


CIRCULAR NO.SU/Sci. & Tech./Colleges./NEP/16/2023

It is hereby inform to all concerned that, the syllabi prepared by the Board of Studies & Ad-hoc Boards and recommended by the Dean, Faculty of Science & Technology, the Hon'ble Vice-Chancellor has accepted **the following curriculum of All Post Graduate Degree Courses as per Norms of National Education Policy – 2020 under the Faculty of Science & Technology run to the Affiliated Colleges, Dr.Babasaheb Ambedkar Marathwada University** in his emergency powers under section 12(7) of the Maharashtra Public Universities Act, 2016 on behalf of the Academic Council as appended herewith.

Sr.No.	Syllabi of Affiliated BAMU, Aurangabad.	Semester
1.	M.Sc.Zoology	Ist and IInd Semester
2.	M.Sc.Microbiology	Ist and IInd Semester
3.	M.A/M.Sc.Mathematics	Ist and IInd Semester
4.	M.Sc.Geology	Ist and IInd Semester
5.	M.Sc.Biophysics	Ist and IInd Semester
6.	M.Sc.Bioinformatics	Ist and IInd Semester
7.	M.Sc. Information Technology	Ist to IVth Semester
8.	M.Sc.Computer Science	Ist to IVth Semester
9.	M.Sc.Botany	Ist and IInd Semester
10.	M.Sc.Environmental Science	Ist and IInd Semester

This is effective from the Academic Year 2023-24 and onwards.

All concerned are requested to note the contents of this circular and bring the notice to the students, teachers and staff for their information and necessary action.

University Campus,
Aurangabad-431 004.

REF.NO.SU/NEP/2023/ 8752-60

Date:- 08.08.2023.

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*Deputy Registrar,
Academic Section*

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- 2] **The Director, University Network & Information Centre, UNIC, with a request to upload this Circular on University Website.**

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**Dr. BABASAHEB AMBEDKAR MARATHWADA UNIVERSITY,
AURANGABAD**



FACULTY OF SCIENCE & TECHNOLOGY

2 Years P. G. Programme in Science

(M. Sc.)

For Other Centers (Affiliated Colleges & Institutes)

As per National Education Policy – 2020

(To be implemented from Academic Year 2023 – 2024)


Course structure and Curriculum

(Outcome Based Credit System)

Subject: BOTANY

(Effective from 2023 – 2024)


Dean
Faculty of Science & Technology
Dr. Babasaheb Ambedkar Marathwada
University, Aurangabad


Prof. Dr. ARVIND S. DHABE
Chairman
Board of Studies in Botany,
Dr. Babasaheb Ambedkar Marathwada University

DR. BABASAHEB AMBEDKAR MARATHWADA UNIVERSIT, AURANGABAD

M. Sc. BOTANY SYLLABUS FOR OTHER CENTRES AS PER NEP-2020

Illustrative Credit-distribution structure for Two year P. G. programme with Multiple Entry and Exit option

Class: M. Sc. I year

Semester: I Semester

Course Type	Course Code	Course Name	Teaching Scheme (Hrs./Week)		Credits Assigned		Total Credits	Scheme of Examination							
			Theory	Practical	Theory	Practical		Theory Maximum Marks 75	Practical Maximum Marks 25	CA 40%	SEE 60%	SEE 60%			
Major Mandatory DSC	BOT/MJ/OC/500	Cell and Molecular Biology	3	-	3	-	14	30	45						
	BOT/MJ/OC/501	Biology & Diversity of Algae and Bryophytes	3	-	3	-		30	45						
	BOT/MJ/OC/502	Taxonomy of Angiosperms	3	-	3	-		30	45						
	BOT/MJ/OC/503	Practical based on BOT/MJ/OC/500 Cell and Molecular Biology	-	2	-	1					10	15			
	BOT/MJ/OC/504	Practical based on BOT/MJ/OC/501 Biology & Diversity of Algae and Bryophytes	-	2	-	1					10	15			
	BOT/MJ/OC/505	Practical based on BOT/MJ/OC/502 Taxonomy of Angiosperms	-	2	-	1					10	15			
	BOT/MJ/OC/506	Horticulture Techniques	-	4	-	2					20	30			
	BOT/DSE/OC/507	Crop Genetics and Plant Breeding - I	3	-	3	-		4	30	45					
	BOT/DSE/OC/508	Practical based on BOT/DSE/OC/507 Crop Genetics and Plant Breeding - I	-	2	-	1						10	15		
		OR													
BOT/DSE/OC/509	Mycology and Plant Pathology-I	3	-	3	-	30	45								
BOT/DSE/OC/510	Practical based on BOT/DSE/OC/509 Mycology and Plant Pathology-I	-	2	-	1				10	15					
	OR														
BOT/DSE/OC/511	Taxonomy of Angiosperms - I	3	-	3	-	30	45								
BOT/DSE/OC/512	Practical based on BOT/DSE/OC/510 Taxonomy of Angiosperms - I	-	2	-	1										
	OR														
BOT/DSE/OC/513	Advanced Plant Physiology and Biochemistry - I	3	-	3	-	30	45								
BOT/DSE/OC/514	Practical based on BOT/DSE/OC/513 Advanced Plant Physiology and Biochemistry - I	-	2	-	1										
	OR														
BOT/DSE/OC/515	Plant Diversity and Conservation - I	3	-	3	-	30	45								
BOT/DSE/OC/516	Practical based on BOT/DSE/OC/513	-	2	-	1										

