3 Outline classification proposed by Ainsworth (1973), Hawksworth et. al., (1995) and Alexopoulos et al., (1996). 1.4 Ultra structure of fungal cell, cell-wall composition, septa, rhizomorph 	12 L
Unit: 2	<p>Discussion of fungi with reference to vegetative structure, reproductive structure, phylogeny, interrelationship (if any) and life cycle pattern of following:</p> <ol style="list-style-type: none"> 2.1 Myxomycota: Dictyosteliales, Ceratiomyxales, Physarales, Stemonitales, Plasmodiophorales. 2.2 Mastigomycotina: Chytridiales, Saprolegniales, Perenosporales. 2.3 Zygomycotina: Mucorales, Endogonales. 	12 L

Unit: 3	Discussion of fungi with reference to vegetative structure, reproductive structure, phylogeny, interrelationship (if any) and life cycle pattern of following: 3.1 Ascomycotina: Taphrinales, Protomycetales, Eurotiales, Erysiphales, Sphaeriales, Pezizales, Myringiales, Hysteriales, Dothidiales, Pleosporales.	12 L
Unit: 4	Discussion of fungi with reference to vegetative structure, reproductive structure, phylogeny, interrelationship (if any) and life cycle pattern of following: 4.1 Basidiomycotina: Uredinales, Ustilaginales, Auriculariales, Dacrymycetales, Tulasnellales, Aphyllophorales, Agaricales, Lycoperdales, Nidulariales, Phallales.	12 L
Unit: 5	Discussion of fungi with reference to vegetative structure, reproductive structure, phylogeny, interrelationship (if any) and life cycle pattern of following: 5.1 Deuteromycotina: Blastomycetes, Hyphomycetes, Coelomycetes.	12 L

Suggested reading:

1. Ainsworth *et.al.*, (1965-73). The fungi, An advanced treatise Vol. I-IV B, Academic press, London, UK.
2. Alexopoulous & Mims (1979). Introductory Mycology, Willey Eastern Ltd. New Dehli, India.
3. Alexopoulous, Mims and Blackwell (1996) Introductory Mycology (4th Ed.). John. Willey and Sons. Inc New York., USA.
4. Aneja K. R, (1996) Experiments in microbiology, Plant pathology, Tissue culture and mushroom cultivation. Vishwa Prakashan New Dehli, India.
5. Burnett and Hunter (1972) Illustrated Genera of Imperfect Fungi, Minnesota.
6. Barron G. L. (1968). The Genera of Phycomycetes from Soil. Williams and Wilkins, Baltimore.
7. Bassey E. A. (1950). Morphology and Taxonomy of Fungi, The Blakriston Ed. Philadelphia
8. Bhide et. al (1987). Fungi of Maharashtra, M. A. C. S. Inst. Pub Pune (M. S.), India.
9. Biligrami et. al (1979-81). Fungi of India (Part I-II). Today and tomorrow's Pub. New Dehli, India.
10. Biligrami K. S. (1991). Fungi of India, International Book House New Dehli, India.
11. Bonner J. T. (1996). The culture of Slime moulds Princaton, Univ press
12. Borse, B. D., Borse, K. N., Pawar, N. S. And Tuwar, A. R. (2012) Marine Fungi of India (Monograph), Broadway Book Center Publishers and Distributors, Panjim, Goa Pp. 1- 471.
13. Borse, B.D., Borse, K. N., Patil, S. Y., Pawara, C. M., Nemade, L. C. And Patil, V. R. (2016) Freshwater Higher Fungi of India, Lulu Publication, USA and Laxmi Book Publisher, Solapur, Maharashtra, India. Pp. 1-636.
14. Borse, B. D., Borse, K. N., Chaudhari, S. A., Patil, V. R., Patil, S. Y., Gisavi, S. A. and Borade D. S. (2017) Freshwater and Marine Fungi of India. Lambart Academic Publishing Group, Meldrum Street, Beau Bassin 71504, Mauritius.

17. Burnett J. H. (1986). *Fundamental of Mycology*, Edward Arnold. London, UK.
18. Clemet and Shear (1993). *The Genera of Fungi*, H. W. Wilson New York, USA.
19. Cummins G. B. (1971). *The Rust Fungi of Cereals Grasses and Bamboos*, Spinrigles, Verlag NewYork, USA
20. Dayal R. & Kiran U. (1989). *Zoosporic Fungi of India* Inter India Pub. New York, USA.
21. Dennis R. W. G. (1977). *British Ascomycetes* (3rd Ed.) J. Ceamer, Vaduz, Germany.
22. Ellis M. B. (1971). *Demaeticeous Hypomycetes*, CMI publication Kew Survey, London.
23. Gauman E. A. (1928). *Comparative Morphology of Fungi* McGraw-Hill Pub. New York, USA
24. Hawksworth D. L. (1971). *Mycologist*. CBI, Kew Kamat M. N. (1959). *Hand Book of Mycology* Vol. I-II Prakash Publication. Pune, India.
25. Kamat M. N. (1959). *Introductory Plant Pathology* Prakash Publication. Pune, India.
26. Khulbe, R. D. (2001) *A manual of Aquatic Fungi (Chytridiomycetes and Oomycetes)*, DayaPublishing House, New Delhi, Pp. 1-255.
27. Lakhanpal and Mukherji (1981). *Indian Myxomycetes* L. Cramer Vaduz.
28. Mehrotra and Aneja (1991, 2015). *An Introduction of Mycology*. Wiely Eastern ltd. New Dehli, India.
29. Mundkur and Thirumatcher (1952). *Ustilagales of India*. CMI Pub. Kew survey, England. Mahadevan and Shridhar (1982). *Methods in Physiological Plant Pathology* II Ed. Sivakarni Pub. Madras, India.
30. Pathak V. R. (1972). *Essentials of Plant Pathology*. Prakash Pub Jodhpur, India.
31. Patahk, Khatri, Pathak. (1996). *Fundamentals of Plant Pathology*, Agro Botanical Pub. Bikaner, India.
32. Sarbhoy A. K. (1983). *Advance Mycology, Today's and Tomorrow's pub*. New Dehli, India Subramanian C. V. (1981). *Hypomycetes*, Academic Press London, UK
33. Tondon R. N. (1968). *Mucorales of India* ICAR Pub. New Dehli, India.
34. Thind K. S. (1977). *Myxomycetes of India* ICAR New Dehli, India.
35. Vasudeva R. S. (1961). *India Cercosporae* ICAR New Dehli, India.
36. Webster J. (1980). *Introduction to Fungi* 2nd ed. Cambridge Uni, press Cambridge.
37. Wolf and Wolf (1964-69). *The Fungi* Vol. I-II, John Wiley and Hafner New York, USA
38. Cummins G. B. (1979). *Illustrated Genera of Rust Fungi*, Burgens Pub. Co. Minnacapolin

Course Code: BO-513		
Course Title: Special Paper- I C. Angiosperm Taxonomy		
Course Code: BO-513	Course Category: Core Course (DSC-37)	
Course Title: Special Paper- I C. Angiosperm Taxonomy	Type: Theory	
Total Contact Hours: 60	Course Credits: 04 (60 L)	
College Assessment (CA) Marks: 40	University Assessment (UA): 60	
Course Objectives:		
<ol style="list-style-type: none"> 1. To study importance of classification in Angiosperms. 2. To study primitive and advanced groups of Angiosperm. 3. To study taxonomic structure of Angiosperms. 4. To study orders of Engler and Prantl's system of Angiosperms classification. 		
Course Outcomes:		
<ol style="list-style-type: none"> 1. Understand the plant morphology and general classification 2. Understand the status of angiosperms in the plant kingdom with specific orders 3. Realize the taxonomic structure of angiosperms 4. Understand various angiosperm orders emphasizing range of floral variation, Taxonomy, phylogeny and evolutionary trends 		
Course Content		
Unit: 1	Classification	12 L
	1.1 Need for classification 1.2 Process of classification 1.3 Classification and Aesthetics 1.4 Hierarchical classification 1.5 General and Special purpose classification 1.6 Horizontal and Vertical classification 1.7 Polythetic and Monothetic classification 1.8 Folk classification 1.9 Phase of Classification.	
Unit: 2	Discussion of the following orders with respect to	12 L
	2.1 Ranales: A group of most primitive dicotyledons, evolutionary trends. 2.2 Amentiferae: A heterogeneous assemblage of moderately advanced dicotyledons, evolutionary trends. 2.3 Sympetalae: Heptaphyletic in origin, evolutionary trends.	
Unit: 3	Taxonomic structure	12 L
	3.1 Taxonomic categories: 3.2 Major categories: Division, Sub Division, Classes, Sub Classes, Orders and Families.	

	<p>3.3 Minor categories: Genus and Species.</p> <p>3.4 Historical development of concept of species.</p> <p>3.5 Species Concept: Typological species concept, Non-dimensional Species Concept, Multi-dimensional Species Concept and Species definition.</p> <p>3.6 Intraspecific categories.</p> <p>3.7 Botanical Survey of India, its organization and role.</p>	
Unit: 4	<p>Discussion of Dicot orders as defined in Engler and Prantl's system with reference to</p> <p>4.1 Range of floral variation.</p> <p>4.2 Taxonomy, phylogeny and evolutionary trends in the Orders Centrospermae, Rosales, Malvales, Contortae and Tubiflorae .</p>	12 L
Unit: 5	<p>Discussion of Monocot orders as defined in Engler and Prantl's system with reference to</p> <p>5.1 Range of floral variation.</p> <p>5.2 Taxonomy, phylogeny and evolutionary trends in the Glumiflorae, Liliflorae, Scitaminae and Microspermae.</p>	12 L

Suggested reading:

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. Heywood V.H.1968. Modern Methods in Plant Taxonomy. Oliver Boyd. Edinburg. Judd Walter S., Campbell C. S., Kollogg, E. A., Stevens P.F. and M. J. Donoghue 2008.
5. Kumar, N. C. 1995. An Introduction to Taxonomy of Angiosperm. Himalaya Publishing House, Girgaon, Mumbai, India.
6. Lawrence George H. M. 1951. Taxonomy of Vascular Plants. Oxford and IBH Publ. Co. Pvt. Ltd. New Delhi, India.
7. Manilal K. S. and M. S. Muktesh Kumar [ed.] 1998. A Handbook of Taxonomic Training. DST, New Delhi, India.
8. Mondal A. K. 2016. Advanced Plant Taxonomy. New Central Book Agency (P) Ltd. Kolkata, India.
9. Mukhopadhyay N. C. 2006. Plant Taxonomy. Avishkar Publishers, Distributors, Jaipur, India.
10. Naik V. N. 1984. Taxonomy of Angiosperms Tata McGraw-Hill Publication Com. Ltd. New Delhi, India.
11. Nair R. 2010. Taxonomy of Angiosperm. A. P. H. Publishing Corporation, New Delhi, India.
12. Pandey, B.P. 1999. Modern Practical Botany Vol. II. S. Chand Publications, New Delhi, India.
13. Plant Systematics. Sinauer Associates, INC, Publishers. Sunderland, Massachusetts, USA.
14. Pullaiah, T and Karuppusamy, S. 2018. Taxonomy of Angiosperms. Regency Publications, New Delhi, India

16. Pullaiah, T. 2003. Taxonomy of Angiosperm. Regency Publications, New Delhi, India. Quicke Donald, L. J. 1993. Principles and Techniques of Contemporary Taxonomy. Blakie Academic & Professional, London.
17. Sambamurthy, A.V.S.S. 2005. Taxonomy of Angiosperms. I K International Publishing House Pvt. Ltd. New Delhi, India.
18. Sharma O. P. 2003. Plant Taxonomy. Tata McGraw-hill Publishing Company Limited, New Delhi, India.
19. Singh, V., Pande, P.C., Jain, D.K. 2013. A Text Book of Angiosperms. Rastogi Publications, Meerut, India
20. Sivrajan V.V. 1984. Introduction to Principle of Plant Taxonomy. Oxford and IBH Publ. New Delhi, India.
21. Stace C. A. 1989 Plant Taxonomy and Biosystematics. Edward Arnold, London, U.K.
22. Stuessy T. F. 2002. Plant Taxonomy. The Systematics Evaluation of Comparative data. Bishen Singh Mahendra Pal Singh, Dehera Dun, India.
23. Subrahmanyam N.S. 2003. Modern Plant Taxonomy. Vikas Publishing House PVT. LTD. New Delhi, India.
24. Taylor, D. V. and L. J. Hickey 1997. Flowering Plants: Origin, Evolution and Phylogeny. CBS Publishers & Distributors, New Delhi, India.
25. Vardhana Rashtra 2009. Taxonomy of Angiosperm. Vol. 1-2, Campus Books International, New Delhi, India.
26. Verma, B. K. 2010. Introduction to Taxonomy of Angiosperms, Delhi, India.
27. Walter S. Judd. Et al. 2002. Plant Systematics- A Phylogeny Approach. Sinauer Associates-Inc. USA

Course Code: BO-513		
Course Title: Special Paper- I D. Plant Physiology		
Course Code: BO-513 D	Course Category: Core Course (DSC-37)	
Course Title: Special Paper- I D. Plant Physiology	Type: Theory	
Total Contact Hours: 60	Course Credits: 04 (60 L)	
College Assessment (CA) Marks: 40	University Assessment (UA): 60	
Course Objectives:		
<ol style="list-style-type: none"> 1. To awake the students with concepts of plant physiology. 2. To inculcate the students with process of photomorphogenesis. 3. To study the growth and post-harvest changes in the plants. 4. To study the advances in photosynthesis and respiration. 5. To inculcate the students with organic acids and secondary metabolites in plants. 		
Course Outcome:		
<ol style="list-style-type: none"> 1. Students will able to know the concepts of plant physiology 2. Students will understand the photomorphogenic processes of plants. 3. Students will get the knowledge of growth process and post-harvest changes in plants. 4. The advance knowledge of photosynthesis and respiration deiminated among the students. 		
Course Content		
Unit: 1	Growth and Morphogenesis	12 L
	<ol style="list-style-type: none"> 1.1 Photomorphogenesis- history and discovery of phytochromes and cryptochromes 1.2 Photochemical and biochemical properties of Phytochrome and cryptochromes. 1.3 Brief account of phytochrome and its biosynthesis, cellular localization and role 1.4 Mechanism of action and photo morphogenetic receptors. 	
Unit: 2	Growth regulators and Stress Physiology	12 L
	<ol style="list-style-type: none"> 2.1 A brief account of discovery, role and possible mechanism of action of a) Brassins b) Salicylic acid c) Jasmonates d) Polyamines. 2.2 A brief accounted plant growth retardants a) CCC b) Maleic hydrazide c) Trizoles d) TIBA 2.3 Responses of plants to biotic (pathogen and insects) and abiotic (water, temperature and salt) and Stresses. 	

Unit: 3	Regulation of Photosynthesis 3.1 Brief account of chlorophyll biosynthesis and pigment organization in thylakoid membrane, 3.2 Regulation of PCR cycle and C4 Pathway, 3.3 RUBISCO and PEP Case, C3 and C4 Intermediates. 3.4 Carbohydrate regulation of starch and sucrose biosynthesis, synthesis and degradation of cellulose. 3.5 A brief account of pectin biosynthesis and enzymes involved in pectin degradation.	12 L
Unit: 4	Regulation of Respiration 4.1 Glycolysis in plants and its regulation, 4.2 Regulation of Pentose Phosphate pathway. 4.3 Regulation of TCA Cycle. 4.4 Regulation of electron transport chain and role of alternate oxidase.	12 L
Unit: 5	Organic acids and Secondary metabolites 5.1 Brief account of organic acids produced in plants. 5.2 Role of organic acids in plant metabolism. 5.3 Organic acid metabolism- metabolism and role of oxalic acid, ascorbic acid and malic acid. 5.4 Secondary metabolites-shikimate pathway and its role in biosynthesis of secondary metabolites	12 L

Suggested reading:

1. Bidwell, R. C. S. (1979): Plant Physiology.
2. Bonner, J. and Varner, E. (1976): Plant Biochemistry.
3. Edwards, G., Walker, D. W. (1983): C3- C4 mechanism and cellular environmental regulation of photosynthesis.
4. Govindjee, H. (1982): Photosynthesis Vol. I & II.
5. Hopkins, W. C. (1995): Introduction to Plant Physiology.
6. Krishnamurthy, H.N. (1992): Physiology of Plant Growth and Development.
7. Marschner, H. W. (1986): Mineral nutrition of Higher Plants.
8. Miller, P (1973): Phytochemistry Vol.I, II and III.
9. Moore, T.C. (1974): Research experience in Plant Physiology, a laboratory manual.
10. Mukharjee, S.P. and Ghosh A.N. (1996): Plant Physiology.
11. Noggle, G.R. and Fritz, G. J. (1976): Introductory Plant Physiology.
12. Randhir Singh and Sawhney, S. K. (1988): Advances in frontier Areas of Plant Biochemistry. Sadashivam and Manikam (1996): Plant Biochemical methods.
13. Salisbury, F. B. and Ross, C.W. (1992): Plant Physiology IV ed.
14. Sinha S.K., Sane P.V., Bhargava S.C. and Agarwal P.K. (1990): Proceeding of International Congress of Plant Physiology Vol. I & II.
15. Smith, H. (1975): Phytochrome and Photomorphogenesis.

16. Steward F.C. (1976): Growth and Organization in plant.
17. Stump, P.K. and Conn, E. (1980) : Biochemistry of Plants. A Comprehensive Treatise.
18. Taiz, L. and Ziegler, F. (1998): The Plant Physiology.
19. Pessarkli, M. (2004): Handbook of Plant and Crop Physiology, Marcel Dekkar Inc. NY.
20. Pessarkli, M. (2005): Handbook of Photosynthesis.
21. Wilkins, M. B. (1976): Physiology of Plant Growth and Development.
22. Annual reviews of Plant Physiology and Molecular Biology.
23. Indian Journal of Plant Physiology.
24. Journal of Experimental Botany.
25. Physiologia Plantarum Sweden.
26. Plant Physiology (Bethesda, USA).
27. The Plant Cell.

Course Code: BO-514	
Course Title: Practical based on BO-511 & BO- 512	
Course Code: BO-514	Course Category: Core Course (DSC-38)
Course Title: Practical based on BO-511 & BO-512	Type: Practical
Total Contact Hours: 60	Course Credits: 02 (60 L)
College Assessment (CA) Marks: 20	University Assessment (UA): 30
<p>Course Objectives:</p> <ol style="list-style-type: none"> 1. To study methods of pollination and fertilization 2. To study applications of embryology in plant tissue culture 3. To practice emasculation, bagging, tagging, and crossing techniques, essential skills in controlled pollination and hybridization studies. 4. To observe alterations in growth patterns and morphological features caused by mutagen exposure. 5. To determine pollen viability using sugar solution and acetocarmine staining. 	
<p>Course Outcomes:</p> <ol style="list-style-type: none"> 1. Able to identify embryological stages. 2. Ability to assess pollen viability accurately using sugar solution and acetocarmine staining, crucial for evaluating pollen quality in breeding programs. 3. Comprehensive understanding of the effects of chemical mutagens on crop germination, growth, and morphology. 4. Mastery of emasculation, bagging, tagging, and crossing techniques, essential for creating controlled crosses and studying inheritance patterns. 	
Course Content	
Practical: 1	Study of stomatal types by peeling method <ol style="list-style-type: none"> a. Types in Dicotyledons b. Types in Monocotyledons
Practical: 2 & 3	Study of different types of woods by double stained preparation of <ol style="list-style-type: none"> a. Dicot woods (Covering different types)
Practical: 4	Study of dicot wood elements by acid maceration method.
Practical: 5	Study of anomalous structures in stem from permanent or prepared slides <ol style="list-style-type: none"> i) <i>Bignonia</i> ii) <i>Aristolochia</i> iii) <i>Boerhavia</i> iv) <i>Amaranthus</i>
Practical: 6	Study of types of flowers (P.S.)