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	Plant Diversity and Conservation -I												
	OR												
	BOT/DSE/OC/517	Seed Technology -I	3	-	3	-					30	45	
	BOT/DSE/OC/518	Practical based on BOT/DSE/ OC/517 Seed Technology -I	-	2	-	1							15
RM	BOT/RM/OC/549	Research Methodology	4	-	4	-					40	60	
			16	12	16	06							
													22
													CREDITS

Class: M. Sc. I year

Semester: II Semester

Course Type	Course Code	Course Name	Teaching Scheme (Hrs./Week)		Credits Assigned		Total Credits	Scheme of Examination			
			Theory	Practical	Theory	Practical		Theory Maximum Marks 75	Practical Maximum Marks 25	SEE	
Major Mandatory DSC	BOT/MJ/OC/550	Cytology and Genetics	3	-	3	-	14	30	45	SEE	50%
	BOT/MJ/OC/551	Plant Development and Reproduction	3	-	3	-		30	45		
	BOT/MJ/OC/552	Biology and Diversity in Fungi and Microbes	3	-	3	-		30	45		
	BOT/MJ/OC/553	Practical based on BOT/MJ/550 Cytology and Genetics	-	2	-	1				10	15
	BOT/MJ/OC/554	Practical based on BOT/MJ/551 Plant Development and Reproduction	-	2	-	1				10	15
	BOT/MJ/OC/555	Practical based on BOT/MJ/552 Biology and Diversity in Fungi and Microbes	-	2	-	1				10	15
	BOT/MJ/OC/556	Botanical Techniques	-	4	-	2				20	30
	BOT/DSE/OC/557	Crop Genetics and Plant Breeding - II	3	-	3	-	4	30	45		
	BOT/DSE/OC/558	Practical based on BOT/DSE/557 Crop Genetics and Plant Breeding - II	-	2	-	1					10
			OR								
	BOT/DSE/OC/559	Mycology and Plant Pathology-II	3	-	3	-	30	45			
	BOT/DSE/OC/560	Practical based on BOT/DSE/559 Mycology and Plant Pathology-II	-	2		1				10	15
		OR									
	BOT/DSE/OC/561	Taxonomy of Angiosperms - II	3	-	3	-	30	45			
	BOT/DSE/OC/562	Practical based on BOT/DSE/561 Taxonomy of Angiosperms - II	-	2	-	1				10	15
		OR									
	BOT/DSE/OC/563	Advanced Plant Physiology and Biochemistry -II	3	-	3	-	30	45			
	BOT/DSE/OC/564	Practical based on BOT/DSE/563	-	2	-	1				10	15

Course Type	Course Code	Course Name	Teaching Scheme (Hrs./Week)		Credits Assigned		Total Credits	Scheme of Examination	
			Theory	Practical	Theory	Practical		Theory Maximum Marks 75	Practical Maximum Marks 25
		Advanced Plant Physiology and Biochemistry –II							
		OR							
	BOT/DSE/OC/565	Plant Diversity and Conservation – II	3	-	3	-		30	45
	BOT/DSE/OC/566	Practical based on BOT/DSE/ 565 Plant Diversity and Conservation - II	-	2	-	1			10
		OR							
	BOT/DSE/OC/567	Seed Technology – II	3	-	3	-		30	45
	BOT/DSE/OC/568	Practical based on BOT/DSE/ 567 Seed Technology – II	-	2	-	1			10
RM	BOT/FP/OC/599	OJT/ Field Project/ Internship	-	8	-	4	04		40
			12	20	12	10	22		
							CREDITS		

Class: M. Sc. II year Semester: III Semester

Course Type	Course Code	Course Name	Teaching Scheme (Hrs./Week)		Credits Assigned		Total Credits	Scheme of Examination		
			Theory	Practical	Theory	Practical		Theory Maximum Marks 75	Practical Maximum Marks 25	SEE CA 50%
Major Mandatory DSC	BOT/MJ/OC/600	Biology and Diversity of Pteridophytes and Gymnosperms	3	-	3	-		30	45	
	BOT/MJOC/601	Plant Ecology and Conservation	3	-	3	-	14	30	45	
	BOT/MJ/OC/602	Plant Biotechnology	3	-	3	-		30	45	
	BOT/MJ/OC/603	Practical based on BOT/MJ/OC/600 Biology and Diversity of Pteridophytes and Gymnosperms	-	2	-	1				10
	BOT/MJ/OC/604	Practical based on BOT/MJ/OC/601 Plant Ecology and Conservation			2	1				10
	BOT/MJ/OC/605	Practical based on BOT/MJ/OC/602 Plant Biotechnology	-	2	-	1				10
DSE (Choose any one from pool of courses)	BOT/MJ/OC/606	Industrial Technology	-	4	-	2			20	30
	BOT/DSE/OC/607	Crop Genetics and Plant Breeding – III	3	-	3	-	4	30	45	
	BOT/DSE/OC/608	Practical based on BOT/DSE/607 Crop Genetics and Plant Breeding - III	-	2	-	1				10
		OR								
	BOT/DSE/OC/609	Mycology and Plant Pathology-III	3	-	3	-				
	BOT/DSE/OC/610	Practical based on BOT/DSE/OC/609 Mycology and Plant Pathology-III	-	2	-	1		30	45	10
										15

Course Code	Course Name	Teaching Scheme (Hrs./Week)		Credits Assigned		Total Credits	Scheme of Examination		
		Theory	Practical	Theory	Practical		Theory Maximum Marks 75	Practical Maximum Marks 25	SEE
BOT/DSE/OC/611	Taxonomy of Angiosperms – III	3	-	3	-	22 CREDITS	30	45	15
BOT/DSE/OC/612	Practical based on BOT/DSE/OC/611 Taxonomy of Angiosperms – III	-	2	-	1				
	OR								
BOT/DSE/OC/613	Advanced Plant Physiology and Biochemistry – III	3	-	3	-		30	45	15
BOT/DSE/OC/614	Practical based on BOT/DSE/OC/613 Advanced Plant Physiology and Biochemistry – III	-	2	-	1				
	OR								
BOT/DSE/OC/615	Plant Diversity and Conservation - III	3	-	3	-		30	45	15
BOT/DSE/OC/616	Practical based on BOT/DSE/OC/615 Plant Diversity and Conservation - III	-	2	-	1				
	OR								
BOT/DSE/OC/617	Seed Technology – III	3	-	3	-		30	45	15
BOT/DSE/OC/618	Practical based on BOT/DSE/OC/617 Seed Technology – III	-	2	-	1				
RP	OJT/ Field Project/ Internship	-	8	-	4				
		12	20	12	10				

Class: M. Sc. II year Semester: IV Semester

Course Type	Course Code	Course Name	Teaching Scheme (Hrs./Week)		Credits Assigned		Total Credits	Scheme of Examination		
			Theory	Practical	Theory	Practical		Theory Maximum Marks 75	Practical Maximum Marks 25	SEE
Major Mandatory DSC	BOT/MJ/OC/650	Bioprospecting and Plant Resource Utilization	3	-	3	-	14	30	45	15
	BOT/MJ/OC/651	Pharmacognosy	3	-	3	-		30	45	15
	BOT/MJ/OC/652	Plant Physiology and Metabolism	3	-	3	-		30	45	15
	BOT/MJ/OC/653	Practical based on BOT/MJ/OC/650 Bioprospecting and Plant Resource Utilization	-	2	-	1				
	BOT/MJ/OC/654	Practical based on BOT/MJ/OC/651 Pharmacognosy	-	2	-	1				
	BOT/MJ/OC/655	Practical based on BOT/MJ/OC/652 Plant Physiology and Metabolism	-	2	-	1				
	BOT/MJ/OC/656	Genetic Engineering and Bioinformatics	-	4	-	2				