Practical: 7	Study of development of microsporangium: wall layers, microspores, male gametophyte of angiosperms (P.S.)
Practical: 8	Study of megasporangium: Megaspores, types of embryo sacs, types of embryos.
Practical: 9	Dissection and mounting of different stages of embryo development using suitable materials (e.g. <i>Cyamopsis tetragonaloba</i> and <i>Cucumis</i> and multiple embryos in Citrus seeds.)
Practical: 10	Study of pollen units: monads, dyads, tetrads, polyads, pollinia and study of Pollen preparation of Angiosperms and Gymnosperms pollen grains by using any suitable method.
Practical: 11	Floral biology in self-pollinated & cross-pollinated crops Sunflowers, Peas, wheat, wheat/maize.
Practical: 12	Pollen viability test through sugar solution and acetocarmine.
Practical: 13	Study of hybridization techniques. e.g. Emasculation, Bagging, Tagging, Labelling and crossing techniques.
Practical: 14	Effect of chemical mutagen (DES/HZ/EMS/SA or any chemical or Physical mutagens) on germination /growth / any Morphological characters of <i>Oryzae sativa/Brassica juncea /green gram/ wheat/ maize</i> or any crop plant.
Practical: 15	Estimation of heterosis: standard, mid-parental and better-parental heterosis.
Note:	
<ul style="list-style-type: none"> i) Submission of permanent slide preparation at least two dicot woods and two whole mounts of wood maceration is necessary. ii) Submission of five palynological slides is compulsory. 	
Suggested reading:	
<ol style="list-style-type: none"> 1. Carlquist, S. (1961) Comparative Plant Anatomy, Hold, Rinehart and Winston, New York, U.S.A. 2. Carlquist, S. (1988) Comparative Wood Anatomy: Systematic, Ecological and Evolutionary Aspects of Dicotyledonous Wood. Springer-Verlag, Berlin, Germany 3. Cutter, D.F. (1978) Applied Plant Anatomy, Longman, London and New York, USA 4. Cutter, E. G. (1969) Plant Anatomy: Experiment and Interpretation. Part-I : Cell and Tissues, Edward Arnold, London, UK. 5. Eames, A.J. (1961) Morphology of Angiosperms, McGraw Hill, New York, U.S.A. 6. Eames, A.J. and McDaniels, L.H. (1974) An Introduction to Plant Anatomy, IInd Ed. McGraw Hill, New York and London, UK. 7. Easu, K. (1960) Anatomy of the Seed Plants, Wiley, New York, U.S.A. 8. Easu, K. (1965) Vascular Differentiation in Plants. Hold, Rinehart and Winston, New York, U.S.A. 9. Easu, K. (1977) Anatomy of Seed Plants, (IInd Ed.) John, Wiley and Sons, New York, U.S.A 10. Fahn, A. (1982) Plant Anatomy, III Ed. Pergamon Press, Oxford U.K. 	

- Fahn, A. (1995) *Secretory Tissues in Plants*. Academic Press. London, U.K.
10. Foster, A.S. (1949) *Practical Plant Anatomy*, IInd, Ed. Van Nosrand, New York, U.S.A. Lyndon, R.F. (1990) *Plant Development. The Cellular Basis*. Unnin Hyman, London, U.K.
 11. M.N.B. (1998) *Wood Anatomy and Major Uses of Wood*. Faculty of Forestry, University Putra Malaysia, Malaysia.
 12. Mauseth, J.D. (1988) *Plant Anatomy*. The Benjamin / Cummings Publ. Co. In. Menio Park, californis, U.S.A.
 13. Metcalfe, C.R. (1960) *Anatomy of the Monocotyledons. I Graminae*. Clarendon Press, Oxford, U.K.
 14. 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.
 15. *Practical Manual of Genetics & Plant Breeding* by Bineeta Singh, G.M. LaL ISBN:9789390660513 Binding: Paperback Year: 2022.
 16. *Plant Breeding Theory and Practice* By Neal C Stoskopf, Dwight T Tomes, B. R. Christie, Bertram R Christie Copyright 1994.
 17. *Principles of Plant Genetics and Breeding*" by George Acquaaah
 18. *Plant Breeding: Principles and Methods*" by B.D. Singh.

Course Code: BO-515	
Course Title: Practical based on Special Paper BO-513 (A)	
Course Code: BO-515	Course Category: Core Course (DSC-39)
Course Title: Practical based on Special Paper BO- 513 (A)	Type: Practical
Total Contact Hours: 60	Course Credits: 02 (60 L)
College Assessment (CA) Marks: 20	University Assessment (UA): 30
<p>Course Objectives:</p> <ol style="list-style-type: none"> 1. The main objective is to give practical knowledge to identify various algal classes 2. To study and understand the local Algal diversity from various habit and habitat. 3. To identify morphology; reproduction within Algae. 4. To study different systems of classification of algae. 5. To know field diversity of various algal groups. 	
<p>Course Outcomes:</p> <ol style="list-style-type: none"> 1. Able to identify and differentiate algae taxa up to Genus and species level. 2. Expertise in knowing algal diversity and distribution according to habitat. 3. Able to classify algae systematically and its conservation in their habitat. 	
Course Content	
Practical: 1-5	<p>Chlorophyceae (Any locally available 25 forms)</p> <p>A) Volvocales: <i>Chlamydomonas, Dunaliella, Pandorina, Eudorina, Volvox, and Gonium</i></p> <p>B) Chlorococcales: <i>Chlorococcum, Chlorella, Trebauxia, Tetraedron, Characium, Charasiosiphon, Ankistrodesmus, Selenestrum, Oocystis, Botryococcus, Coelastrum, Scenedesmus, Pediastrum, Hydrodictyon, Protosiphon and Crucigenia.</i></p> <p>C) Ulotrichales: <i>Ulothrix, Uronema, Microspora, Sphaeroplea, Cyllindrocapsum, Ulva, Enteromorpha, Schizomeris and Monostroma,</i></p> <p>D) Chaetophorales: <i>Stigeoclonium, Chaetophora, Draparnaldia, Draparnaldiopsis, Fritschiella, Coleochaete, Trentepohlia, and Cephaleuros</i></p> <p>E) Cladophorales: <i>Cladophora, Rhizoclonium, Pithophora, Chaetomorpha, and Sponogomorpha</i></p> <p>F) Oedogoniales: <i>Oedogonium, Bulbochaete and Oedocladium</i></p> <p>G) Conjugales: <i>Spirogyra, Zygnema, Mougeotia, Sirogonium, Sirocladium, Cosmarium, Euastrum, Pleurotaenium, Closterium and Cylindrocystis</i></p> <p>H) Siphonales: <i>Caulerpa, Bryopsis, Dichotomosiphon, Codium, Halimeda,</i></p>

	<p><i>Udotea Chaemodoris, Boergesenia, Valonia, Valoniopsis, Neomeris, Acetabularia and Tydemania</i></p> <p>I) Charales: <i>Chara and Nitella</i></p>
Practical: 6-7	<p>Study of following classes (Any locally available 08 forms)</p> <p>A) Xanthophyceae: <i>Vaucheria and Botrydium</i></p> <p>B) Chrysophyceae: <i>Dinobryon and Synura</i></p> <p>C) Bacillariophyceae: <i>Coscinodiscus, Melosira, Cyclotella, Chaetoceros, Cymbella, Cocconeis, Biddulphia, Navicula, Nitzschia, Synedra, Pinnularia, Fragilaria, Gyrosigma, Pleurosigma, Gomphonema and Surirella.</i></p> <p>D) Euglenophyceae: <i>Euglena, Phacus, Lepocinclis and Trachelomonas</i></p>
Practical: 8-9	<p>Phaeophyceae (Any locally available 08 forms)</p> <p><i>Ectocarpus, Giffordia, Sphacelaria, Dictyota, Padina, Stoechospermum, Spatoglossum, Dictyopteris, Iyengaria, Colpomenia, Hydroclathrus, Sargassum, Turbinaria, Zonaria, Rosenvingea, Laminaria, Fucus, Cystoseria, Chnoospora, Macrocystis, Nereocystis and Postelsia</i></p>
Practical: 10-11	<p>Rhodophyceae (Any locally available 08 forms)</p> <p><i>Porphyra, Compsopogon, Batrachospermum, Liagora, Scinaia, Gelidium, Gelidiella, Grateloupia, Gracilaria, Hypnea, Rhodymenia, Champia, Ceramium, Caloglossa, Acanthophora, Chondrus, Laurencia, Polysiphonia, Asparagopsis, Helminthocladia, Sebdenia, Halymenia, Botryocladia, Gastroclonium, Nematium and Amphiroa</i></p>
Practical: 12-13	<p>Cyanophyceae (Any locally available 08 forms)</p> <p><i>Chroococcus, Gloeocapsa, Gloeotheca, Merismopedia, Aphanothece, Coelosphaerium, Microcystis, Oscillatoria, Phormidium, Lyngbya, Arthrospira, Spirulina, Gloeothrichia, Cylandrospermum, Nostoc, Anabaena, Nostochopsis, Hapalosiphon, Stigonema, Tolypothrix, Rivularia, Scytonema, Calothrix and Dichothrix</i></p>
Practical: 14	Artificial key of the genera based on Morphology and Reproductive Characters.
Practical: 15	Field work Surveys and collection of algae from local water reservoir as ponds, rivers, lakes and polluted habitats.
Notes:	<p>(i) Classification of algae should be followed according to F. E. Fritsch.</p> <p>(ii) Students will submit their scientific survey reports and algal collection at the time of Examination.</p>
Suggested reading:	<p>1. Anand, N. (1998). Indian Freshwater Microalgae, Bishen Singh Mahendra Pal Singh, Dehradun, India.</p>

2. Bold, H and Wynne. M. J (1978) Algal structure and reproduction. Prentice Hall of India pvt. Ltd. New Delhi, India.
3. Bony, A.D. (1978). Phytoplankton. Edward Arnold pub. Ltd. London, U.K.
4. Chapman, V.J. and Chapman D.J. (1979). The Algae. English Language Book Society and Mc.Millan, Co, London, U.K.
5. Daws, C. J. (1981). Marine Botany. Wiley Publication Com. New York, USA.
6. Desikachary, T.V. (1959). Cyanophyta. ICAR, New Delhi, India.
7. Fritsch, F.E. (1959-1961). The Structure and Reproduction of the Algae. Vol. 1 & 2 Cambridge University Press, U.K.
8. Ghandi, H.P. Fresh Water Diatoms of Central Gujrat, Bishen Singh Mahendra Pal Singh Dehradun, India.
9. Gonzalves, E. (1981). Oedogoniales. ICAR, New Delhi, India.
10. Gordon, F. Leedale (1969). Euglenoid Flagellates Biological techniques series Prentice-Hall, Inc, Englewood, London, U.K.
11. Irvine D. E. G. & D. M. John (1984). Systematics of Green Algae (The systematic associations special vol. 27), Academic Press, London
12. Iyengar, M.O.P. and Desikachary, T.V. (1981). Volvocales. ICAR, New Delhi, India.
13. Lee, R.E. (1989). Phycoogy. Cambridge University Press, Cambridge, U.K.
14. Misra, J.N. (1966). Pheohyceae in India. ICAR, New Delhi, India.
15. Morris, I (1967). An Introduction To The Algae Hutchinson University Press
16. Pal, B.P. and Sunderlingam et al. (1962). Characeae. ICAR, New Delhi, India
17. Philipose, M.T. (1960). Chroococcales. ICAR, New Delhi, India.
18. Prescott, G.W. (1968). The Algae : A Review. Houghton-Mifflin Co. Boston.
19. Ramanathan, M.S. (1964). Ulotrichales. ICAR, New Delhi, India.
20. Randhawa, M.S. (1959). Zygnemataceae. ICAR, New Delhi, India.
21. Round, F.E. (1973). The Biology of the Algae. Edward Arnold, London, U.K.
22. Sahoo, Dinabandhu and Debasish Nivedita (2001). The Checklist of Seaweeds of Indian Coast APH Publishing Corporation, Delhi, India.
23. Sarode, P.T. and Kamat N.D. (1984). Freshwater Diatoms of Maharashtra. Saikrupa Pub. Aurangbad (M.S.), India. (12)
24. Smith, G.M. (1950). Freshwater Algae of the United States. Mc.Graw Hill, New York, U.S.A.
25. Srinivasan, K.S. (1969). Phycologia Indica. Icones of Indian Marine Algae. Vol. 1 and 2. Botanical Survey of India, India.
26. Venkatraman, G.S. (1969). Vaucheriaceae ICAR, New Delhi, India

Course Code: BO-515	
Course Title: Practical based on Special Paper BO-513 (B)	
Course Code: BO-515	Course Category: Core Course (DSC-39)
Course Title: Practical based on Special Paper BO- 513 (B)	Course Type: Practical
Total Contact Hours: 60	Total Credits: 02 (60 L)
College Assessment (CA) Marks: 20	University Assessment (UA) Marks: 30
<p>Course Objectives:</p> <ol style="list-style-type: none"> 1. Know the classification of fungi with reasons. 2. To study vegetative structure of various groups of fungi. 3. To know the asexual and sexual structures of various groups of fungi. 4. To. prepare artificial key based on reproductive structures. 	
<p>Course outcomes:</p> <ol style="list-style-type: none"> 1. Able to know asexual and sexual structures of various groups of fungi. 2. Able to classify the fungi based on reasons. 3. Able to prepare artificial key based on reproductive structures 4. Higher cognitive skills about taxonomy of fungi will develop 	
Course Content	
<p>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.)</p>	
Practical: 01	Myxomycota (Any 04 Genera)
Practical: 02	Mastigomycotina (Any 04 Genera)
Practical: 03	Zygomycotina (Any 04 Genera)
Practical: 04-06	Ascomycotina (Any 12 Genera)
Practical: 07-09	Basidiomycotina (Any 12 Genera)
Practical: 10-11	Deteuromycotina (Any 08 Genera)

Practical:12 &13	Preparation of artificial key based on appropriate characters
Practical: 14	Isolation of aquatic fungi by baiting in the laboratory
Practical:15	Botanical Excursion

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

Suggested reading:

1. Ainsworth *et.al.*, (1965-73). The fungi, An advanced treatise Vol. I-IV B, Academic press, London, UK.
2. Alexopoulos & Mims (1979). Introductory Mycology, Willey Eastern Ltd. New Dehli, India.
3. Alexopoulos, Mims and Blackwell (1996) Introductory Mycology (4th Ed.). John. Willey and Sons. Inc New York., USA.
4. Aneja K. R, (1996) Experiments in microbiology, Plant pathology, Tissue culture and mushroom cultivation. Vishwa Prakashan New Dehli, India.
5. Burnett and Hunter (1972) Illustrated Genera of Imperfect Fungi, Minnesota.
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7. Basse E. A. (1950). Morphology and Taxonomy of Fungi, The Blakriston Ed. Philadelphia
8. Bhide et. al (1987). Fungi of Maharashtra, M. A. C. S. Inst. Pub Pune (M. S.), India.
9. Biligrami et. al (1979-81). Fungi of India (Part I-II). Today and tomorrow's Pub. New Dehli, India.
10. Biligrami K. S. (1991). Fungi of India, International Book House New Dehli, India.
11. Bonner J. T. (1996). The culture of Slime moulds Princaton, Univ press
12. Borse, B. D., Borse, K. N., Pawar, N. S. And Tuwar, A. R. (2012) Marine Fungi of India (Monograph), Broadway Book Center Publishers and Distributors, Panjim, Goa Pp. 1- 471.
13. Borse, B.D., Borse, K. N., Patil, S. Y., Pawara, C. M., Nemade, L. C. And Patil, V. R. (2016) Freshwater Higher Fungi of India, Lulu Publication, USA and Laxmi Book Publisher, Solapur, Maharashtra, India. Pp. 1-636.
14. Borse, B. D., Borse, K. N., Chaudhari, S. A., Patil, V. R., Patil, S. Y., Gisavi, S. A. and Borade D. S. (2017) Freshwater and Marine Fungi of India. Lambart Academic Publishing Group, Meldrum Street, Beau Bassin 71504, Mauritius.
15. Burnett J. H. (1986). Fundamentals of Mycology, Edward Arnold. London, UK.
16. Cletet and Shear (1993). The Genera of Fungi, H. W. Wilson New York, USA.
17. Cummins G. B. (1979). Illustrated Genera of Rust Fungi, Burgens Pub. Co. Minnacapolin
18. Cummins G. B. (1971). The Rust Fungi of Cereals Grasses and Bamboos, Spinrigles, Verlag New York, USA
19. Dayal R. & Kiran U. (1989). Zoosporic Fungi of India Inter India Pub. New York, USA.
20. Dennis R. W. G. (1977). British Ascomycetes (3rd Ed.) J. Ceamer, Vaduz, Germany.
21. Ellis M. B. (1971). Dematiaceous Hypomycetes, CMI publication Kew Survey, London.

25. Gauman E. A. (1928). Comparative Morphology of Fungi McGraw-Hill Pub. New York, USA
26. Hawksworth D. L. (1971). Mycologist. CBI, Kew Kamat M. N. (1959). Hand Book of Mycology Vol. I-II Prakash Publication. Pune, India.
27. Kamat M. N. (1959). Introductory Plant Pathology Prakash Publication. Pune, India.
28. Khulbe, R. D. (2001) A manual of Aquatic Fungi (Chytridiomycetes and Oomycetes), Daya Publishing House, New Delhi, Pp. 1-255.
29. Lakhanpal and Mukherji (1981). Indian Myxomycetes L. Cramer Vaduz.
30. Mehrotra and Aneja (1991, 2015). An Introduction of Mycology. Wiely Eastern ltd. New Dehli, India.
31. Mundkur and Thirumatcher (1952). Ustilagenales of India. CMI Pub. Kew survey, England. Mahadevan and Shridhar (1982). Methods in Physiological Plant Pathology II Ed. Sivakarni Pub. Madras, India.
32. Pathak V. R. (1972). Essentials of Plant Pathology. Prakash Pub Jodhpur, India.
33. Patahk, Khatri, Pathak. (1996). Fundamentals of Plant Pathology, Agro Botanical Pub. Bikaner, India.
34. Sarbhoy A. K. (1983). Advance Mycology, Today's and Tomorrow's pub. New Dehli, India Subramanian C. V. (1981). Hypomycetes, Academic Press London, UK
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36. Thind K. S. (1977). Myxomycetes of India ICAR New Dehli, India.
37. Vasudeva R. S. (1961). India Cercosporae ICAR New Dehli, India.
38. Webster J. (1980). Introduction to Fungi 2nd ed. Cambridge Uni, press Cambridge.
39. Wolf and Wolf (1964-69). The Fungi Vol. I-II, John Wiley and Hafner New York, USA.

Course Code: BO-515	
Course Title: Practical based on Special Paper BO-513 (C)	
Course Code: BO-515	Course Category: Core Course (DSC-39)
Course Title: Practical based on Special Paper BO- 513 (C)	Type: Practical
Total Contact Hours: 60	Course Credits: 02 (60 L)
College Assessment (CA) Marks: 20	University Assessment (UA): 30
<p>Course Objectives:</p> <ol style="list-style-type: none"> 1. To study the Angiosperm families with respect to morphological characters. 2. To study importance of classification of Bentham and Hookers system in Angiosperms. 2. To study primitive and advanced groups of Angiosperm. 3. To study taxonomic structure of Angiosperms. 	
<p>Course Outcomes:</p> <ol style="list-style-type: none"> 1. Understand the habit, habitat and plant morphology of Angiosperm plants 2. Understand the status of angiosperms in the plant kingdom. 3. Know the vegetative characteristics and reproductive characteristics of the plant. 4. Understand various angiosperm families emphasizing their morphology, distinctive features, and biology. 5. Students will understand different flora for identification of Angiosperm plants. 6. Students will find out dichotomous keys on vegetative and floral characters. 	
Course Content	
Practical: 1 to 10	Study of Angiosperm families locally available in the region covering all orders/series (Sensu Bentham and Hooker, at least 20 families).
Practical: 11 & 12	Preparation of artificial dichotomous keys of (i) indented (ii) bracketed type based on vegetative and floral characters.
Practical: 13 & 14	Identification of plant specimens up to species level with help of flora`s.
Practical: 15	Botanical Excursion and submission of tour report and photographs of plants.
<p>Suggested reading:</p> <ol style="list-style-type: none"> 1. Davis, P.H. and Heywood, V.H. 1963. Principles of Angiosperm Taxonomy. Oliver and Boyd, London. Lawrence, G.H.M. (1974). Taxonomy of Vascular Plants. Oxford and IBH Publishing Co. Pvt.Ltd. New Delhi. 2. Mondal, A.K. 2005. Advanced Plant Taxonomy. New Central Book Agency (P) Ltd. India. 	