DSE (Choose any one from pool of courses)	BOT/DSE/OC/657 BOT/DSE/OC/658	Crop Genetics and Plant Breeding – IV Practical based on BOT/DSE/OC/657 Crop Genetics and Plant Breeding - IV OR	3	-	2	3	-	1	4	30	45	10	15
	BOT/DSE/OC/659 BOT/DSE/OC/660	Mycology and Plant Pathology-IV Practical based on BOT/DSE/OC/659 Mycology and Plant Pathology-IV OR	3	-	2	3	-	1		30	45	10	15
	BOT/DSE/OC/661 BOT/DSE/OC/662	Taxonomy of Angiosperms – IV Practical based on BOT/DSE/OC/661 Taxonomy of Angiosperms – IV OR	3	-	2	3	-	1		30	45	10	15
	BOT/DSE/OC/663	Advanced Plant Physiology and Biochemistry –IV	3	-	3	3	-	-		30	45		
	BOT/DSE/OC/664	Practical based on BOT/DSE/OC/663 Advanced Plant Physiology and Biochemistry –IV OR	-	2	-	-	1	1				10	15
	BOT/DSE/OC/665 BOT/DSE/OC/666	Plant Diversity and Conservation – IV Practical based on BOT/DSE/ OC/665 Plant Diversity and Conservation- IV OR	3	-	2	3	-	1		30	45	10	15
	BOT/DSE/OC/667 BOT/DSE/OC/668	Seed Technology – IV Practical based on BOT/DSE/ OC/667 Seed Technology – IV	3	-	2	3	-	1		30	45	10	15
RP	BOT/FP/ 699	FP	-	8	-	-	4	4	04			40	60
			12	20	12	10	22	CREDITS					

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M. Sc. BOTANY SYLLABUS FOR OTHER CENTRES AS PER NEP-2020

Illustrative Credit distribution structure for Two year P. G. Programme with Multiple Entry and Exit option

Class: M. Sc. I year

Semester: I Semester

Course code: BOT/MJ/OC/500

Course name: CELL AND MOLECULAR BIOLOGY

Course type: Major Mandatory Discipline Specific Course

Credits: 3, Contact Hours: 45 clock hours, 3 hours/ week

Marks: 75, Internal assessment: 30, External assessment: 45

Unit I Cell Membrane

- i) The fundamental structure of cell
- ii) Plasma membrane: Molecular organization, current models and functions. Cell wall architecture, biosynthesis, assembly, growth and cell expansion.
- iii) Plasmodesmata: Structure and role in movement of molecules and macromolecules

Unit II Cell Organelles

- i) Chloroplast and Mitochondria: Ultrastructure, function and biogenesis. The organization of genome and patterns of gene expression.
- ii) Vacuoles: Tonoplast membrane, ATPases, transporters, as storage organelle.

Unit III Other Cellular Organelles

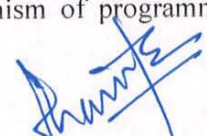
- i) Structure and functions of microbodies, Golgi apparatus, Lysosomes and Endoplasmic reticulum.
- ii) Nucleus: Microscopic and submicroscopic organization. Structure and function of nuclear Envelope. The ultrastructure of nucleolus and its role in rRNA biosynthesis.
- iii) Ribosomes: Structure and site of protein synthesis. Mechanism of translation, details of initiation, elongation and termination. The structure and role of RNA.

Unit IV Cytoskeleton

- i) Organization and role of microtubules and microfilaments, Implications in flagellate and other movements.

Unit V Cell Cycle and its molecular aspects

- i) Control mechanism, the role of cyclin and cyclin dependent kinases, Retinoblastoma and E₂F proteins. Cytokinesis and cell plate formation. Mechanism of programmed cell death (Apoptosis) and Senescence.


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Suggested Readings for BOT/OC/500 Theory

1. Lewin, B. 2000, Genes VII, Oxford University Press, New York.
2. Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K. and Watson, J.D.I 1999. Molecular Biology of the cell. Garland Publishing, Inc. New York.
3. Wolfe, S. L. 1993. Molecular and cellular biology. Wodsworth publishing company, California, U.S. A.
4. De, D. N. 2000. Plant cell vacuoles. An introduction. CSIRO Publication, Collingwood, Australia.
5. Kleinsmith, I. J. and Kish, V.M. 1995. Principles of Cell and Molecular Biology (End Edition). Harper Collins College publishers, New York, U.S.A.
6. Lodish, H., Berk, A., Zipursky, S. Z., Matsudaira, P., Baltimore, D. and Darnell, J., 2000. Molecular Cell Biology. (4th Edition). W.H. Freeman and company, New York, U. S. A
7. Click, B. R. and Thompson, J. E. 1998. Methods in Plant Molecular biology and biotechnology. CRC Press, BOCA RBTON Florida.
8. Glover, D. M. and Hames, B. D. (Eds.) 1995. DNA cloning I :: A practical approach, Core techniques, first edition, TASIRL Press al Oxford University Press, Oxford.
9. Gunning B. E. S. and Steer, M. W. 1996. Plant cell biology, structure and function. Jones and Bartlet Publishers, Boston, Massachusetts.
10. Hackett, P. B., Funchs, J. A. and Messing, J. W. 1998. An Introduction to recombinant DNA techniques : Basic experiments in gene manipulation. The Benjamin Cummings Publishing Company, Inc. Memno Park, California.
11. Hall, J. L. and Moore, A. L. 1983. Isolation of membranes and organelles from plant cells. Academic Press, London, U.K,
12. Harris, N. and Opataks, K. J. 1994. Plant Cell Biology : A practical approach. IRL Press at Oxford University Press, Oxford, U.K.
13. Shaw, C. H. (Ed.) 1988. Plant Molecular Biology : A Practical Approach. IRL Press, Oxford.

Review Journals

1. Annual review of plant physiology and molecular biology.
2. Current advances in Plant Sciences.
3. Trends in Plant Sciences.
4. Nature reviews: Molecular and Cell Biology.

Course code: BOT/MJ/OC/501

Course name: BIOLOGY & DIVERSITY OF ALGAE AND BRYOPHYTES

Course type: Major Mandatory Discipline Specific Course

Credits: 3, Contact Hours: 45 clock hours, 3 hours/ week

Marks: 75, Internal assessment: 30, External assessment: 45

Unit I. i. Introduction and history of phycology with special reference to Indian work.
ii. Algae in diversified habitats (Terrestrial, fresh water, marine). Algal blooms.
iii. Criteria used in classification of algae, pigments, reserve food and flagella; and important systems of classification of algae.

Unit II. A general account of thallus organization, reproduction and life history of algae. Study of important groups of algae with reference to General account, cell structure and method of reproduction and their economic importance -

- a) **Cyanophyta:** *Nostoc*, *Oscillatoria*, *Rivularia* and *Spirulina*
- b) **Chlorophyta:** Volvocales (*Chlamydomonas*, *Volvox*), Oedogonials (*Oedogonium*, *Cladophora*), Zygnematales (*Spirogyra*, *Zygnema* and *Cosmarium*)
- c) **Xanthophyta:** *Botrydium* and *Vaucheria*.
- d) **Bacillariophyta:** *Pinnularia* and *Navicula*
- e) **Phaeophyta:** *Ectocarpus* and *Sargassum*.
- f) **Rhodophyta:** *Batracospermum* and *Polysiphonia*

Bryophytes:

Unit III. Characteristic features, classification, distribution, Habit and Habitat of Bryophytes.

Unit IV. External and internal morphology, reproduction, gametophytes and sporophytes, phylogeny and interrelationships of the orders:

- Sphaerocarpaceae, Takakiales, Marchantiales, Jungermanniales, Anthocerotales, Sphagnales, Andreales, Bryales.

Unit V. Bioprospecting of Algae and Bryophytes: BGA bio-fertilizers, Freshwater and Marine algae as food and fodder, Algae in industry. Role of algae in human welfare. Ecological and Economic importance of Bryophytes.

Suggested Readings on Biology & Diversity of Algae and Bryophytes

Algae:

1. Chapman V. J. & D. J. Chapman (1983). *The Algae*, The MacMillan Press Ltd., London.
2. Desikachary T. V. (1959) *Cyanophyta*, ICAR, New Delhi.
3. Fritsch F. E. (1961). *The Structure and Reproduction of the Algae*, Vol.I & H, Cambridge University Press, London.
4. Kumar H. D. (1988) *Introductory Phycology*, Affiliated East-West Press Pvt. Ltd., New Delhi.
5. Prescott G. W. (1969). *The Algae: A Review*, Thomas Nelson .and Sons Ltd., Melbourne.
6. Round F. E. (1981). *The Ecology of Algae*, Cambridge University Press, London.
7. Smith G. M. (1950). *The fresh water algae of the United states*, McGrawHill Hoc Co., New York.
8. Vijayraghavan & Sunita Kumari (1995). *Chlorophyta*, Bisen Singh Mahendra P. Singh, Dehra Dun.
9. Sharma O. P. (2018), *A text Book of Algae*, Tata Mc Graw Hill, New Delhi
10. Bilgrami, K. S. (2020), *A text Book of Algae*,
11. Arunnam N., Ragland Anita and Kumarion N, (2018), *Fundamentals of Algae and Bryophytes*, Saras Publication, Tamil Nadu
12. Samba Murty A. V. S. S. (2020), *A text book of Algae*, Wiley Publication, New Delhi