3. Naik, V.N. 2000. Taxonomy of Angiosperm. Tata McGraw-Hill Publishing Company Ltd., NewDelhi.
4. Pullaiah, T. 2003. Taxonomy of Angiosperm. Regency Publications, New Delhi, India.
5. Sambamurty, A.V.S.S. 2005. Taxonomy of Angiosperms. I.K. International,Pvt. Ltd., New Delhi,India.
6. Saxena, N.B. and Saxena, S. 2001. Plant Taxonomy. Pragati Prakashan, Meerut, UP, India.
7. Singh, G. 2004. Plant Systematics: Theory and Practice. Oxford and IBH Publishing Co. Pvt. Ltd.New Delhi, India
8. Sivarajan, V.V.2001. Introduction to the Principles of Plant Taxonomy. Oxford and IBH PublishingCo. Pvt.Ltd. New Delhi, India.
9. Subrahmanyam N. S. 2012. Modern Plant Taxonomy. Vikash Publishing House Pvt. Ltd. New Delhi,India.
10. Tiagi, Y.D. and Kshetrapal, S. 1995. An Introduction to the Taxonomy of Angiosperms. Publishing:Ramesh Book Depot, Jaipur, Rajasthan, India.
11. Verma, B.K. 2011. Introduction to Taxonomy of Angiosperm. PHI Learning, Pvt. Ltd., New Delhi,India.
12. Flora of Dhule and Nandurbar District.
13. Flora of Maharashtra State.
14. Flora of Jalgaon District.

Course Code: BO-515	
Course Title: Practical based on Special Paper BO-513 (D)	
Course Code: BO-515	Course Category: Core Course (DSC-39)
Course Title: Practical based on Special Paper BO- 513 (D)	Type: Practical
Total Contact Hours: 60	Course Credits: 02 (60 L)
College Assessment (CA) Marks: 20	University Assessment (UA): 30
Course Objectives: <ol style="list-style-type: none"> 1. To aware the students with total starch present in plant 2. To study the organic acids present in the plant 3. To study the changes took place in protein starch content during the seed germination. 4. To inculcate the students with the protocol of estimation of primary and secondary metabolites. 	
Course Outcomes: <ol style="list-style-type: none"> 1. The students will get the knowledge of estimation of compound. 2. The student will know the stepwise process of isolation and separation of compounds. 3. Students will get practical knowledge of effect of environmental factors such as light and temperature on growth processes. 	
Course Content	
Practical: 1	Estimation of Starch
Practical: 2	Study of oxalic acid accumulation in leaf tissue.
Practical: 3	Estimation of Ascorbic acids
Practical: 4	Estimation of Cellulose
Practical: 5 and 6	Estimation of polyphenols
Practical: 7 and 8	Study of phosphorus distribution in different plant parts.
Practical: 9 and 10	Study of changes in starch /protein contain during seed development
Practical: 11	Study of lipid accumulation during development if Oil seeds
Practical: 12	Study of effect of light on chlorophyll biosynthesis

Practical: 13	Study of enzyme inorganic pyrophosphatase
Practical: 14	Study of changes in respiration rate during ripening of fruits.
Practical: 15	Hormonal regulation of leaf and petal senescence.

Suggested reading:

1. Bidwell, R. C. S. (1979): Plant Physiology.
2. Bonner, J. and Varner, E. (1976): Plant Biochemistry.
3. Edwards, G., Walker, D. W. (1983): C3- C4 mechanism and cellular environmental regulation of photosynthesis.
4. Govindjee, H. (1982): Photosynthesis Vol. I & II.
5. Hopkins, W. C. (1995): Introduction to Plant Physiology.
6. Krishnamurthy, H.N. (1992): Physiology of Plant Growth and Development.
7. Marschner, H. W. (1986): Mineral nutrition of Higher Plants.
8. Miller, P (1973): Phytochemistry Vol.I, II and III.
9. Moore, T.C. (1974): Research experience in Plant Physiology, a laboratory manual.
10. Mukharjee, S.P. and Ghosh A.N. (1996): Plant Physiology.
11. Noggle, G.R. and Fritz, G. J. (1976): Introductory Plant Physiology.
12. Randhir Singh and Sawhney, S. K. (1988): Advances in frontier Areas of Plant Biochemistry. Sadashivam and Manikam (1996): Plant Biochemical methods.
13. Salisbury, F. B. and Ross, C.W. (1992): Plant Physiology IV ed.
14. Sinha S.K., Sane P.V., Bhargava S.C. and Agarwal P.K. (1990): Proceeding of International Congress of Plant Physiology Vol. I & II.
15. Smith, H. (1975): Phytochrome and Photomorphogenesis.
16. Steward F.C. (1976): Growth and Organization in plant.
17. Stump, P.K. and Conn, E. (1980) : Biochemistry of Plants. A Comprehensive Treatise.
18. Taiz, L. and Ziegler, F. (1998): The Plant Physiology.
19. Pessarkli, M. (2004): Handbook of Plant and Crop Physiology, Marcel Dekkar Inc. NY.
20. Pessarkli, M. (2005): Handbook of Photosynthesis.
21. Wilkins, M. B. (1976): Physiology of Plant Growth and Development.
22. Annual reviews of Plant Physiology and Molecular Biology.
23. Indian Journal of Plant Physiology.
24. Journal of Experimental Botany.
25. Physiologia Plantarum Sweden.
26. Plant Physiology (Bethesda, USA).
27. Practical plant physiology Gupta
28. Text book of practical botany by Ashok M. Bendre and Ashok Kumar (2009-10) Rastogi Publication.
29. Practical Manual of biochemistry. By Devid Plummer TMH Publications.
30. Biochemical Analysis S. Sadasivam and Manickam

Course Code: BO-516 (A)		
Course Title: Biostatistics and Bioinformatics		
Course Code: BO-516 (A)	Course Category: Elective Course (DSE-7)	
Course Title: Biostatistics and Bioinformatics	Type: Theory	
Total Contact Hours: 60	Course Credits: 04 (60 L)	
College Assessment (CA) Marks: 40	University Assessment (UA): 60	
<p>Course Objectives:</p> <ol style="list-style-type: none"> 1. To understand the ways to collect the data in a scientific way. 2. To learn the concept of a sample and sampling from the population. 3. To recognize importance of Biostatistics in interpreting and summarize the biological data and design suitable experiments. 4. To learn the statistical inference. 5. To use Bioinformatic tools to analyze different protein or nucleotide sequences to reach meaningful conclusions. 		
<p>Course Outcomes:</p> <ol style="list-style-type: none"> 1. Students acquaint the ways to report the results in a scientific way. 2. Able to recognize importance of Bio statistics in interpreting the biological data and inference 3. Students understood the skills to analyses biological data and use computational tools, software, databases, and technologies to explore relationships across data sets and solve structural, functional, and evolutionary questions. 		
Course Content		
Unit: 1	<p>Fundamental of Biostatistics</p> <ol style="list-style-type: none"> 1.1 Introduction to Bio statistics, Definition 1.2 Population 1.3 Sample and Samplings 1.4 Collection of data, Types of data, Classification of data, Tabulation of data, Graphic representation of data (Histogram, Frequency Polygon, Frequency curve), Significance and limitation of graphic representation. 	12 L
Unit: 2	<p>Measure of Central Tendency and Measure of Dispersion</p> <ol style="list-style-type: none"> 2.1 Measure of Central tendency: Mean, Median, Mode 2.2 Merits and Demeritsof Central tendency 2.3 Measure of Dispersion: Range, Mean Deviation/ Average Deviation Standard Deviation, Coefficient of Variation 2.4 Merits and Demerits of Measure of Dispersion. 	12 L

Unit: 3	Statistical inference 3.1 Chi-Square test (X^2 - test), 3.2 Test of Significance (t-test/Student test), 3.3 Analysis of Variance (ANOVA) 3.4 Correlation: Correlation analysis, Types of correlation, Methods of studying of correlation, Degree of correlation,significance test of correlation coefficient.	12 L
Unit: 4	Introduction to Bioinformatics 4.1 Definition and Scope of Bioinformatics 4.2 Historical perspective and evolution of Bioinformatics and application of Bioinformatics. 4.3 Computational tools and Algorithms: Basic Algorithm designs and analysis 4.4 Overview of programming language used in bioinformatics: World Wide Web (WWW), Hypertext Markup Language (HTML), Hypertext Transfer Protocol (HTTP), telnet, File Transfer Protocol (FTP), Python. Sequence Analysis: Understanding DNA, RNA and Protein sequencing; pairwise sequence alignment and multiple sequence alignment; Analysis of 3D structure using tools like Pymol.	12 L
Unit: 5	Biological Database 5.1 Introduction to biological database: sequence database; primary database and secondary database 5.2 Nucleic acid sequence database NCBI (Gene bank) EMBL, DDBJ, Pub Med and PDB along with software. 5.3 Protein / Amino acid database sequence; database PIR-PSD, Swiss Port. 5.4 Data analysis tools; Sequence Comparisons and alignments 5.5 Introduction and Applications of BLAST and FASTA 5.6 Genomics and proteomics: Introduction, types, significance, and scope.	12 L

Suggested reading:

1. Arora, P. N. and P. K. Malhan (2006) Biostatistics: Himalaya Publishing House, Girgaon Mumbai -400004. Pp. 578.
2. Baxevanis, A.D. and Francis Ouellette, B.F. (1998) "Bioinformatics– a practical guide to theanalysis of genes and proteins" John Wiley and Sons
3. Bergman N. H. (2007)," Comparative genomics" Volume 2, Humana Press
4. Campbell, R.C., (1998.) Statistics for Biologists, Cambridge University Press.
5. Cantor C.R., Smith C.L., (1993) "Genomics: the science and technology behind the Human GenomeProject" John Wiley and Sons
6. Choudhuri S., Carlson D. B. (2008), "Genomics: fundamentals and applications" InformaHealthcare
7. Danniel, W.W., (1987) Biostatistics New York, John Wiley Sons.
8. Griffiths A. J. F., Miller J.H., Suzuki D.T., (2000) "An Introduction to Genetic Analysis" W.H.Freeman and Co., Publishers.

9. Khan Irfan Ali and Atiya Khanum (2004): Fundamental of Biostatistics. Ukaaz Publication,Hydrabad- 500036 (Andhra Pradesh).
10. Mount, D. (2004) "Bioinformatics: Sequence and Genome Analysis"; Cold Spring HarborLaboratory Press, New York. (ISBN 0-87969-712-1)
11. N. Gurumani (2005) An Introduction to Biostatistics. MJP Publishers, Channai-600005.
12. Pevsner J (2009), "Bioinformatics and functional genomics", Edition 2, John Wiley and Sons
13. Primrose S. B., Twyman R. M. (2004), "Genomics: applications in human biology" Wiley-Blackwell
14. Primrose S. B., Twyman R. M. (2006), "Principles of gene manipulation and genomics" WileyBlackwell 12) Saccone C., Pesole G., (2003), "Handbook of comparative genomics: principleand methodology" John Wiley and Sons
15. Sharma, V. Munjal, A. and Shankar, A. (2008) "A text book of Bioinformatics" first edition,Rastogi Publication, Meerut – India.
16. Spiegel M. R. 91961) Theory and Problems of Statistics
17. Suhai S (2000), "Genomics and proteomics: functional and computational aspects" Springer

Course Code: BO-516 (B)		
Course Title: Banana Technology		
Course Code: BO-516 (B)	Course Category: Elective Course (DSE-7)	
Course Title: Banana Technology	Type: Theory	
Total Contact Hours: 60	Course Credits: 04 (60 L)	
College Assessment (CA) Marks: 40	University Assessment (UA): 60	
Course Objectives:		
<ol style="list-style-type: none"> 1. To know morphology, Taxonomy of Banana. 2. To study the scope and importance of Banana. 3. Understand the knowledge of cultivation practices of Banana. 4. To study the commercial by-products of Banana. 5. To understand the advertising and marketing of Banana 		
Course Outcomes:		
<ol style="list-style-type: none"> 1. Students get the knowledge of cultivation of Banana. 2. Students knows the knowledge of harvesting, packaging, advertising and marketing of Banana. 3. It gives opportunities to student in various food preservation industries. 4. This course helps to create self-employment among the students. 		
Course Content		
Unit: 1	Introduction	12 L
	<ol style="list-style-type: none"> 1.1 Banana-growing zones in India and world. 1.2 Banana breeding agencies in India. 1.3 Role of Banana in a development of country and prospects for improvement. 1.4 Scope and importance of Banana. 1.5 Nutritive value and commercial importance of Banana. 	
Unit: 2	Cultivation practices: Banana	12 L
	<ol style="list-style-type: none"> 2.1 External morphology of Banana with diagnostic features of different varieties 2.2 Season of planting 2.3 Planting material and Desuckering 2.4 Preparation Land and methods of cultivation 2.5 Setting of followers for ratooning 2.6 Fertilizers and Irrigation management 2.7 Weeding, disease and pest management 	
Unit: 3	Banana harvesting and packaging	12 L
	<ol style="list-style-type: none"> 3.1 Maturity index 3.2 Harvesting and Handling 	

	<p>3.3 Pre- cooling, dehanding & Grading</p> <p>3.4 Packing, storage, preservation and transportation</p> <p>3.5 Export of Banana</p>	
Unit: 4	<p>Banana: value added products</p> <p>4.1 Edible product: w.r.t. ingredients, procedure and preparation of</p> <p>a) Chips and Banana puree</p> <p>b) Banana flavor and Banana Beverage (Wine, Beer, Rum)</p> <p>c) Banana Jam and Jelly</p> <p>d) Banana bread, biscuits, candy and powder</p> <p>4.2 Banana wastes utilization</p> <p>a) Fibre (Banana Silk/Ropers/Bags)</p> <p>b) Banana papers (Tissue Paper, Card Paper)</p> <p>c) Bioenergy (Bio-diesel, Biogas)</p> <p>d) Vermicompost</p> <p>e) Fodder</p>	12 L
Unit: 5	<p>Marketing and Advertising</p> <p>5.1 Marketing:</p> <p>a) Product identification, Brand policies, packing, labeling in respect of banana & by- products.</p> <p>b) Sales forecasting: Importance, Types, Stages, Indent forecasting, Techniques, Sales forecasting of new goods.</p> <p>5.2 Advertising:</p> <p>a) Objective, types, advertising media, Advertising creation, advertising long out, advertising organization</p> <p>b) Distribution: Methods, channels, Types, channel choice middlemen, wholesale service and retail service.</p>	12 L

Suggested reading:

1. Harrigan W.F. (1998). Laboratory Method in food Microbiology. 3rd Edn, Academic Press.
2. Hugo W.B. and Russell A. D. (Eds) (1983). Pharmaceutical Microbiology 3rd Edn, P.G Publishing Pvt. Ltd., Singapore.
3. Belit H. D. and Groch W. (1999). Food Chemistry, 2nd Edn, Springer Verlag, Germany.
4. K.G. Shanmugavelu; K. Arvindakshan and S. Sathiyamoorthy (1992). Banana: Taxonomy, breeding and production technology. Metropolian book Co. Pvt. Ltd., New Delhi.
- 5.H.P. Singh, S. Uma and S. Sathiamoorthy (2001) A Tentative Key for identification and Classification of Indian Bananas. National Research Centre for Banana (ICAR), Tiruchirapalli, India.
6. S. Uma, S. Sathiamoorthy and P. Durai (2005) Indian Genetic Resource and Catalogue.National Research Centre for Banana (ICAR), Tiruchirapalli, India.
7. C. K. Narayana S. Sathiamoorthy and M.M. Mustaffa (2006) Commercial value added Banana products. National Research Centre for Banana (ICAR), Tiruchirapalli, India.
8. C. K. Narayana and M.M. Mustaffa (2006) Improved post-harvest handling technology inBanana. National Research Centre for Banana (ICAR), Tiruchirapalli,India.

Course Code: BO-516 (C)		
Course Title: Forensic Botany		
Course Code: BO-516 (C)	Course Category: Elective Course (DSE-7)	
Course Title: Forensic Botany	Type: Theory	
Total Contact Hours: 60	Course Credits: 04 (60 L)	
College Assessment (CA) Marks: 40	University Assessment (UA): 60	
Course Objectives:		
<ol style="list-style-type: none"> 1. This course explores the world of understand the importance of plants in forensic science. 2. Understand the Role of different branches of botany to solve forensic cases 3. Understand forensic importance of different parts of plants 4. Understand modern method of extraction and Isolation of plant material from biological sample. 		
Course Outcomes:		
<ol style="list-style-type: none"> 1. Relate the concept and applications of forensic botany. 2. Determine the value of plants from forensic point of view. 3. Recognize forensic importance of botanical specimens. 4. Categorize various botanical specimens for forensic evidences. 5. Justify cases based on classic and modern botanical evidences. 		
Course Content		
Unit: 1	Introduction	12 L
	<ol style="list-style-type: none"> 1.1 Forensic Botany- Definition, Scope and Importance 1.2 Plants are Ubiquitous 1.3 Plants as Poisons 1.4 Plants as Trace/Transfer Evidence 1.5 Plants in Our Society – Food, Fiber, Medicine, Beauty, Recreation, Law Enforcement 1.6 Botanical evidence encounters in forensic investigation 	
Unit: 2	Classic Forensic Botany Cases	12 L
	<ol style="list-style-type: none"> 2.1 Introduction 2.2 Plant anatomy and systematics 2.3 Plant Ecology 2.4 Forensic palynology- Pollen grains as objects of forensic investigations, pollen Analysis- Pollen fingerprint, Sample Preparation for Pollen Analysis and Interpreting Forensic Pollen Assemblages, Molecular palynology in forensics, The Significance of the Evidence. 	

	<p>2.5 Forensic mycology- Fungi, Fungi as indicators of burial sites and the time of death, Fungal spores, Fungi DNA sequencing technologies in forensic, applications of forensic mycology.</p> <p>2.6 Forensic limnology - Diatoms as objects of forensic investigations, Microscopy techniques in diatoms identifications, Diatoms test and drawing confirmation, Diatoms and PMI estimations, algae and protists in forensic investigations.</p> <p>2.7 Plant molecular biology and DNA, Drug enforcement and DNA.</p>	
Unit: 3	<p>Plant Identification and examination of plant derivative</p> <p>3.1 Plant identification</p> <p>3.2 Plant remains</p> <p>a) Bark - Forensic importance, types of bark and anatomy, methods of identification and comparison.</p> <p>b) Seeds and fruits - Forensic importance types of Seeds and fruits, methods of identification and comparison.</p> <p>c) Litter (leaves, cones, needles, twigs, bark, seeds/nuts, logs, reproductive organs) – Forensic importance types of Litter, methods of identification and comparison.</p> <p>d) Timber (dendrochronology and dendrochemistry) - types of wood and anatomy, methods of identification and comparison.</p>	12 L
Unit: 4	<p>Poisonous plant and types of plant toxins</p> <p>4.1 Botanical Source, Poisonous plant part, poison and its effect on human body of following-</p> <p><i>Abrus precatorius, Anacardium occidentale, Argemone mexicana, Cannabis sativa, Croton tiglium, Atropa belladonna, Erythroxylum coco, Gloriosa superba, Jatropha curcas, Lathyrus sativus, Nicotiana tabacum, Ricinus communis, Semicarpus anacardium, Strychnos nux vomica.</i></p>	12 L
Unit: 5	<p>Methods of extraction and Isolation</p> <p>5.1 Plant poison: Introduction, classification and their main active constituents, method of extraction of plant material from biological sample, identification by colour test and TLC and UV- Visible spectrophotometer and other instrumental techniques.</p> <p>5.2 Modern method of extraction and Isolation: Solid phase extraction, solid phase micro-extraction, accelerated solvent extraction, preparative HPTLC.</p>	12 L

Suggested reading:

1. Alan Gunn. Essential Forensic Biology, (2nd Edition) John Wiley & Sons Ltd. 2009.
2. Chowdhuri, S. Forensic Biology, B P R & D, Govt. of India. 1971.
3. Coyle HM. Forensic Botany: Principles and applications to criminal casework, 1st Edition, CRC Press Pvt Ltd, Taylor and Francis Group, United Kingdom, 2004.
4. Hall DW and Byrd J. Forensic Botany: a practical guide. 1st Edition, Wiley-Blackwell publishers Pvt Ltd, United States, 2012.
5. Heather Miller Coyle. Forensic Botany, (2nd Edition) CRC Press INC. 2012
6. Idalia Kasprzyk. Forensic botany: who?, how?, where?, when? Science & Justice 63 (2023) 258–275
7. James SH, Nordby JJ, Bell S. Forensic Science: An Introduction to Scientific and Investigative Techniques, 4th Edition, CRC Press Pvt Ltd, Taylor and Francis Group, United Kingdom, 2015.
8. Richard Li. Forensic Biology, 2nd edition, CRC Press 2015
9. Saferstein, R. Science Handbook, Vol. I, II and III, Prentice Hall, New Jersey, 1982.

Course Code: BO-517	
Course Title: Research Project	
Course Code: BO-517	Course Category: Research Project (RP)
Course Title: Research Project	Type: Theory
Total Contact Hours: 60	Course Credits: 04 (60 L)
College Assessment (CA) Marks: 40	University Assessment (UA): 60
Course Objectives: <ol style="list-style-type: none"> 1. To provide training in scientific skills. 2. To prepare students for professional training programme or entry level jobs in any area of Botany. 	
Course Outcomes: At the end of the project, students should have acquired capabilities to <ol style="list-style-type: none"> 1. think critically in acquiring knowledge surveying literature 2. collect information and be familiar with methods in designing and executing experiments 3. pursue data collection and entrain themselves in interpreting of data of from their scientific experiments 4. would have grown in their ability to design, analyze and execute an experiment and eventually 5. brim with confidence and ability in communication skills, both in writing and in-articulation 	
Course Content	
Chapter: 1	Introduction The title of Chapter 1 shall be Introduction. It shall justify and highlight the problem posed, define the topic and explain the aim and scope of the work presented in the dissertation. It may also highlight the significant contributions from the investigation.
Chapter: 2	Review of Literature This shall normally form Chapter 2 and shall present a critical appraisal of the previous work published in the literature pertaining to the topic of the investigation.
Chapter: 3	Material and Methods This chapter deals with a detail methodology by which researcher used to collect/ synthesize the data.
Chapter: 4	Results and Discussions This shall form the penultimate chapter of the dissertation and shall include a thorough evaluation of the investigation carried out and bring out the contributions from the study. The discussion shall logically lead to inferences and conclusions as well as scope for possible further future work.

Chapter: 5	<p>Summary and Conclusions</p> <p>This will be the final chapter of the dissertation. A brief report of the work carried out shall form the first part of the Chapter. Conclusions derived from the logical analysis presented in the results and discussions chapter shall be presented and clearly enumerated, each point stated separately. Scope for future work should be stated lucidly in the last part of the chapter.</p>
Chapter: 6	<p>References/Bibliography</p> <p>The candidates shall follow the style of citation and style of listing in one of the standard journals in the subject area consistently throughout his/her dissertation (mentioned below). However, the names of all the authors along with their initials and the full title of the article/monogram/book etc. have to be given in addition to the journals/publishers, volume, number, pages(s) and year of publication. Citation from websites should include the names(s) of author(s) (including the initials), full title of the article, website reference and when last accessed. Reference to personal communications, similarly, shall include the author, title of the communication (if any) and date of receipt. The example is given below:</p> <p>For journal: Ojha SN, Tiwari D, Anand A, Sundriyal RC (2020) Ethnomedicinal Knowledge of a Marginal hill Community of Central Himalaya: Diversity, Usage Pattern, and Conservation Concerns. Journal of Ethnobiology and Ethnomedicine. 16: 29.</p> <p>For Chapter in book: Tewari LM, Tewari G, Chopra N, Tewari A, Pandey NC, Kumar M (2020) Phytochemical Screening and Antioxidant Potential of Some Selected Wild Edible Plants of Nainital District, Uttarakhand. In: Natural Products and their Utilization Pattern (Eds. Tewari G, Tewari A, Tewari LM). New York, NY: Nova Science Publishers, Inc. pp 71–97.</p> <p>For book: Chauhan NS (1999) Medicinal and Aromatic Plants of Himachal Pradesh. Indus Publishing Company, New Delhi.</p>
Chapter: 7	<p>Appendix</p> <p>Detailed information, lengthy derivations, raw experimental observations etc. are to be presented in the separate appendices, which shall be numbered in Roman Capitals (e.g. “Appendix IV”). Since reference can be drawn to published/unpublished literature in the appendices, these should precede the “Literature Cited” section.</p>
	<p style="text-align: center;">Type -Setting, Text Processing and Printing</p> <p>The text shall be printed employing using a standard text processor. The standard font shall be Times New Roman of 14 pts for headings and 12 pts for text with 1.5 line spacing.</p>

Auxiliary

1. Binding: Spiral or hard Binding

2. Front Covers:

The front covers shall contain the following details:

- Full title of dissertation in 6 mm/22 point's size font properly centered and positioned at the top.
- Full name of the candidate in 4.5 mm 15 point's size font properly centered at the middle of the page.
- A 40 mm dia replica of the University emblem followed by the name of department, name of the University and the year of submission, each in a separate line and properly centered and located at the bottom of page.

3. Blank Sheets:

In addition to the white sheets (binding requirement) two white sheets shall be put at the beginning and the end of the dissertation.

4. Title Sheet:

This shall be the first printed page of the thesis and shall contain the submission statement: the dissertation submitted in partial fulfillment of the requirements of the Degree e.g. M.Sc., the name and enrollment No. of the candidate, name(s) of the Supervisor and Co-supervisor (s) (if any), Department, University and year of submission. Sample copy of the 'Title Sheet' is enclosed (Annexure I)

5. Dedication:

Sheet If the candidate so desires(s) he may dedicate his/her dissertation, which statement shall follow the title page. If included, this shall form the page 1 of the auxiliary sheets but shall not have a page number.

6. A Declaration of Academic Honesty and Integrity by Candidate:

A declaration of Academic honesty and integrity is required to be included along with every thesis/dissertation after the Supervisor's certificate. The format of this declaration is given in Annexure 'II' attached.

7. Certificate from Candidate/Supervisor and Convener (Annexure 'III'):

8. Abstract:

The 500 word (maximum) abstract shall highlight the important features of the dissertation. The abstract in the dissertation, however, shall have two more parts, namely, the layout of the dissertation giving a brief chapter-wise description of the work and the key words.

9. Contents:

The contents shall follow the abstract and shall enlist the titles of the chapters, section and sub-section using decimal notation, as in the text, with corresponding page number against them, flushed to the right. Two separate lists of figure captions and table titles along with their numbers and corresponding page numbers against them shall follow the contents.

10. Abbreviation Notation and Nomenclature:

A complete and comprehensive list of all abbreviations, notations and nomenclature including Greek alphabets with subscripts and superscripts shall be provided after the list of tables and figures.

Assessment:

Dissertation submission by the students would be assessed both by external and internal examiner during end semester university practical examinations.

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

SEMESTER – IV, Level – 6.5

Course	Course Type	Course Code	Course Title	Credits	Teaching Hours/Week			Marks (Total 100)			
					T	P	Total	Internal (CA)		External (UA)	
								T	P	T	P
DSC-40	DSC	BO-521	Sp. Paper- II A. Phycology Sp. Paper- II B. Mycology Sp. Paper- II C. Angiosperm Taxonomy Sp. Paper- II D. Plant Physiology	4	4	--	4	40	--	60	--
DSC-41	DSC	BO-522	Sp. Paper- III A. Phycology Sp. Paper- III B. Mycology Sp. Paper- III C. Angiosperm Taxonomy Sp. Paper- III D. Plant Physiology	4	4	--	4	40	--	60	--
DSC-42	DSC	BO-523	Practical based on Sp. Paper BO-521 (A/B/C/D)	2	-	4	4	--	20	--	30
DSC-43	DSC	BO-524	Practical based on Sp. Paper BO-522 (A/B/C/D)	2	-	4	4	--	20	--	30
DSE-8	DSE	BO-525(A)	Post Harvest Technology	4	4	--	4	40	--	60	--
		BO-525(B)	Green House Technology	4	4	--	4	40	--	60	--
		BO-525(C)	Green Belt and Green Credit	4	4	--	4	40	--	60	--
		BO-526	Research Project	6	-	12	12	--	60	--	90

Cumulative Credits For Second Year – 44

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

Course Code: BO-521		
Course Title: Special Paper- II A. Phycology		
Course Code: BO- 521	Course Category: Core Course (DSC- 40)	
Course Title: Special Paper- II A. Phycology	Type: Theory	
Total Contact Hours: 60	Course Credit: 04 (60 Lecturers)	
College Assessment (CA)Marks: 40	University Assessment (UA): 60	
<p>Course Objectives:</p> <ol style="list-style-type: none"> 1. To know about algal cell Biology. 2. To understand algal physiology and Biochemistry 3. To know about the cultivation of algae and its application 4. To aware about commercial, and industrial utilization of algae <p>Course Outcomes:</p> <ol style="list-style-type: none"> 1. Able to understand algal cell Biology, Physiology and Biochemistry 2. Able to cultivate algae for its utilization 3. Able to know various algal utilization. 		
Course Content		
Unit 1	<p>Algal Cell Biology</p> <ol style="list-style-type: none"> 1.1 Prokaryotic, Mesokaryotic, and Eukaryotic Cell structure in algae 1.2 Algal Cell wall, Algal Flagella and Cell division in algae 1.3 The nucleus and Chromosomes in algae 1.4 Origin and evolution of Sexuality in algae (All three types) 1.5 Cyanophages 	15 L
Unit 2	<p>Algal Physiology and Biochemistry</p> <ol style="list-style-type: none"> 2.1 Biological nitrogen fixation: Mechanism of nitrogen fixation in Blue green algae, Nitrogen fixing blue green algae, Factors affecting on nitrogen fixation 2.2 Extracellular products from algae 2.3 Carbohydrates and Proteins in Algae 2.4 Essential fatty acids 2.5 Plant growth regulators 2.6 Algal toxins: Toxin producing algae, Hepatotoxins, Neurotoxins, mode of action and symptoms. 	15 L
Unit 3	<p>Algal Cultivation</p> <ol style="list-style-type: none"> 3.1 Definition, General requirements for culturing of algae, types of culture media. 3.2 Preparatory culture, isolation of algae, streak culture, nutritive solution, dilution culture. 	12 L

	<p>3.3 Types of cultures: Enrichment culture synchronous culture, continuous culture, mass culture.</p> <p>3.4 Cultivation of algae in waste water.</p> <p>3.5 Current status of the large-scale culture of algae in India.</p>	
Unit 4	<p>Marine Algal Cultivation</p> <p>4.1 Introduction, Necessity of marine algal cultivation</p> <p>4.2 Principle methods of cultivation:</p> <p>a) Vegetative propagation / <i>Eucheuma</i> type mariculture</p> <p>b) Nonmotile spore type / <i>Porphyra</i> type mariculture</p> <p>c) Motile spore (Zoospore) type / The <i>Laminaria</i> type Mariculture</p> <p>4.3 Marine algal cultural status and utilization in India</p>	08 L
Unit 5	<p>Algal Utilization</p> <p>5.1 Nutritional Value of Microscopic and Macroscopic algae</p> <p>5.2 Micro algae industrial raw material</p> <p>5.3 Industrial uses: Agar Agar, Alginates, Carrageen and other by-products of marine algae.</p> <p>5.4 Algal fuel: Biogas from algae, algal energy products,</p> <p>5.5 Cyanobacteria in human welfare: Production of fine chemicals, polysaccharides, bioactive molecules, pigments, antioxidants, and biofertilizer. Reclamations of Usar soils</p> <p>5.6 Algae in Pharmacy Iodine, Vitamins, Proteins, Antibiotics.</p> <p>5.7 Human food. Role of algae as nutrients supplement</p>	10 L

Suggested Readings:

1. C. Van den Hoke, D. G. Mann & H.M. Jahns (1995) *Algae An introduction to Phycology*, Cambridge University Press.
2. Carr N.G. & B. A. Whitton (1982) *The Biology of Cyanobacteria Botanical Monograph Vol-II Blackwell Scientific Publication, London, UK*
3. Janet R. Stein (1975) *Phycological methods*, Cambridge University Press.
4. John D. Dodge (1973) *The Fine Structure of algal cells*, Academic Press, New York, USA.
5. John S. Burlew (1976) *Algal Culture from Laboratory to Pilot Plant*, Carnegie Institution of Washington Publication 600, Washington, D. C., USA
6. Peter S. Dixon (1973) *Biology of the Rhodophyta*, Oliver & Boyd Croythorn House, 23 Ravelston Terrace, Edinburgh
7. Ralph A. Lewin. (1976) *The Genetics of Algae (Botanical Monographs Vol. 12)*, Blackwell Scientific Publications, Oxford.
8. Tilden J. E. (1968) *The Algae and Their life relations (Fundamentals of Phycology)* Hafner Publishing Co, London, UK.
9. Alan J. Brook (1981) *The Biology of Desmids*. University of California Press, Berkeley.

Course Code: BO-521		
Course Title: Special Paper- II B. Mycology		
Course Code: BO- 521 B	Course Category: Core course (DSC-40)	
Course Title: Special Paper- II B. Mycology	Type: Theory	
Total Contact Hours: 60	Course Credit: 04 (60 Lectures)	
College Assessment (CA) Marks: 40	University Assessment (UA): 60	
<p>Course Objectives:</p> <ol style="list-style-type: none"> 1. Recognise, describe, and preserve industrially significant moulds. 2. To get knowledgeable about the potential for fungus growth, fermentation technology, alcohol production, antibiotics, and organic acid. 3. To study both useful and detrimental uses of fungi for society and environments. 4. To aware students about organisms found in soil and their role in soil development. 5. To understand the roles of fungi in air and aquatic habitat. 6. Introduce students to fungal biotechnology. 7. To understand the genetics of fungi and how to improve fungal strains. 8. To understand Nanotechnology with the help of fungi, and how nanoparticles are useful for society. 9. To study the Symbiotic relation of fungi with algal partner and plant roots. <p>Course Outcomes:</p> <ol style="list-style-type: none"> 1. This paper acquaints students with culturing, maintenance and preservation of industrial important fungi. 2. Able to know Nanotechnology, fermentation technology, mushroom technology, fungal toxins, soil microflora, importance of soil microflora, nitrogen fixation, fungal ecology, fungal genetics and fungal biotechnology. 		
Course Content		
Unit 1	Soil Microbiology 1.1 Structure of soil, Types of soil, Microbial distribution in soil, Role of microbes in soil and their effect on plant growth. Humus and its role in agriculture Rhizosphere and Rhizoplane Microbial association in soil, Nitrogen fixation.	12 L
Unit 2	Fungi in Ecology 2.1 Fungal ecology and role of fungi as producer, Decomposer, and parasite. Parasitic role of fungi in human cattle and plants. 2.2 Airomycology: Bioaerosol, organisms found in air, methods to study Airomycology and importance of fungi found in air. 2.3 Aquatic mycology: Different organisms found in water, methods, and importance of aquatic fungi.	12 L
Unit 3	Industrial Perspectives of Fungi 3.1 Food Industry- Process and importance of Mushroom cultivation. Role in Cheese, Sauce, Citric acid production.	12 L

	3.2 Drug industry- Ergot alkaloids, Antibiotic and Vitamins. 3.3 Beverage industry- Alcohol production. 3.4 Others- Production and uses of Mycoprotein, Growth Hormone, Zearalenone, Mycoinsecticides, Myco-weedicides.	
Unit 4	4.1 Fungal Genetics: Para sexuality, compatibility system, Heterothallism, and tetrad analysis. 4.2 Myco-technology: Cytoplasmic isolation and fusion, r-DNA technology in fungi, Strain improvement in Penicillium and Yeast.	12 L
Unit 5	5.1 Myconanotechnology- History, method of formation of Gold and silver nano particles by fungi and scope in agriculture, biomedical and health care. 5.2 Mycorrhizae- Types, mutualist dynamics, and importance of mycorrhizae study. 5.3 Lichen- Types, mutualist dynamics and importance.	12 L

Suggested Readings:

1. Barron J. H. (1975) The nematodes destroying Fungi. Can. Biol. Pub. Ltd. Gulph Ontario.
2. Burnett J. H. (1975) Myogenetics: Introduction to General Genetics of Fungi Wiley-Blackwell, London.
3. Casida L. F.JR. (1968) Industrial Microbiology New International Publishers, New Delhi.
4. Dayal R. (2000) Predaceous Fungi Common wealth Publishers.
5. Dongre, M.A., Ashraf, M.S., Koshariya, A.K.and A Reddypriya (2023). Plant Pathology and Plant Diseases. AG Publishing House (AGPH Books), Bhopal, India, pp229.
6. Dubey R. C. (1995) A text Book of Biotechnology. S. Chand and Company Ltd. New Delhi.
7. Essar K E and R Kuenen (1967) Genetics of Fungi Sringer-Verzlag, Berline.
8. Funcham (1990) Fungal Genetics Oxfort and Edinburgh, Blackwell Scientific Publication.
9. Griffin (1973) Ecology of Fungi, Chapman and Hall, London
10. Hudson H J (1961) Fungal Sporophytism. Edward Arnold Ltd. London.
11. Martin A (1961) An introduction to soil microbiology Vol. I, II, III Rastogi Publication, Meerut.
12. Moore, D. and Frazer, (2007) L.A.N. Essential Fungal Genetics - Springer New York.
13. Nair M C and Balakrishinan (1986) (Eds.) Beneficial Fungi and Their Utilization, Scientific Pub.Jodhpur.
14. Panseriya, Haresh & Gosai, Haren & Trivedi, Hiral & Vala, Anjana & Dave, Bharti. (2022). Fungi and Nanotechnology: History and Scope. 10.2174/9789815051360122030004.
15. Pathak Y B (1998) Mushroom Production and Processing Technology Vol III Himalaya Publishing, Bombay.
16. Purkyastha and Chanda (1976) Indian Edible Mushroom, Firma Klam Pvt. Ltd. Calcutta.
17. Singh B D (1998) Biotechnology Kalyani Pub. New Delhi.
18. Smith G (1969) An Introduction to Industrial Mycology, Edward Arnold London.

19. Varma, A. Hock, B. (2013) Mycorrhiza: Structure, Function, Molecular Biology and Biotechnology, Springer Berlin Heidelberg.
20. Vernon Ahmadjian (1973), The Lichens. Academic press Inc, New York.

Course Code: BO-521		
Course Title: Special Paper- II C. Angiosperm Taxonomy		
Course Code: BO 521	Course Type: Core Course (DSC-40)	
Course Title: Special Paper- II C. Angiosperm Taxonomy	Type: Theory	
Total Contact Hours: 60	Course Credits: 04(60L)	
College Assessment (CA): 40	University Assessment (UA): 60	
<p>Course Objectives:</p> <ol style="list-style-type: none"> 1. To study Cronquist's system of classification of angiosperms. 2. To study phylogeny and interrelationship of different orders. 3. To study biosystematics and ultra structural systematic. 4. To study the numerical taxonomy of angiosperms. 5. To study chemotaxonomy of Angiospermic plants. <p>Course outcomes:</p> <ol style="list-style-type: none"> 1. Able to know Cronquist's system of classification. 2. Able to know phylogeny and interrelationship of different orders and taxa. 3. Able to understand biosystematics and ultra structural systematic. 4. Able to understand the numerical taxonomy of angiosperms. 5. Able to understand chemotaxonomy of Angiospermic plants. 		
Course Content		
Unit 1	Cronquist's system of classification (1968, 1988) w.r.t. 1.1 Outline of the system. 1.2 Refinements over his earlier system of 1968. 1.3 Salient features of the system. 1.4 Merits and demerits of system. 1.5 Description, characterization and critical tendencies of the subclasses.	12 L
Unit 2	Discussion on the orders (Sensu Cronquist) w. r. t. morphological characters, floral variation, phylogeny and interrelationship 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	12 L
Unit 3	Systematics 3.1 Biosystematics a. Concept, aims and objectives, categories. b. Methods in biosystematics, ecotypic variations, scope and limitations. c. Comparison of classical taxonomy and biosystematics. 3.2 Ultra structural Systematics a. SEM and TEM studies and plant systematic	12 L

	<p>b. SEM and plant surface structure.</p> <p>c. TEM and dilated cisternae of endoplasmic reticulum and sieve element Plastids.</p> <p>d. Applications of data in the classification of higher taxa</p>	
Unit 4	<p>Numerical Taxonomy</p> <p>4.1 Phenetic methods in taxonomy (taxometris)</p> <p>4.2 Principles, construction of taxonomic groups</p> <p>4.3 OTUs, unit character, measurement of resemblances, cluster analysis</p> <p>4.4 Phenons and ranks, discrimination, nomenclature and numerical taxonomy.</p> <p>4.5 Applications, merits and demerits, cladistics and cladogram, parsimony analysis, cladistics and classification.</p>	12 L
Unit 5	<p>Chemotaxonomy</p> <p>5.1 Origin of chemotaxonomy, classes of compounds and their biological significance.</p> <p>5.2 Stages in chemotaxonomic investigations, techniques.</p> <p>5.3 Uses of chemical criteria in plant taxonomy, protein and taxonomy, seed proteins, techniques of protein electrophoresis,</p> <p>5.4 Chemical protein analysis procedures, analysis of amino acid sequence and its significance in systematics,</p> <p>5.5 Serology and taxonomy, history, precipitation reaction techniques, antigen, antisera antibody, application of serological data in systematics.</p>	12 L

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 & rofessional, 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 Sing 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.

Course Code: BO-521		
Course Title: Special Paper- II D. Plant Physiology		
Course Code: BO-521	Course Category: Core Course (DSC-40)	
Course Title: Special Paper- II D. Physiology	Course Type: Theory	
Total contact Hours: 60	Course Credits: 04 (60L)	
College Assessment (CA) Marks: 40	University Assessment (UA): 60	
<p>Course Objectives:</p> <ol style="list-style-type: none"> 1. To awake the students with concepts of Plant Physiology. 2. To inculcate the students with process of photomorphogenesis. 3. To study the growth and post-harvest changes in the plants. 4. To study the advances in photosynthesis and respiration. 5. To inculcate the students with organic acids and secondary metabolites in plants. <p>Course Outcomes:</p> <ol style="list-style-type: none"> 1. Students will able to know the concepts of Plant Physiology 2. Students will understand the photomorphogenic processes of plants. 3. Students will get the knowledge of growth process and post-harvest changes in plants. 4. The advance knowledge of photosynthesis and respiration deiminated among the students 		
Course Content		
Unit 1	Membrane transport and translocation of water and solutes 1.1 Mechanism of xylem and phloem transport. 1.2 Phloem loading and unloading. 1.3 Passive and active solute transport. 1.4 Membrane transport of proteins. 1.5 Root microbe interaction in facilitating nutrient uptake.	12 L
Unit 2	Photochemistry and photosynthesis 2.1 General concept and historical background. 2.2 Evolution of photosynthetic apparatus. 2.3 Photosynthetic pigments in light harvesting complex. 2.4 Photorespiration and its significance. 2.5 Biosynthesis of starch and sucrose. 2.6 Ecological significance and modifications of CAM	12 L
Unit 3	Nitrogen and Sulphur metabolism 3.1 Nitrogen fixation, nitrogenase 3.2 nif, node and Hup genes 3.3 Regulation of nitrogen fixation. 3.4 Products of nitrogen fixation and their transport 3.5 Mechanism of nitrate uptake. 3.6 Sulphate uptake, transport reduction and Assimilation.	12 L

Unit 4	Stress Physiology 4.1 Brief idea of plant responses to water deficit, salinity, metal ions stress freezing and heat stress, oxidative stress and draught resistance mechanism. 4.2 Signal transduction. Overview, receptors and G-protein, phospholipids signaling. 4.3 Role of cyclic nucleotides, Calcium-Calmodulin cascade, protein kinase and phosphatases. 4.4 Specific signaling mechanism e.g. Two component sensor-regulator system in plants.	12L
Unit 5	Physiology of flowering 5.1 Photoperiodism and its significance. 5.2 Endogenous clock and its regulation. 5.3 Floral induction and development. 5.4 Genetic and molecular analysis. 5.5 Role of vernalization. 5.6 Role of phytochrome in photoperiodism. 5.7 Hormonal regulation of vernalization.	12L

Suggested Readings:

1. Miller, P (1973) : Phytochemistry Vol.I, II and III.
2. Epstein, E (1972) : Mineral nutrition of plants : Principals and perspectives.
3. Bonner, J. and Varner, E. (1976): Plant Biochemistry.
4. Gregory, P (1976) : Biochemistry of Photosynthesis.
5. Devlin, R.M. and Witham (1975): Plant Physiology.
6. Beevers, H (1976): Nitrogen Metabolism in plants.
7. Stump, F.A. and Conn, E.E. (1981) : Biochemistry of Plants. A Comprehensive Treatise Vol. II, III, IV, IX and XII.
8. Mukharjee S.P. and ghosh A.N. (1996) Plant Physiology.
9. Wilkins, M.B. (1976): Physiology of Plant Growth and Development.
10. Noggle, G.R. and Fritz, G. J. (1976): Introductory Plant Physiology.
11. Marschner, H. W. (1986): Mineral nutrition of Higher Plants.
12. Salisbury, F.B. (1971): The biology of Flowering.
13. Krishnamurthy, H.N. (1992): Physiology of Plant Growth and Development.
14. Salisbury, G.B. and Ross, F.V.(1990): Plant Physiology.
15. Levitt, J. (1969, 1980): Responses of Plants to Environmental Stress.
16. Taiz L. and Zeiger F. (2004): Plant Physiology.
17. Pessarkli M. (2005): Handbook of Photosynthesis. II nd Edition.

Course Code: BO- 522																
Course Title- Special Paper- III A. Phycology																
Course Code: BO- 522	Course Category: Core Course (DSC- 41)															
Course Title: Special Paper- III A. Phycology	Course Type: Theory															
Total Contact Hours: 60	Course Credit: 04 (60 Lecturers)															
College Assessment (CA): 40	University Assessment (UA): 60															
<p>Course Objectives:</p> <ol style="list-style-type: none"> 1. To study ecological classification of algae. 2. To understand those environmental factors which control their survival growth, distribution and causal mechanisms 3. To helps in bio-monitoring the water bodies and pollution control. 4. To know phycological techniques, for water supplies. 5. To study the role of algae in sewage disposal. <p>Course Outcomes:</p> <ol style="list-style-type: none"> 1. Able to understand ecological classification of algae, Habitats of algae. 2. Able to know algae and sewage disposal and eutrophication. 3. Able to know correlation between Physical, Chemical and Biological factors affecting in aquatic ecosystem. 4. Able to Know how to use algae as bioindicators. 																
Course Content																
Unit 1	<p>Ecological Classification of Algae</p> <table style="width: 100%; border: none;"> <tr> <td style="width: 50%;">1. Phytoplankton</td> <td style="width: 50%;">2. Benthic algae</td> </tr> <tr> <td>3. Cryophilic algae</td> <td>4. Thermophilic algae</td> </tr> <tr> <td>5. Soil Algae</td> <td>6. Epiphytic algae</td> </tr> <tr> <td>7. Lithophytes</td> <td>8. Endophytic algae</td> </tr> <tr> <td>9. Symbiotic algae</td> <td>10. Parasitic algae</td> </tr> <tr> <td>11. Epizooic Algae</td> <td>12. Endozoic algae</td> </tr> <tr> <td>13. Halophytic algae</td> <td>14. Aerial algae</td> </tr> </table>	1. Phytoplankton	2. Benthic algae	3. Cryophilic algae	4. Thermophilic algae	5. Soil Algae	6. Epiphytic algae	7. Lithophytes	8. Endophytic algae	9. Symbiotic algae	10. Parasitic algae	11. Epizooic Algae	12. Endozoic algae	13. Halophytic algae	14. Aerial algae	05 L
1. Phytoplankton	2. Benthic algae															
3. Cryophilic algae	4. Thermophilic algae															
5. Soil Algae	6. Epiphytic algae															
7. Lithophytes	8. Endophytic algae															
9. Symbiotic algae	10. Parasitic algae															
11. Epizooic Algae	12. Endozoic algae															
13. Halophytic algae	14. Aerial algae															
Unit 2	<p>A) Fresh Water Bodies</p> <ol style="list-style-type: none"> i. 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. ii. Flora of Lentic and Lotic series and its feature 	20 L														
	<p>B) Marine Environment</p> <ol style="list-style-type: none"> i. General considerations, physical and chemical factors, marine phytoplankton nature, seasonal growth cycles, productivity. ii. Marine benthic algae, shore type Zonation patterns and factors governing them, Zonation pattern of East and west Coast of India. 															

Unit 3	Algae and Sewage Disposal 3.1. Necessity of sewage disposal 3.2. Composition of sewage (Physical, chemical biological) 3.3. Treatment of waste water: Pretreatment, secondary biological treatment. 3.4. Types of algal stabilization ponds 3.5. Algal flora their periodicity and succession in sewage stabilization ponds.	10 L
Unit 4	Eutrophication and Biomonitoring of Water Quality 4.1. Definition of Water pollution 4.2. Types of water pollutants 4.3. Eutrophication: Definition, Process of eutrophication, Effects of eutrophication and algal bloom, Controls of water blooms, pollution tolerant genera. 4.4. Saprobic zones (Kolwevitz and Marson 1909); Saprobic zones (Partick 1977) 4.5. Algae in organically polluted waters and home sewage 4.6. Common algae in water supplies 4.7. Diatoms as indicators of water pollutions 4.8. Nygaard's tropic state indices. 4.9. Palmer's pollution index 4.10. Filter clogging algae: Algae causing odour, taste, colour, and slime in water. 4.11. Uses of algae in water supplies; Control of algae in water supplies.	15 L
Unit 5	Phycological Techniques 5.1. Field Collection procedure for marine and freshwater algae. phytoplankton, Phytoplankton counts methods. 5.2. Ecological Field Methods: Macro algae. 5.3. Preservation, preparation of herbarium and permanent slides. 5.4. Histochemical and general methods, stains and fixatives.	10 L
Suggested Readings: <ol style="list-style-type: none"> 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, a. 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. Mervin (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.

Course Code: BO-522		
Course Title: Special Paper-III B. Mycology		
Course Code: BO-522	Course Type: Core Course (DSC-41)	
Course Title: Special Paper III B. Mycology	Type: Theory	
Total contact Hours: 60	Course Credits: 04 (60 L)	
College Assessment (CA): 40	University Assessment (UA): 60	
<p>Course objectives:</p> <ol style="list-style-type: none"> 1. To know scope and significance and history of plant pathology. 2. To study pathogenesis, defense mechanism and physiology of diseased plants. 3. To make aware about Specific Plant diseases and disease management. 4. To know seed pathology, Market pathology, Forest pathology and medical mycology. <p>Course outcomes:</p> <ol style="list-style-type: none"> 1. Able to know concept, scope and importance of the plant pathology. 2. Able to describe development of disease, pathogenesis, defense mechanism. 3. Higher cognitive skills about abiotic and biotic diseases of plants will develop. 		
Course Content		
Unit 1	Plant Pathology	12 L
	<ol style="list-style-type: none"> 1.1 Definition, Objectives, Scope and significance of plant pathology, History of Plant Pathology in India. 1.2 Concept of disease, Disease pyramid, Classification of Plant diseases 1.3 Koch's Postulates, General symptoms of Plant diseases. 1.4 Stages in development of disease (Disease cycle). 	
Unit 2	<ol style="list-style-type: none"> 2.1 Pathogenesis (Mechanism of infection): penetration, invasion and growth. 2.2 Plant-parasite relationship. 2.3 Chemical Weapons of pathogen: <ol style="list-style-type: none"> a) Enzymes in plant diseases b) Microbial toxins in plant diseases, Non-Host specific toxins and Host-specific toxins. 	12 L
Unit 3	<ol style="list-style-type: none"> 3.1 Effect of environment on disease development 3.2 Defense mechanism: <ol style="list-style-type: none"> a) Structural defense mechanism b) Biochemical defense mechanism 3.3 Physiology of diseased plants 	12 L
Unit 4	Specific Plant diseases and disease management	12 L
	<ol style="list-style-type: none"> 4.1 Abiotic: Environmental factors that cause disease- temperature, moisture, oxygen, light and mineral deficiency. 	

	<p>4.2 Biotic: Plant diseases caused by</p> <p>a) Viruses: Leaf curl of Tomato, Yellow vein mosaic of Bhindi</p> <p>b) Mycoplasmas: Little leaf of Brinjal, Grassy shoot of Sugarcane</p> <p>c) Bacterial: Citrus canker, Angular leaf spot of Cotton.</p> <p>d) Nematode: Root knot of vegetable, Soybean cyst nematode.</p> <p>e) Fungal: Downy mildew of crucifers, Downy mildew of Grapes, Powdery mildew of Grapes, Rust of Wheat, Smut of Jowar, Red rot of Sugarcane.</p> <p>4.3 Physical, Chemical and Biological Control measures</p>	
Unit 5	<p>5.1 Seed Pathology: External and internal seed born diseases and their control measures, storage mycoflora and toxins.</p> <p>5.2 Forest Pathology: Forest diseases, management and wood decay.</p> <p>5.3 Market pathology: Post harvest fungal diseases of fruits and vegetables and their control measures.</p> <p>5.4 Medical Mycology: Mycotic infections, Dermatophytes and Deep mycetes.</p>	12 L
<p>Suggested Readings:</p> <ol style="list-style-type: none"> 1. Agrios G. N. (1969). Plant Pathology. Academic Press, New York, USA. 2. Ainsworth G. C. 1952. Medical Mycology. Pitman Press, London, UK. 3. Bakshi B. K. 1976 Forest pathology. Controller of Pub. New Delhi, 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., Calcutta . 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 Delhi, 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, 15. Mukherji and Bhasin 1986 Plant diseases of India Tata Mac Graw Hill Publ Co Ltd New Delhi 16. Nene Y. L. 1976 Fungicides in plant diseases controls. Oxford and IBH Publ. Co. New Delhi, 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.

Course Code: BO-522		
Course Title: Special Paper- III C. Angiosperm Taxonomy		
Course Code: BO-522	Course Type: Core Course (DSC-41)	
Course Title: Special Paper- III C. Angiosperm Taxonomy	Type: Theory	
Total Contact Hours: 60	Course Credits: 04 (60L)	
College Assessment (CA) Marks: 40	University Assessment (UA): 60	
<p>Course Objectives:</p> <ol style="list-style-type: none"> 1. To trace the origin of Angiosperms. 2. To study embryology of Angiosperm plant. 3. To study palynology of Angiosperm plant. 4. To study wood anatomy of Angiosperm plant. 5. To study ecological anatomy of Angiosperms. <p>Course Outcomes:</p> <ol style="list-style-type: none"> 1. Understand the theories of origin of Angiosperms 2. Understand the embryological mechanism of Angiosperms 3. The students would be able to know about Palynology 4. Understand various angiosperm woods and ecological anatomy. 		
Course Content		
Unit 1	<p>Origin of Angiosperms</p> <ol style="list-style-type: none"> 1.1 Time of origin of angiosperms 1.2 Cradle of angiosperms 1.3 Theories of origin of Angiosperms with respect to time, place and possible ancestors: <ol style="list-style-type: none"> a) The Isoetes– monocotyledons theory b) The Coniferales- Amentiferae theory c) The Gnetales- Angiosperm theory d) The Anthostrobilus- (Bennettitalean) theory e) The Caytonialean theory f) The Stachyosporry- Phyllospermae theory g) The Pteridosperm theory h) The Pentoxylales theory i) The Durian theory 	12 L
Unit 2	<p>Wood Anatomy</p> <ol style="list-style-type: none"> 2.1 Introduction and definition 2.2 Wood: Types a) Hard Wood b) Sap wood c) Porous wood d) Non porous e) Homoxylous f) Heteroxylous 2.3 Elements of wood, their structure and distribution. 2.4 Properties and uses of wood in relation to structure and composition 	12 L

	2.5 Anatomy and identification of important timbers: <i>Tectona grandis</i> , <i>Mangifera indica</i> , <i>Casuarina equisetifolia</i> , <i>Albizia lebbek</i> , <i>Acacia nilotica</i> , <i>Syzygium cumini</i> , <i>Melia azadarch</i> and <i>Peltophorum pterocarpum</i>	
Unit: 3	Ecological Anatomy 3.1 Hydrophytes: a) Submerged b) Free floating c) Anchored floating d) Amphibious 3.2 Xerophytes: a) Microphyllous b) Sclerophyllous c) Trichophyllous d) Malacophyllous 3.3 Halophytes 3.4 Parasites 3.5 Epiphytes	12 L
Unit 4	Embryology of Angiosperms 4.1 Different schools of embryology and their contributions 4.2 Artificial pollination, fertilization 4.3 Apomixis: Types and evolutionary significance 4.4 Sexual incompatibility: Significance, types, Self- incompatibility: genetic basis, barriers to fertilization, biological significance 4.5 Endosperm, endosperm – ultra structure and histo-chemistry 4.6 Embryo as a reaction system, homologies, experimental embryogenesis 4.7 Embryo-endosperm relationship 4.8 Fertilization in <i>Tambourissa</i> and <i>Butomopsis</i> and their significance	12 L
Unit 5	Palynology 5.1 Palynology, its scope and importance 5.2 Pollen units, pollen biochemistry, and pollen physiology. 5.3 NPC system for numerical expression of aperture details, its merits and demerits 5.4 Pollenkitt, sporopollenin, pollen wall proteins, pollen germination in vivo and in vitro 5.5 Pollen storage and viability, pollen sterility 5.6 Pollen polymorphism 5.7 Palynology in relation to angiosperm phylogeny	12 L

Suggested Readings:

1. Agashe, S.N. and Caulton, E. 2009. Pollen and Spores: Applications with Special Emphasis on Aerobiology and Allergy. Science Publishers, New Delhi, India
2. Bhattacharya Kashinath, Majumdar Manas Rajan and Bhattacharya Swati Gupta 2011. A Text Book of Palynology. New Central Book Agency. Kolkata WB, India.
3. Bhojwani, S. S. and Bhatnagar, S. P. 1984. Embryology of Angiosperms. Vikas Publ. House, New Delhi, India.
4. Bhojwani, S. S., Bhatnagar, S. P. and P. K. Dantu 2015. The Embryology of Angiosperms. Vikas Publ. House, New Delhi, India.
5. Carlquist, S. 1961 Comparative Plant anatomy, Hold, Rinehart and Winson, New York, USA.
6. Cronquist, A. 1981. An Integrated System of Classification of Flowering Plants. Columbia University Press, New York, USA.
7. Cronquist, A. 1988. The Evolution and Classification of Flowering Plants (2nd ed.) Allen Press, U.S.A.
8. Das, Susheela M. 2017. A Text Book of Plant Anatomy: Theory & Objective. Dominant Publishers & Distributors Pvt .Ltd. New Delhi, India.
9. Davis P. H. and V. H. Heywood. 1991. Principles of Angiosperm Taxonomy. Today and Tomorrow Publications, New Delhi, India.
10. Erdman G. 1952. Pollen Morphology and Plant Taxonomy. Angiosperms. Alquist and Wiksell. Stockholm.
11. Erdman G. 1952. Pollen Morphology and Plant Taxonomy. Angiosperms. Hafner Publ. Co. New York, USA.
12. Esau K. 1960. Anatomy of Seed Plants, Wiley. New York, USA.
13. Fahn, A. 1982. Plant Anatomy. Pergamon Press, London, UK.
14. Gupta Sangeeta. 2020. Field Identification of Selected Timbers of India A hand Book. Indian Council of Forestry Research and Education, Dehradun, India.
15. Naik, V. N. 1984. Taxonomy of Angiosperms. Tata McGraw-Hill Publishing Company Ltd. Mumbai, India.
16. Singh, V., Pande. P.C., Jain, D.K. 2013. A Text Book of Angiosperms. Rastogi Publications, Meerut, India

Course Code: BO-522		
Course Title: Special Paper-III D. Plant Physiology		
Course Code: BO- 522	Course Type: Core Course (DSC-41)	
Course Title: Special Paper- III D. Plant Physiology	Type: Theory	
Total contact Hours: 60	Course Credits: 04 (60L)	
College Assessment (CA) Marks: 40	University Assessment (UA): 60	
<p>Course Objectives:</p> <ol style="list-style-type: none"> 1. To awake the students with concepts of Plant Biochemistry. 2. To inculcate the students with structure of biomolecules. 3. Study the role of biomolecules in plant growth. 4. To study the Chemical characteristics and properties of biomolecules. 5. To inculcate the students with organic molecules their storage and synthesis in plants. <p>Course Outcomes:</p> <ol style="list-style-type: none"> 1. Students will able to know the concepts of Plant Biochemistry. 2. Students will understand the biomolecules processes of plants. 3. Students will get the knowledge of role of biomolecules in plant growth. 4. The advance knowledge of Biochemistry to deiminated among the students. 		
Unit 1	<p>Biological and Chemical organization of cell</p> <ol style="list-style-type: none"> 1.1 Introduction and scope of biochemistry 1.2 Hydrogen ion concentration and buffers 1.3 Phytochemical characteristics of prokaryotic and eucaryotic cell. 1.4 Chemical composition of cell organelles in eukaryotic cell. 1.5 Differences in chemical composition of eukaryotic and prokaryotic cell. 	12 L
Unit 2	<p>Carbohydrates</p> <ol style="list-style-type: none"> 2.1 Introduction 2.2 Classification of carbohydrates based on number of carbon and groups with suitable examples. 2.3 Homopolysaccharides, heteropolysaccharides, Mucopolysaccharides and their properties 2.4 Properties of monosaccharides. 2.4 Properties of disaccharides 2.5. Properties of polysaccharide. 2.6 Importance of carbohydrates in plants. 	12 L
Unit 3	<p>Proteins</p> <ol style="list-style-type: none"> 3.1 Introduction of amino acids, nomenclature and classification of amino acids. 3.2 Structure of amino acids. 3.3. Properties of amino acids. 3.4 Structure of proteins- Primary, secondary, tertiary and quarternary 3.5 Mechanism of formation of peptide bond. 	12 L

	3.6 Functions of proteins.	
Unit 4	Lipids and Nucleic acids 4.1 Introduction and classification of lipids 4.2 Properties of fatty acids. 4.3 Biological Significance of lipids. 4.4 Synthesis of fats (Triglyceride molecules) 4.5 Introduction and types of nucleic acids. 4.6 Nucleotides and nucleosides, importance of nucleic acids	12 L
Unit 5	Enzymes and Vitamins 5.1 Introduction and characteristics of enzymes. 5.2 Types of enzymes: simple and conjugated enzymes. 5.3 Co-enzymes, Isoenzyme, Isozymes, Multienzyme complex. 5.4 Biological roles of enzymes. 5.5 Introduction and classification of vitamins 5.6 Nomenclature of vitamins. 5.7 Source, importance and deficiency symptoms of vitamins.	12 L

Suggested Readings:

1. Cherry, J.H (1989): Environmental stresses in plants. Biochemical and Physiological mechanisms.
2. Evans, L.T.(1972): Crop Physiology.
3. Fageria, N. K.(1992): Maximizing crop yield.
4. Fertilizer association of India (1974): Fertilizer handbook of Usage.
5. Fitter, A. H. and Hay, R. K. M. S. (1987): Environmental Plant Physiology.
6. Gupta, U. S. (1972): Crop Physiology.
7. Gupta, U. S. (1975): Physiological aspects of dryland farming.
8. Hale, M.C. and Orcutt, D.M. (1987): The Physiology of Plants Under Stress.
9. ICAR handbook of Fertilizers.
10. Kozlowski, T. T. (1984): Flooding and Plant Growth. M. Sc. Part II Syllabus...
11. Levitt, J. (1969, 1980): Responses of Plants to Environmental Stress.
12. Mansfield, C.A. (1976): Effect of air pollutant on plants.
13. Marschner, H. W. (1986): Mineral nutrition of Higher Plants.
14. McLaren, J.S. (1985): Chemical manipulation of crop growth and Development.
15. Mehrotra, R.S. (1980): Plant Pathology.
16. Paleg, L.G. and Aspinal, D.(1982): The Physiology and Biochemistry of Drought resistant in Plants.
17. Pojakoff Mayber A. and Gale, J. (1975): Plants in saline environment.
18. Rice, E. L. (1982): Allelopathy (Physiological Ecology).
19. Sharma, S. K. and Gupta, I. S. (1986): Physiological aspects of dryland farming.
20. Sinha S.K., Sane P.V., Bhargava S.C. and Agarwal P.K. (1990): Proceeding of International Congress of Plant Physiology Vol. I & II.
21. Srivastava, Y. N. Environmental pollution.
22. Turner, N. C. and Cramer, P.J.(1980): Adaptation of plants to water and high temperature stress.
23. Upeke, L. K. (1982): Tropical tree crops.

24. Yawalkar and Agarwal, Manures and fertilizers.
25. Pessarkli, M. (2004): Handbook of Plant and Crop Physiology, Marcel Dekkar Inc. NY.
26. Pessarkli, M. (2005): Handbook of Photosynthesis.
27. Nickell, L.G. (1986): Plant growth regulators in Agriculture.
28. Asana, R.D. and Sarin M.N. (1968): Crop Physiology in India IARI Publ.
29. Taiz L. and Zeiger F. (2002): Plant Physiology.

The Plant Physiology Journals

- Annual reviews of Plant Physiology and Molecular Biology.
- Indian Journal of Plant Physiology.
- Journal of Experimental Botany.
- Physiologia Plantarum Sweden.
- Plant Physiology (USA).
- Everymans Science.

Course Code: BO- 523	
Course Title: Practical Based on BO-521 Special Paper- II A. Phycology	
Course Code: BO- 523	Course Category: Core Course (DSC- 42)
Course Title: Practical Based on BO- 521 Special Paper- II A. Phycology	Type: Practical
Total Contact Hours: 60	Course Credit: 04 (60 L)
College Assessment (CA): 20	University Assessment (UA): 30
<p>Course Objectives:</p> <ol style="list-style-type: none"> 1. To understand algal physiology, biochemistry and genetics. 3. To know about cultivation of algae and its application. 4. To aware about commercial utilization of algae. 5. To know role of algae in industries 6. To know the various practical methods for algal amylases <p>Course Outcomes:</p> <ol style="list-style-type: none"> 1. Able to understand algal physiology, biochemistry 2. Able to cultivate algae for its utilization 3. Able to analyse algal for its by products 	
Course Content	
Practical 1	Preparation of algal culture media (De's modified Beneck's medium for Blue Green Algae)
Practical 2-3	Isolation and cultivation of algae by dilution and streak culture technique
Practical 4	Mass culture of blue green algae as bio-fertilizer
Practical 5-6	Biomass estimation, total chlorophyll / fresh and dry weight
Practical 7	Extraction and separation of amino acids of algae by chromatography methods
Practical 8	Extraction and separation of carbohydrates of algae by chromatography methods
Practical 9	Cytological studies of: <i>Chara, Hydrodictyon, Cladophora, Spirogyra, Oedogonium</i> (any 1 form)
Practical 10	Extraction of Mucilage from algal material.
Practical 11	Extraction of Agar-Agar from Marine algae
Practical 12	Extraction of Alginic acid from Marine algae

Practical 13	Extraction and Estimation of algal proteins from polluted and unpolluted waters
Practical 14	Collection of algae to nearby ponds rivers lakes and pullulated habitats, submission of 10 algal forms and Tour report is essential.
Practical 15	Botanical excursion of marine and fresh water habitats.
Suggested Readings:	
<ol style="list-style-type: none"> 1. C. Van den Hoke, D. G. Mann & H.M. Jahns (1995) Algae An Introduction to Phycology, Cambridge University Press 2. Janet R. Stein (1975) Phycological methods, Cambridge University Press. 3. John S. Burlew (1976) Algal Culture from Laboratory to Pilot Plant, Crnegie Institution of Washington Publication 600, Washington, D. C., USA. 4. Peter S. Dixon (1973) Biology of the Rhodophyta, Oliver & Boyd Croythorn House, 23 Ravelston Terrace, Edinburgh. 5. Tilden J. E. (1968) The Algae and Their life relations (Fundamentals of Phycology) Hafner Publishing Co, London, UK. 6. Daws, C. J. (1981). Marine Botany. Wiley Publication Com. New York, USA. 7. Round, F.E. (1973). The Biology of the Algae. Edward Arnold, London, U.K. 	

Course Code: BO- 523	
Course Title: Practical Based on BO- 521 Special Paper- II B. Mycology	
Course Code: BO- 523	Course Category: Core Course (DSC-42)
Course Title: Practical Based on BO- 521 Special Paper- II B. Mycology	Type: Practical
Total Contact Hours: 60	Course Credit: 02 (60 L)
College Assessment (CA) Marks: 20	University Assessment (UA): 30
<p>Course Objectives:</p> <ol style="list-style-type: none"> 1. Understand techniques for isolating, culturing and propagating fungi from soil, air or water. 2. To get knowledgeable about Citric acid fermentation and estimation. 3. To aware students about different types of fungi found in soil, air and water and identifying them on the based on culturing and morphological characters. 4. To understand the methods for establishing pure culture. <p>Course Outcomes:</p> <ol style="list-style-type: none"> 1. Able to understand laboratory equipment working and uses. 2. Students are aware with culturing, maintenance, and preservation of industrial important fungi. 3. Able to make student to fermentation of citric acid. 	
Course Content	
Practical 1	To study principle working and uses of Autoclave, Laminar ait flow hood, Inoculation Chamber, Inoculating needles, pH meter, Incubator and Hot air oven.
Practical 2	Preparation of PDA solid media for fungal growth.
Practical 3	Preparation of Czapek Dox Agar media for fungal growth.
Practical 4	Sterilisation of glassware and media prepared for isolation of fungi.
Practical 5	Preparation of slants and petri plate for culturing fungi.
Practical 6	Isolation of fungi from soil by serial dilution method and calculating CFU.
Practical 7	Identification of fungi isolated from soil using cultural and morphological characters.
Practical 8 & 9	Establishment of pure culture for any one fungus isolated from soil.
Practical 10	Isolation of fungi from air / water by suitable method and identification of fungi.
Practical 11 & 12	Mushroom spawn preparation, Mushroom bed preparation, cultivation, and harvesting.

Practical 13 & 14	Fermentation of Citric acid and estimation of it by following standard method.
Practical 15	Field visit to understand fungi in nature/ Visit to industry/ standard mycology research lab.
Note: - Field visit/ Industrial visit/ Research lab visit is compulsory	
Suggested Readings:	
<ol style="list-style-type: none"> 1. Agrios, Plant Pathology –Academic Press, London. 2. Ainsworth, G.C. and Sussmann, A.S. The Fungi. 3. Aneja K. R, (1996) Experiments in microbiology, Plant pathology, Tissue culture and mushroom cultivation. Vishwa Prakashan New Dehli, India. 4. Bennett, J.H. Fundamentals of Mycology. 5. Berry, R, Industrial mycology (Vol. I) 6. Bilgrami and Dubey, A text book of modern Plant Pathology - Vikas Publication, New Delhi. 7. Bio-synthesis and metabolism (Vol. II) 8. Change. S.T. & P.G. Miles, Edible mushrooms and their cultivation 9. Dubey, S.C. Biotechnology. 10. Dubey, S.C. Biotechnology. 11. Mehrotra, Plant Pathology – Tata McGraw Hill, New Delhi. 12. P.D. Sharma, Microbiology and Pathology – Rastogi Publication, Meerut. 13. Palezar, Chand and King Microbiology –, McGraw Hills, London. 14. Powel, C&D. J. Bagyaraj, V.A. Mycorrhizae. 15. S.S. Purohit Microbiology and Pathology –, Agro Bot. Jodhpur. 16. Smith, J.E. The Filamentous Fungi. 17. V.N. Pathak, Fundamentals of Plant Pathology –Agro Botanica, Jodhpur. 	

Course Code: BO-523
Course Title: Practical based on
BO-521 Special Paper- II C. Angiosperm Taxonomy

Course Code: BO-523	Course Type: Core Course (DSC-42)
Course Title: Practical based on BO-521 Special Paper- II C. Angiosperm Taxonomy	Type: Practical
Total Contact Hours: 60	Course Credits: 02 (60 L)
College Assessment (CA): 20	University Assessment(UA): 30

Course Objectives:

1. To study the Angiosperm families with respect to morphological characters.
2. To study importance of classification of Bentham and Hookers system in Angiosperms.
3. To study primitive and advanced groups of Angiosperm.
4. To study taxonomic structure of Angiosperms.

Course outcomes:

1. Understand the habit, habitat and plant morphology of Angiosperm plants
2. Understand the status of angiosperms in the plant kingdom.
3. Know the vegetative characteristics and reproductive characteristics of the plant.
4. Understand various angiosperm families emphasizing their morphology, distinctive features, and biology.
5. Students will understand different flora for identification of Angiosperm plants.
6. Students will find out dichotomous keys on vegetative and floral characters.

Course Content

Practical 1-9	Study of Angiospermic families from locally available plants covering all orders/series (Sensu Bentham and Hooker, at least 20 families).
Practical 10-11	Preparation of artificial keys (i. indented ii. bracketed) based on vegetative and floral characters.
Practical 12-13	Identification of plant specimens up to species with help of available floras.
Practical 14-15	Botanical Excursion tour, submission of tour report and photographs of plants

Suggested Readings:

1. Cook T. (1903). The Flora of Presidency of Bombay, Vol. I, Vol. II & Vol. III (Indian Reprint) Bishen Singh, Mahendra Pal Singh, Dehradun.
2. S R Kshirsagar and D A Patil (2008) Flora of Jalgaon District Maharashtra
3. Jain S. K. and Rao R. R. Handbook of Field and Herbarium Methods, Today and Tomorrow Publishers, New Delhi
4. N. P. Singh & S. Karthikeyan (2000) Flora of Maharashtra state Dicotyledones Vol-1
5. Manilal, K. S. and M. S. Muktesh Kumar [ed.] (1998). A Handbook of Taxonomic Training. DST, New Delhi.

6. Naik, V. N. (1984).Taxonomy of Angiosperms. Tata McGraw-Hill Publication Com. Ltd. New Delhi.
7. Gangulee H.C. Das K.S. ,Dutta C .(2014)College Botany Volume I, New Central Book Agency (P) Ltd. .Kolkata.
8. Dutta A.C.(2013) Botany for Degree Students, Sixth edition, Oxford University Press, New Delhi.
9. Sachdeva S.K.(1990)Angiosperms–Morphology, Anatomy, Taxonomy, Evolution, Kalyani Publication, Ludhiana.
10. Pandey S.N. Mishra S.P. (2009) Taxonomyof Angiosperms, Ane Books Pvt .Ltd .,New Delhi.
11. Singh M.P., Sharma A.K. (2002) Text book of .Botany, Anmol Publication, Pvt. Ltd., New Delhi.
12. Sundararajan S.(2003) Practical Manual of Plant Morphology, Anmol Publication, Pvt .Ltd., New Delhi
13. Bendre A. Kumar A.(1999) A Textbook of Practical Botany II, Rastogi Publication, Meerut

Course Code: BO- 523
Course Title: Practical Based on
BO-521 Special Paper- II D. Plant Physiology

Course Code: BO-523	Course Type: Core Course (DSC-42)
Course Title: Practical based on BO-521 Special Paper- II D. Physiology	Type: Practical
Total Contact Hours: 60	Course Credits: 02 (60 L)
College Assessment (CA) Marks: 20	University Assessment (UA): 30

Course Objectives:

1. To awake the students with concepts of plant physiology.
2. To inculcate the students with process of photomorphogenesis.
3. To study the growth and post-harvest changes in the plants.
4. To study the advances in photosynthesis and respiration.
5. To inculcate the students with organic acids and secondary metabolites in plants.

Course Outcome:

1. Students will able to know the concepts of plant physiology.
2. Students will understand the photomorphogenic processes of plants.
3. Students will get the knowledge of growth process and post-harvest changes in plants.
4. The advance knowledge of photosynthesis and respiration deiminated among the students

Course Content

Practical 1	Study of enzyme ATPase.
Practical 2-3	Sugar and Amino acid analysis of phloem sap with paper chromatography.
Practical 4-5	Determination of chlorophyll a / b ratio of C3 and C4 plants.
Practical 6-7	Estimations of nitrate in different plant parts.
Practical 8	Study of nitrate reductase in plants.
Practical 9-10	Study of effect of PEG induced water stress on seed germination.
Practical 11	Study of effect of light on flowering.
Practical 12	Study of effect of temperature on seed germination.
Practical 13	Effect of red and far-red light on seed germination.
Practical 14-15	Extraction and separation of photosynthetic pigments by solvent method.

Suggested Readings:

1. Miller, P (1973) : Phytochemistry Vol.I, II and III.
2. Epstein, E (1972) : Mineral nutrition of plants : Principals and perspectives.
3. Bonner, J. and Varner, E. (1976): Plant Biochemistry.
4. Gregory, P (1976) : Biochemistry of Photosynthesis.
5. Devlin, R.M. and Witham (1975): Plant Physiology.
6. Beevers, H (1976): Nitrogen Metabolism in plants.
7. Stump, F.A. and Conn, E.E. (1981) : Biochemistry of Plants. A Comprehensive Treatise Vol. II, III, IV, IX and XII.
8. Mukharjee S.P. and ghosh A.N. (1996) Plant Physiology.
9. Wilkins, M.B. (1976): Physiology of Plant Growth and Development.
10. Noggle, G.R. and Fritz, G. J. (1976): Introductory Plant Physiology.
11. Marschner, H. W. (1986): Mineral nutrition of Higher Plants.
12. Salisbury, F.B. (1971): The biology of Flowering.
13. Krishnamurthy, H.N. (1992): Physiology of Plant Growth and Development.
14. Salisbury, G.B. and Ross, F.V.(1990): Plant Physiology.
15. Levitt, J. (1969, 1980): Responses of Plants to Environmental Stress.
16. Taiz L. and Zeiger F. (2004): Plant Physiology.
17. Pessarkli M. (2005): Handbook of Photosynthesis. II nd Edition.
18. An Introduction to practical biochemistry 3rd edition by Devid p. plummer TMH publication
19. Biochemical methods 4th editions by S. Sadasivam and A Manickam, New age international publishers

Course Code: BO-524
Course Title: Practical Based on
BO-522 Special Paper- III A. Phycology

Course Code: BO- 524	Course Category: Core Course (DSC- 43)
Course Title: Practical Based on BO-522 Special Paper- III A. Phycology	Course Type: Practical
Total Contact Hours: 60	Course Credit: 02 (60 L)
College Assessment (CA): 20 Marks	University Assessment (UA): 30

Course Objectives:

1. To study ecological classification of algae.
2. To understand those environmental factors which control their survival growth, distribution and causal mechanisms
3. To helps in bio-monitoring the water bodies and pollution control.
4. To know phycological techniques, for water supplies.
5. To study the role of algae in sewage disposal.

Course Outcomes:

1. Able to understand ecological classification of algae, Habitats of algae.
2. Able to know algae and sewage disposal and Eutrophication
3. Able to understand algal diversity in East & Weast coast o India.
4. Able to count Phytoplankton.
5. Able to do water analysis.

Course Content

Practical 1-2	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 3-5	Study of Algae in east & west coast of India
Practical 6-7	Qualitative and quantitative studies of phytoplankton using standard Methods Lacky's simple drop method and Haemocytometer method.
Practical 8	Study of Palmer's pollution index for assessing the water quality of any polluted habitat
Practical 9-13	Water analysis: pH, Turbidity, Total dissolved solids, dissolved oxygen, Free CO ₂ , BOD, COD, Carbonate, Bicarbonate, Total Alkalinity, Chlorides, Hardness, Calcium, Magnesium, Nitrate, Sulphate, Phosphate (any 6)
Practical 14	Collection of algae to nearby ponds rivers lakes and pullulated habitats, submission of 10 algal forms and Tour report is essential.
Practical 15	Botanical excursion of marine and fresh water habitats.

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. APHA, (2022) Standard Method for the Examination of Water and Waste Water. 24th.Edition American Public Health Association, New York, U.S.A.
4. Anand, N. (1989) Handbook of Blue Green Algae. Bishen Singh Mahendra Pal Singh, Dehradun, India.
5. Fatma, T.(1999) Cyanobacterial And Algal Metabolism and Environmental Biotechnology. Narosa Pub. House, New Delhi, India.
6. Palmer, C. Mervin (1980) Algae and Water Pollution. Castle House Publications Ltd., London, U.K
7. R. Ramesh, M. Anbu (1996) Chemical Methods for Environmental Analysis. McMillan India Ltd., Mumbai, India.
8. Trivedi, R.K. and Goel P.K. (1986) Chemical and Biological methods for Water Pollution Studies. Environmental Pub., Karad (M.S.), India.
9. Mark M. Littler & Diane S. Litter (1985) Hand book of Phycological Methods, Cambridge University Press.
10. Misra, J.N. (1966). Phaeophyceae in India. CAR, New Delhi, India.

Course Code: BO-524	
Course Title: Practical Based on BO-522 Special Paper- III B. Mycology	
Course Code: BO- 524	Course Category: Core Course (DSC- 43)
Course Title: Practical Based on BO-522 Special Paper- III B. Mycology	Course Type: Practical
Total Contact Hours: 60	Course Credit: 02 (60 L)
College Assessment (CA): 20 Marks	University Assessment (UA): 30
<p>Course Objectives:</p> <ol style="list-style-type: none"> 1. To know basic technique of plant pathology. 2. To study various plant pathogenic diseases w.r.t. Causal organism, Symptoms, Disease cycle and disease management. 3. To Know about preparation of different fungicidal solutions and calculation of fungicidal spray concentrations. 4. To make aware about Seed pathology, Market pathology, and Forest pathology. <p>Course Outcomes:</p> <ol style="list-style-type: none"> 1. Able to know basic technique of plant pathology 2. Able to describe various plant pathogenic diseases. 3. Higher cognitive skills about isolation and purification of Fungal plant pathogens will develop. 4. Higher cognitive skills about preparation of different fungicidal solutions and calculation of fungicidal spray concentrations will develop. 	
Course Contents	
Practical 1	Basic Techniques in Plant Pathology
Practical 2-3	Isolation and purification of Fungal plant Pathogens from diseased plant tissues.
Practical 4	Study of diseases caused by Bacteria and Viruses (any three)
Practical 5	Study of diseases caused by Mycoplasma and Nematodes (any three)
Practical 6	Study of diseases caused by Mastigomycotina and Plasmodiophorales (any three)
Practical 7	Study of diseases caused by Ascomycotina (any three)
Practical 8	Study of diseases caused by Basidiomycotina (any three)
Practical 9	Study of diseases caused by Deuteromycotina (any three)
Practical 10	Study of diseases caused by Phanerogamic plant parasites (any three)

Practical 11	Study of Forest plant pathogens (any three)
Practical 12	Study of seed pathology
Practical 13	Study of Post harvest diseases.
Practical 14	Preparation of different fungicidal solutions and calculation of fungicidal spray concentrations.
Practical 15	Botanical Excursion Tour

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 Dehli, 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.

Course Code: BO-524	
Course Title: Practical Based on BO-522 Special Paper- III C. Angiosperm Taxonomy	
Course Code: BO-524	Course Type: Core Course (DSC-43)
Course Title: Practical Based on BO- 522 Special Paper- III C. Angiosperm Taxonomy	Type: Practical
Total contact Hours: 60	Course Credits: 02 (60 L)
College Assessment (CA) Marks: 20	University Assessment (UA): 30
<p>Course Objectives:</p> <ol style="list-style-type: none"> 1. To study ecological anatomy of Angiosperms 2. To study anatomical features of timber and wood 3. To study pollen tetrad, embryo development and endosperm types 4. To study pollen fertility, sterility, polymorphism and palynotaxonomy 5. To study pollen by acetolysis <p>Course outcomes:</p> <ol style="list-style-type: none"> 1. Understand basic and advanced techniques of plant anatomy, embryology and palynology. 2. Understand the ecological and anatomical features of angiosperms, timber and wood. 3. Recognize embryo development and endosperm types 4. Understand pollen tetrad, fertility, sterility and polymorphism 5. Understand utilization of anatomical, embryological and palynological data for taxonomy. 	
Course Content	
Practical 1 to 5	<p>Study of anatomical features of ecological interest of the following:</p> <ol style="list-style-type: none"> 1. Hydrophytic leaves (Any two): <i>Potamogeton, Ceratophyllum, Hydrilla, Ottelia, Vallisneria, Typha, Limnophila, Phylla nodiflora, Bacopa monieri, Nymphaea, Nelumbo</i> 2. Hydrophytic stem or petiole (Any two): <i>Limnophila, Hydrilla, Potamogeton, Bacopa monieri, Nymphaea, Nelumbo</i> 3. Xerophytic leaves (Any two): <i>Euphorbia nerifolia, Calotropis sp., Pentatropis sp., Nerium sp., Ficus sp.</i> 4. Xerophytic stem (Any two): <i>Casuarina equisetifolia, Tamarix sp., Capparis deciduas, Caralluma sp., Euphorbia tirucaulli, Sarcostema sp.</i> 5. Epiphytes: Study of velamen tissue (either from epiphytic root material or permanent slide)
Practical 6 to 8	Identification of four important timbers with the help of anatomical character and prepare an artificial key of timber wood on the basis of anatomical characters
Practical 9-11	<p>Embryology</p> <ol style="list-style-type: none"> 9. To study types of tetrads, pollen unit- Monad, Diad, Polyad and Pollinia from locally available plant material. 10. To study different types of endosperms from locally available materials. 11. Dissection and mounting of stages of embryo development, multiple embryos

	from locally available materials.
Practical 12-15	Palynology 12. To observe pollen fertility and sterility. 13. To study pollen polymorphism. 14. Palynotaxonomy of four selected taxa (either family or a genus). 15. To study of pollen from honey by acetolysis or any other suitable method.
Suggested Readings:	
<ol style="list-style-type: none"> 1. Bhattacharya Kashinath, Majumdar Manas Rajan and Bhattacharya Swati Gupta 2011. A Text Book of Palynology. New Central Book Agency.Kolkata WB, India. 2. Kumar Satish. 2011. Plant taxonomy and Embryology. Kedar Nath Ram Nath, Meerut, UP, India. 3. Kumar, Satish and Harginder Sing. 2019. Plant Resources Utilization, Plant Pathology, Palynology and Biostatics. Pragati Prakashan, Meerut, UP, India. 4. Narayan, Raghvendra Pratap and Ashutosh Tripathi. 2019. Introduction To Palynology And Biostatistics. R.P.Publication, Delhi, India. 5. .Pandey, B.P. 1999. Modern Practical Botany Vol. II. S. Chand & Company Ltd., New Delhi, India. 6. Pandey, B. P. 2001. Plant Anatomy. S. Chand & Company Ltd., New Delhi, India. 7. Pandey B.P. 2012. Modern Practical Botany. Vol II. S. Chand & Company Ltd., New Delhi. 8. Pandey, S.N. 1997. Plant Anatomy and Embryology. Vikas Publishing House Pvt Ltd, New Delhi, India. 9. S. Sundar Rajan. 2000. Practical Manual of Plant Anatomy and Embryology. Anmol Publications Pvt. Ltd. Delhi, India. 10. Singh, V. 2010. Plant Anatomy and Embryology of Angiosperms. Global Media Publications. Meerut, UP, India. 11. Yadav Swapnil. 2022. Anatomy of Angiosperms. Mahaveer Publications, Indore, MP, India. 	

Course Code: BO-524 Course Title: Practical based on BO-522 Special Paper III D. Plant Physiology	
Course Code: BO-524	Course Types: Core Course (DSC-43)
Course Title: Practical based on BO-522 Special Paper III D. Physiology	Course Type: Practical
Total Contact Hours: 60	Course Credits: 02 (60 L)
College Assessment (CA) Marks 20	University Assessment (UA) 30
Course Objectives: <ol style="list-style-type: none"> 1. To awake the students with concepts of Plant Biochemistry. 2. To inculcate the students with practical knowledge of biomolecules. 3. Study the estimation of biomolecules. 4. To study chemical characteristics of biomolecules practically. 	
Course Outcomes: <ol style="list-style-type: none"> 1. Students will get the practical knowledge of chemicals and safety measure during the laboratory work. 2. Students will understand the Characteristics of biomolecules of plants. 3. Students will get the knowledge of estimation of biomolecules present in plants. 	
Course Content	
Practical 1	The determination of pH of different solutions using pH meter.
Practical 2	Titration of a mixture of strong acid and a weak base.
Practical 3-4	Extraction and Separation of sugars by paper chromatography.
Practical 5-6	Extraction and separation of amino acids by two-dimensional chromatography.
Practical 7-8	Quantitative estimation of amino acids using ninhydrin reaction.
Practical 9	Biochemical tests for study of carbohydrates, proteins and lipids in plants.
Practical 10	Determination of acid value of fats.
Practical 11	Isolation of RNA from Yeast.
Practical 12	Study of effect of temperature on activity of alpha amylase enzyme.
Practical 13-14	Study of Protein/ Amino acid profile in plants under normal and stress condition.

**Practical
15**

The estimation of DNA from suitable plant material.

Suggested Readings:

- 1.Cherry, J.H (1989): Environmental stresses in plants. Biochemical and Physiological mechanisms.
- 2.Evans, L.T.(1972): Crop Physiology.
- 3.Fageria, N. K.(1992): Maximizing crop yield.
- 4.Fertilizer association of India (1974): Fertilizer handbook of Usage.
- 5.Fitter, A. H. and Hay, R. K. M. S. (1987): Environmental Plant Physiology.
6. Gupta, U. S. (1972): Crop Physiology.
- 7.Gupta, U. S. (1975): Physiological aspects of dryland farming.
- 8.Hale, M.C. and Orcutt, D.M. (1987): The Physiology of Plants Under Stress.
- 9.ICAR handbook of Fertilizers.
- 10.Kozlowski, T. T. (1984): Flooding and Plant Growth. M. Sc. Part II Syllabus.
- 11.Levitt, J. (1969, 1980): Responses of Plants to Environmental Stress.
- 12.Mansfield, C.A. (1976): Effect of air pollutant on plants.
- 13.Marschner, H. W. (1986): Mineral nutrition of Higher Plants.
- 14.McLaren, J.S. (1985): Chemical manipulation of crop growth and Development.
- 15.Mehrotra, R.S. (1980): Plant Pathology.
- 16.Paleg, L.G. and Aspinal, D.(1982): The Physiology and Biochemistry of Drought resistant in Plants.
- 17.Pojakoff Mayber A. and Gale, J. (1975): Plants in saline environment.
- 18.Rice, E. L. (1982): Allelopathy (Physiological Ecology).
- 19.Sharma, S. K. and Gupta, I. S. (1986): Physiological aspects of dryland farming.
- 20.Sinha S.K., Sane P.V., Bhargava S.C. and Agarwal P.K. (1990): Proceeding of International Congress of Plant Physiology Vol. I & II.
- 21.Srivastava, Y. N. Environmental pollution.
- 22.Turner, N. C. and Cramer, P.J.(1980): Adaptation of plants to water and high temperature stress.
- 23.Upeke, L. K. (1982): Tropical tree crops.
- 24.Yawalkar and Agarwal, Manures and fertilizers.
- 25.Pessarkli, M. (2004): Handbook of Plant and Crop Physiology, Marcel Dekkar Inc. NY.
26. Pessarkli, M. (2005): Handbook of Photosynthesis.
27. Nickell, L.G. (1986): Plant growth regulators in Agriculture.
28. Asana, R.D. and Sarin M.N. (1968): Crop Physiology in India IARI Publ.
29. Taiz L. and Zeiger F. (2002): Plant Physiology.

The Plant Physiology Journals

- Annual reviews of Plant Physiology and Molecular Biology.
- Indian Journal of Plant Physiology.
- Journal of Experimental Botany.
- Physiologia Plantarum Sweden.
- Plant Physiology (USA).
- Everyman's Science.

Course Code: BO-525(A)		
Course Title: Post-Harvest Technology		
Course Code: BO-525 (A)	Course Type: Elective Course (DSE-8)	
Course Title: Post Harvest Technology	Course Type: Theory	
Total contact Hours: 60	Course Credits: 04 (60 L)	
College Assessment (CA) Marks: 40	University Assessment (UA): 60	
<p>Course Objectives:</p> <ol style="list-style-type: none"> 1. One of the primary goals of post-harvest technology is to preserve the quality of harvested crops and extend their shelf life. 2. Minimization of Post-Harvest Losses due to factors such as spoilage, damage during handling and transportation, and inefficient storage practices. 3. Value Addition and Quality Enhancement another objective is to add value to harvested crops by processing them into higher-value products. 4. Post-harvest technology plays a crucial role in facilitating market access and enhancing the competitiveness of agricultural products. By ensuring product quality, safety, and consistency. 5. To understand post-harvest technologies help farmers and agribusinesses to improving their profitability and sustainability. <p>Course Outcomes:</p> <ol style="list-style-type: none"> 1. Students will gain an understanding of the physiological changes that occur in harvested crops, including respiration, transpiration, and ripening processes. 2. Students will learn best practices for handling harvested crops to minimize damage and maintain product quality. 3. Students will become familiar with various storage technologies used to prolong the shelf life of agricultural products. 4. Students will learn about different preservation methods employed in post-harvest technology to slow down spoilage and extend the shelf life of crops. 5. Students will gain an understanding of food safety principles and regulations related to post-harvest handling and processing. 7. Students will learn about value-added processing techniques and strategies to enhance the marketability of agricultural products. 		
Course Content		
Unit 1	History, Scope and importance of post-harvest technology	12 L
	<ol style="list-style-type: none"> 1.1 Composition and nutritive value of horticultural crops. 1.2 Factors leading to post-harvest loss. 1.3 Maturity indices of horticultural crops. 1.4 Physiology and biochemistry of fruit ripening, ethylene evolution and ethylene management. 1.5 Post harvest handling (harvesting, sorting, grading and packing and transportation) of fruits, vegetables and flowers. 1.6 Post harvest treatments (pre cooling, hot water, hot air and vapour heat, fungicide & biologically safe chemicals, irradiation, curing, 	

	pulsing etc.) for quality retention of horticultural crops.	
Unit 2	<p>Present status and future prospects of preservation industry in India</p> <p>2.1 Principles and methods of preservation Raw materials for processing.</p> <p>2.2 Processing of fruits and vegetables (canning; drying and dehydration fruit beverages and juice concentrates; sugar based products; tomato products; fermented products, value added products etc.)</p> <p>2.3 Food additives, minimal processing. Packaging technique and storage system for processed products.</p> <p>2.4 Importance of quality, quality management standards, ISO/BIS, PFA, AGMARK, etc.; HACCP, Codex alimentarius, Total quality management (TQM) etc.; Food standards (FPO, PFA etc.). Food laws and regulations.</p>	12 L
Unit 3	<p>Study of machinery and equipment used in processing of horticultural product</p> <p>3.1 Preparation of preserved products: a) Mix fruit Jam b) Wood apple/Guava Jelly c) Lemon/ Orange Squash d) Tomato chili sauce) Pickle f) drying of fruit and vegetable.</p> <p>3.2 Chemical analysis of nutritive value of fresh and processed fruits and vegetables.</p> <p>3.3 Visit to cold storage and CA storage units; visit to fruit and vegetable processing units to study the layout, equipment, hygiene, sanitation</p>	12 L
Unit 4	<p>Packaging Handling and Transportation</p> <p>4.1 Benefits, Function, Requirement for an ideal package, Prevention for mechanical damage, Cooling, Ventilation, packing materials CFB packing and others, plastic containers and paper trays, Modern packaging systems, packing method for different types produce.</p> <p>4.2 Handling techniques to minimize physical damage and bruising, Transportation systems and considerations for maintaining produce quality.</p> <p>4.3 Storage Facilities and Techniques: Types of storage facilities (cold storage, warehouses, silos, etc.). Optimal storage conditions for different crops/plants (temperature, humidity, ventilation). Control of pests and diseases during storage.</p> <p>4.4 Precooling: Room cooling, forced air cooling and hydro cooling, icing, vacuum cooling, ice bank cooler and evaporative cooling. Physical injuries and disorders.</p>	12 L
Unit 5	<p>Preservation of Fruits and Vegetables</p> <p>5.1 Introduction, scope and importance of fruits and vegetables preservation</p> <p>5.2. Methods of preservation: a) Temporary preservation: i) Asepsis ii) Exclusion of moisture iii) Use of mild antiseptic iv) Pasteurization v) Low temperature.</p>	12 L

<p>b) Permanent preservation: i) Sterilization and Processing: Use of sugar, salts, vinegar or preservation by food additives i. e. Chemical preservatives: citric acid. Potassium meta-bisulphite, sodium benzoate, Sulphur-dioxide ii) Drying, Dehydration and concentration of fruits and vegetables iii) Ionizing radiation.</p>

Suggested Readings:

1. Kader, A. A. (2013). Postharvest technology of horticultural crops-An overview from farm to fork. *Ethiopian Journal of Applied Science and Technology*, (1), 1-8.
2. Chakraverty, A., Mujumdar, A. S., & Ramaswamy, H. S. (Eds.). (2003). *Handbook of postharvest technology: cereals, fruits, vegetables, tea, and spices* (Vol. 93). CRC press.
3. McFarlane, J. A. (1988). Storage methods in relation to post-harvest losses in cereals. *International Journal of Tropical Insect Science*, 9(6), 747-754.
4. Ikegwu, T. M., Ezegbe, C. C., Okolo, C. A., & Ofoedu, C. E. (2022). Postharvest preservation technology of cereals and legumes. In *Postharvest Technology-Recent Advances, New Perspectives and Applications*. IntechOpen.
5. Chakraverty, A., & Singh, R. P. (2014). *Postharvest technology and food process engineering*. CRC Press.
6. Raghavan, A. S. M. G. V., & Ramaswamy, H. S. (2003). *Handbook of Postharvest Technology Cereals, Fruits, Vegetables, Tea, and Spices*.
7. Narayanasamy, P. (2005). *Postharvest pathogens and disease management*. John Wiley & Sons.
8. Ikegwu, T. M., Ezegbe, C. C., Okolo, C. A., & Ofoedu, C. E. (2022). Postharvest preservation technology of cereals and legumes. In *Postharvest Technology-Recent Advances, New Perspectives and Applications*. IntechOpen.
9. Studman, C. J. (2001). Computers and electronics in postharvest technology—a review. *Computers and electronics in Agriculture*, 30(1-3), 109-124.
10. Kudra, T., & Raghavan, G. S. V. (1991). **POST HARVEST TECHNOLOGY OF CEREALS PULSES AND OILSEEDS: OXFORD IBH PUBLISHING CO. PVT LTD.** New Delhi, 1988. *Drying Technology*, 9(2), 527-528.
11. Bourne, M. (1977). Post harvest food losses—the neglected dimension in increasing the world food supply.
12. Verma, L. R., & Joshi, V. K. (2000). Post-harvest technology of fruits and vegetables. *Post harvest technology of fruits and vegetables*, 1, 1-76.
13. Palumbo, M., Attolico, G., Capozzi, V., Cozzolino, R., Corvino, A., de Chiara, M. L. V. & Cefola, M. (2022). Emerging postharvest technologies to enhance the shelf-life of fruit and vegetables: an overview. *Foods*, 11(23), 3925.
14. Ribeiro, C., & Alvarenga, B. (2012). Prospects of UV radiation for application in postharvest technology. *Emirates Journal of Food and Agriculture*, 586-597.
15. W.V.Cruess (2012) *Commerical fruit and vegetable products* Agrobios (India) Jodhpur.
16. Azad, K. C. and Sharma, V. K. (2000). *Horticulture Technology* (Vol. I&II). Deep and Deep Publications, New Delhi, India.
17. Bal, J. S. (1997). *Fruit growing*. Kalyani Publication, New Delhi, India.

18. Edmond, J. B., Senn, T. L., Andrew, F. S. and Halfacr, R. G. (1990). *Fundamentals of Horticulture*. Tata McGraw Hill Publishing Co. Ltd. New Delhi, India.
19. Girdhari Lal., Siddhappa, G. S. and Tandon, G. L. (1998). *Preservation of fruits and vegetables*. ICAR New Delhi, India.
20. Khan, M. R. (1995). *Horticulture and Gardening*. Nirali Prakashan, Pune, India.
21. Sharma, V. K. (2004). *Advances in Horticulture*. Deep and Deep Publications, New Delhi, India.
22. George, Acquah (2008). *Horticulture: Principles and Practices*, 4th Ed. PHI Learning private Ltd. New Delhi, India.
23. Thompson AK. 1995. *Post Harvest Technology of Fruits and Vegetables*. Blackwell Sci.
24. Verma, L.R. and Joshi, V.K 2000. *Post harvest Technology of Fruits and vegetables: Handling, Processing, Fermentation and Waste Management*. Indus Publ. Co.

Course Code: BO-525(B)		
Course Title: Green House Technology		
Course Code: BO-525(B)	Course Type: Elective Course (DSE-8)	
Course Title: Green House Technology	Type: Theory	
Total Contact Hours: 60	Course Credits: 04	
College Assessment (CA) Marks: 40	University Assessment (UA): 60	
Course Objectives:		
<ol style="list-style-type: none"> 1. To learn the significance and Utilization of Green House 2. To Understand the method of construction and maintenance of Green House 3. To learn the Methods of Production of Vegetables and Flowers in Green House. 		
Course Outcomes:		
<ol style="list-style-type: none"> 1. Students know the applications, utilization, construction and maintenance of Green House. 2. Students acquaint the methods of production and maintenance of vegetables and flowers in Green House. 3. Learn the cultivation practices of vegetable and flowers. 		
Course Content		
Unit 1	Green House an Artificial House for Plants	12 L
	<ol style="list-style-type: none"> 1.1 Introduction, Definition, Scope and Importance of Green House 1.2 Origin and Development of Green House Industry 1.3 Advantages of Green House 1.4 Types of Green Houses: Based on Shape, Based on Utility, Based on Construction, Based on Covering Material. 1.5 Green House Construction: Location, Climate, Doors, Working Rooms, Ventilation, Temperature, Humidity, Heating, Cooling, Watering 	
Unit 2	Root Media	12 L
	<ol style="list-style-type: none"> 2.1 Soil: Texture, Water Holding Capacity, Porosity, Permeability, PH 2.2 Manures and Composting: FYM, Green Manuring, Organic Manuring, 2.3 Meat Meal, Blood Meal, Fish Meal, Horn and Hoof Meal Nutrient Solutions for Growth Media. 2.4 Macro-Micro Nutrition. 2.5 Molar, Normal PPM concept. 	
Unit 3	Various Types of Cultures	12 L
	<ol style="list-style-type: none"> 3.1 Water Culture: Nutritional Aspects, Physical Aspects, Plant Support, Unit Construction, Commercial Use, Unit Operation 3.2 Sand Culture: Nutrient Aspects, Physical Aspect, Unit Construction, Bed Construction, Commercial Use, Transplanting, Water application, Drip Culture, Dry Salt Culture 3.3 Gravel Culture: Media Characteristics, Unit Construction, Construction details, General Design, Commercial Use, Unit 	

	Operations	
Unit 4	<p>Production Technology</p> <p>4.1 Vegetables cultivation techniques - Introduction – Varieties – Nursery preparation – Soil – Climate – Field preparation – Season and planting –Irrigation and weed management – Nutrient and fertilizer management – Harvesting – Postharvest management of Tomato, <i>Capsicum</i>, Cucumber, Cauliflower, Broccoli.</p> <p>4.2 Flowers cultivation techniques - Introduction – Varieties – Nursery preparation – Soil – Climate – Field preparation – Season and planting – Irrigation and weed management – Nutrient and fertilizer management – Harvesting – Postharvest management of <i>Gerbera</i>, Rose, <i>Chrysanthemum</i></p>	12 L
Unit 5	<p>Pest Disease Management</p> <p>5.1 Pesticide</p> <p>5.2 Insecticide</p> <p>5.3 Nematicide</p> <p>5.4 Fungicide</p> <p>5.5 Fumigants</p> <p>5.6 Weed Control</p> <p>5.7 Biological Control</p>	12 L
<p>Suggested Readings:</p> <ol style="list-style-type: none"> 1. Mathur, A. M., S. C. Kaushik and Surendra Kothari (2006) Green House Science and Technology. Himanshu Publication, New Delhi 2. Nicolas Castilla (2013) Green House Technology Management CABI, New York 3. Ojha, T. P. and A. M. Michel (2021) Principles of Agricultural Engineering, Balaji Offset Printers, New Delhi 4. Prasad S. and V. Kumar (1999) Green House Management for Horticultural Crops, Agribios, India. 5. Sharma A. K. and V. M. Salokhi (2008) Green House Technology and Application 6. Sutar R. F. (2020) Design and Maintenance of Green House, Agrimoon.com 7. Taft L. R. (2021) Green House Management Forcing of Flowers, Vegetables and Fruits. Biotech Publisher, New Delhi. 		

Course Code: BO-525(C)		
Course Title: Green Belt and Green Credit		
Course Code: BO-525(C)	Course Category: Core Course (DSE-8)	
Course Title: Green Belt and Green Credit	Type: Theory	
Total Contact Hours: 60	Course Credits: 04 (60 L)	
College Assessment (CA) Marks: 40	University Assessment (UA): 60	
Course Objectives:		
<ol style="list-style-type: none"> 1.To understand the concepts of green belt and green credit and its principles 2.To provide adequate knowledge of plant-pollutant interactions and their adverse impacts. 3.To learn about the Green Belt development, design, and regulatory provisions in India. 4.To understand the basic guidelines and their effective role in environmental protection and combating climate change. 		
Course Outcomes:		
<ol style="list-style-type: none"> 1. Get familiar with the basic concepts of green belt development, design and need in the urban setup. 2. Apply principles of green belt development in smart city planning and management. 3. Evaluate the impact of urban pollutants on green belts and smart city ecosystems. 4. Identify and recommend technological solutions for smart city green belt development and monitoring. 		
Course Content		
Unit 1	Introduction to Green Belts	12 L
	<ol style="list-style-type: none"> 1.1 Introduction of green belts: Definition, concept, Historical background of green belts. 1.2 Green Belt Movement, Principle, Need and Importance, Purposes, Challenges and Scope. 1.3 Green Belt control on Environment protection and climate. 1.4 Characteristics of smart cities and role of green belts in smart city development. 1.5 Advantages and Disadvantages of green belts. 1.6 Future Challenges for Green Belt Development 	
Unit 2	Design and Implementation of Green Belts.	12 L
	<ol style="list-style-type: none"> 2.1 Theoretical models for green belt development. 2.2 Site selection criteria for green belts. 2.3 Seedling preparation, Plantation techniques, Roadside plantation & around periphery of reservoir, Plantation precaution. 2.4 Selection of Plants for Green Belt and biodiversity enhancement. 2.5 Maintenance and management of green belts. 2.6 Factors affecting green belt development 	
Unit 3	Ecological Importance of Green Belts	12 L
	<ol style="list-style-type: none"> 3.1 Biodiversity conservation and habitat preservation in green belts. 3.2 Role of green belts in mitigating climate change and promoting ecosystem services. 	

	<p>3.3 Functions of green belts in promoting urban resilience and reducing environmental risks.</p> <p>3.4 Ecological restoration techniques and practices in green belt management.</p> <p>3.5 Monitoring and evaluation of ecological health and biodiversity in green belts.</p>	
Unit 4	<p>Introduction to Green Credit</p> <p>4.1 Introduction to the concept of green Credit, its principles and objectives of Green Credit.</p> <p>4.2 Historical background, Definition and significance of Green Credit.</p> <p>4.3 Green credit rules and its implementation.</p> <p>4.4 Activities Covered Under Green Credit.</p> <p>4.5 Mechanism of the Green Credit Programme</p> <p>4.6 The Economic Impact of Green Credit.</p> <p>4.7 Types of green credit schemes: carbon credit, biodiversity credit, water credit</p> <p>4.8 Significance of the Green Credit.</p>	12 L
Unit 5	<p>Green credit activities</p> <p>5.1 Waste Management and Air Pollution Reduction based Green Credit</p> <p>5.2 Tree Plantation- based, Water based and Sustainable Agriculture based green credit</p> <p>5.3 Mangrove conservation and restoration based green credit</p> <p>5.4 Eco mark based Green Credit</p> <p>5.5 Sustainable building and infra based green credit</p>	12 L

Suggested Readings:

1. Acharya N.K. (2001) Textbook on intellectual property rights, Asia Law House.
2. Amati, M. (2016). Urban green belts in the twenty-first century, Routledge. A Compendium on Law and Policies, Daya Publishing House, New Delhi.
3. Burnwal, K., Jagwani, D. (2013). Air Pollution Abatement through Trees & Green Belt Development. LAP Lambert Academic Publishing.
4. Carter-Whitney, M. and Esakin, T.C. (2010) Ontario's greenbelt in an international context. Toronto, ON, Canada: Canadian Institute for Environmental Law and Policy.
5. CPCB (2000). Guidelines for Green Belt development, CPCB, MoEF, Gol, New Delhi.
6. CPCB (2007). Phytoremediation of particulate matter from ambient environment through dust capturing plant species, Central Pollution Control Board and Ministry of Environment and Forest.
7. CPCB (2019). Amended Guidelines on the provision of Buffer Zone around waste processing and disposal facilities, Central Pollution Control Board.
8. Ganguli P. (2001) Intellectual Property Rights: Unleashing the Knowledge Economy,
9. Gopalakrishnan N.S. and Agitha T.G. (2009) Principles of Intellectual Property
10. Guru M. and Rao M.B. (2003) Understanding Trips: Managing Knowledge in IUCN (2019). Best Practice Guidelines for the Establishment of Coastal Greenbelt, Green Coast, Shrilanka: 2007

11. Masters, G.M. (2004) Introduction to environmental engineering and science, Prentice Hall.
12. Miller A.P. and Davis M.H. 2000. Intellectual Property: Patents, Trademarks and MoEFCC (2023). Gazette Notification of Ministry of Environment Forest and Climate Change on Green Credit published on 26th June 2023
13. NITI Aayog (2023). Thinking for our planet, Lifestyle for Environment (LiFE), NITI Aayog, Govt of India
14. Parulekar A. and D' Souza S. (2006) Indian Patents Law – Legal & Business
15. Poneke, M.H.K. (2019) Outer Green Belt Management Plan, New Zealand.
16. Saha R. (2006) Intellectual Property Rights in NAM and Other Developing Countries:
17. Santra, S.C. (2001) Environmental Science. New Central Book Agencies, Pvt., Ltd.
18. Sturzaker, J. and Mell, I. (2016) Green Belts: Past; Present; Future?. United
19. V. Vijay Kumar, S. Swathy, R. Radhika, M.A. Fasi Khan and Dr. B. Chakradhar (2019). Green Belt Requirement for New and Expansion Projects for obtaining Environmental Clearance in India.
20. Wadehra B.L. (2000) Law Relating to Patents, Trade Marks, Copyright, Designs &
21. Watal J. (2001) Intellectual property rights in the WTO and developing countries.
22. <https://www.deccanherald.com/opinion/green-credit-programme-an-opportunity-and-a-challenge-2802010>
23. <https://www.metacorp.in/challenges-faced-in-green-credits-program-landscape-with-solutions>
24. <https://www.centreforcities.org/reader/benefits-challenges-green-belt/>

Course Code: BO-526	
Course Title: Research Project	
Course Code: BO-526	Course Category: Research Project (RP)
Course Title: Research Project	Type: Theory
Total Contact Hours: 60	Course Credits: 06
College Assessment (CA) Marks: 60	University Assessment (UA): 90
<p>Course Objectives:</p> <ol style="list-style-type: none"> 1. To provide training in scientific skills. 2. To prepare students for professional training programme or entry level jobs in any area of Botany. <p>Course Outcomes:</p> <p>At the end of the project, students should have acquired capabilities to</p> <ol style="list-style-type: none"> 1. Student thinks critically in acquiring knowledge surveying literature 2. Able to collect information and be familiar with methods in designing and executing experiments 3. Able to pursue data collection and entrain themselves in interpreting of data of from their scientific experiments 4. Student would have grown in their ability to design, analyze and execute an experiment and eventually 5. Student brim with confidence and ability in communication skills, both in writing and in-articulation. 	
Course Content	
Chapter 1	Introduction The title of Chapter 1 shall be Introduction. It shall justify and highlight the problem posed, define the topic and explain the aim and scope of the work presented in the dissertation. It may also highlight the significant contributions from the investigation.
Chapter 2	Review of Literature This shall normally form Chapter 2 and shall present a critical appraisal of the previous work published in the literature pertaining to the topic of the investigation.
Chapter 3	Material and Methods This chapter deals with a detail methodology by which researcher used to collect/ synthesize the data.
Chapter 4	Results and Discussions This shall form the penultimate chapter of the dissertation and shall include a thorough evaluation of the investigation carried out and bring out the

	contributions from the study. The discussion shall logically lead to inferences and conclusions as well as scope for possible further future work.
Chapter 5	<p>Summary and Conclusions</p> <p>This will be the final chapter of the dissertation. A brief report of the work carried out shall form the first part of the Chapter. Conclusions derived from the logical analysis presented in the results and discussions chapter shall be presented and clearly enumerated, each point stated separately. Scope for future work should be stated lucidly in the last part of the chapter.</p>
Chapter 6	<p>References/Bibliography</p> <p>The candidates shall follow the style of citation and style of listing in one of the standard journals in the subject area consistently throughout his/her dissertation (mentioned below). However, the names of all the authors along with their initials and the full title of the article/monogram/book etc. have to be given in addition to the journals/publishers, volume, number, pages(s) and year of publication. Citation from websites should include the names(s) of author(s) (including the initials), full title of the article, website reference and when last accessed. Reference to personal communications, similarly, shall include the author, title of the communication (if any) and date of receipt. The example is given below:</p> <p>For journal: Ojha SN, Tiwari D, Anand A, Sundriyal RC (2020) Ethnomedicinal Knowledge of a Marginal hill Community of Central Himalaya: Diversity, Usage Pattern, and Conservation Concerns. Journal of Ethnobiology and Ethnomedicine. 16: 29.</p> <p>For Chapter in book: Tewari LM, Tewari G, Chopra N, Tewari A, Pandey NC, Kumar M (2020) Phytochemical Screening and Antioxidant Potential of Some Selected Wild Edible Plants of Nainital District, Uttarakhand. In: Natural Products and their Utilization Pattern (Eds. Tewari G, Tewari A, Tewari LM). New York, NY: Nova Science Publishers, Inc. pp 71–97.</p> <p>For book: Chauhan NS (1999) Medicinal and Aromatic Plants of Himachal Pradesh. Indus Publishing Company, New Delhi.</p>
Chapter 7	<p>Appendix</p> <p>Detailed information, lengthy derivations, raw experimental observations etc. are to be presented in the separate appendices, which shall be numbered in Roman Capitals (e.g. “Appendix IV”). Since reference can be drawn to published/unpublished literature in the appendices, these should precede the “Literature Cited” section.</p>

Type -Setting, Text Processing and Printing

The text shall be printed employing using a standard text processor. The standard font shall be Times New Roman of 14 pts for headings and 12 pts for text with 1.5 line spacing.

Auxiliary

1. Binding:

Spiral or hard Binding

2. Front Covers:

The front covers shall contain the following details:

- Full title of desertation in 6 mm/22 point's size font properly centered and positioned at the top.
- Full name of the candidate in 4.5 mm 15 point's size font properly centered at the middle of the page.
- A 40 mm dia replica of the University emblem followed by the name of department, name of the University and the year of submission, each in a separate line and properly centered and located at the bottom of page.

3. Blank Sheets:

In addition to the white sheets (binding requirement) two white sheets shall be put at the beginning and the end of the dissertation.

4. Title Sheet:

This shall be the first printed page of the thesis and shall contain the submission statement: the dissertation submitted in partial fulfillment of the requirements of the Degree e.g. M.Sc., the name and enrollment No. of the candidate, name(s) of the Supervisor and Co- supervisor (s) (if any), Department, University and year of submission. Sample copy of the 'Title Sheet' is enclosed (Annexure I)

5. Dedication:

Sheet If the candidate so desires(s) he may dedicate his/her dissertation, which statement shall follow the title page. If included, this shall form the page 1 of the auxiliary sheets but shall not have a page number.

6. A Declaration of Academic Honesty and Integrity by Candidate:

A declaration of Academic honesty and integrity is required to be included along with every thesis/dissertation after the Supervisor's certificate. The format of this declaration is given in Annexure 'II' attached.

7. Certificate from Candidate/Supervisor and Convener (Annexure 'III'):

8. Abstract:

The 500 word (maximum) abstract shall highlight the important features of the dissertation. The abstract in the dissertation, however, shall have two more parts, namely, the layout of the dissertation giving a brief chapter- wise description of the work and the key words.

9. Contents:

The contents shall follow the abstract and shall enlist the titles of the chapters, section and sub-section using decimal notation, as in the text, with corresponding page number against them, flushed to the right. Two separate lists of figure captions and table titles along with their numbers and corresponding page numbers against them shall follow the contents.

10. Abbreviation Notation and Nomenclature:

A complete and comprehensive list of all abbreviations, notations and nomenclature including Greek alphabets with subscripts and superscripts shall be provided after the list of tables and figures.

Assessment:

Dissertation submission by the students would be assessed both by external and internal examiner during end semester university practical examinations.