Bryophytes:

1. Smith (1955) *Cryptogamic Botany I & II*, McGraw-Hill, New York.
2. Prem Puri (1980) *Bryophytes*, Atmaram& Sons, Delhi.
3. Parihar N. S. (1991) *Bryophytes*, Central Book Dept., Allahabad.
4. Verdorn - (1932) *Manual of Bryology*, The Hegue.
5. Bower P. O. (1935) *Primitive; land Plants*, Macmillan and Co., London.
6. Campbell (1940) *Evolution of land Plants*, Stanford University Press.
7. Kashyap S. R. (1929, 1932), *Liverworts of Western Himalays and the Pan); plain*, Vol. I & II, The University of Punjab, Lahore.
8. Tewari, Shiv Datt and GiriBala Pant (2005) *Bryophytes of Kumaun Himalaya*. Publisher- Bhisnan Singh Mahendra Pal Singh- Dehradun.

Course code: BOT/MJ/OC/ 502

Course name: TAXONOMY OF ANGIOSPERMS

Course type: Major Mandatory Discipline Specific Course

Credits: 3, Contact Hours: 45 clock hours, 3 hours/ week

Marks: 75, Internal assessment: 30, External assessment: 45

UNIT- I: Angiosperms: Definition, its characteristic features and probable causes of their evolutionary success. Taxonomy: Definition, scope, principles, aims and objectives and functions of taxonomy. Phases of plant classification.

Phylogeny of Angiosperms: A general account of origin of Angiosperms with reference to time and place and possible ancestors: Euanthial theory (Bennettitales, Caytoniales, Gnetales, Cycadales) and Pseudanthial theory (Pentoxylales, Pteridospermales, Glossopteridales).

UNIT- II: Categories of classification – Major, Minor and Infra-specific categories; Species Concepts, Speciation, Causes of variations in population. Brief history on account of artificial, natural, phylogenetic systems of classifications with special reference to Bentham and Hooker, Cronquist's system, Takhtajan's system and Broad outline of APG IV (2016) system of classification and its merits and demerits.

UNIT-III: Botanical Nomenclature: Concept of nomenclature, Binomial nomenclature and its advantages, formation of code, Melbourne Code 2012, Shenzhen Code 2018, Principles of International Code of Nomenclature of Algae, Fungi and Plants (ICN), ending of taxa names, Typification.

UNIT-IV: Taxonomic evidences: Morphology, anatomy, embryology, palynology, cytology, phyto-chemistry and numerical taxonomy. Taxonomic tools: Serological and molecular techniques, GIS, GPS, Use of computers in angiosperms taxonomy (Use of computer and data bases for identification of plants with the help of websites). Herbarium Techniques, Major herbaria of the World and India. Contributions of Herbarium BAMU.

UNIT-V: Angiosperm Families: Nymphaeaceae, Hydatellaceae, Magnoliaceae, Papaveraceae, Malvaceae, Leguminaceae, Sapotaceae, Apiaceae, Asteraceae, Rutaceae, Apocynaceae, Solanaceae, Liliaceae, Arecaceae and Poaceae.

Suggested Readings

1. Cole, A. J. 1969. Numerical Taxonomy. Academic Press. London.
2. Davis, P. H. and Heywood, V. H. 1973. Principles of Angiosperms Taxonomy. Robert E. Krieger Pub. Co. New York.
3. Daniel Mammen (2009) Taxonomy, Evolution at work, Narosa Publication, New Delhi.
4. Grant, V. 1971. Plant Speciation, Columbia, University Press, New York.
5. Grant, W. F. 1984. Plant Biosystematics, Academic Press, London.
6. Harrison, H . J. 1971. New concepts in Flowering Plant Taxonomy. Hieman Educational Book Ltd., London.
7. Heslop-Harrison, J. 1967. Plant Taxonomy. English Language Book Soc. & Edward Arnold Pub. Ltd. U. K.
8. Heywood, V. H. and Moore, D. M. 1984. Current Concepts in Plant Taxonomy, Academic Press, London.
9. Jones, A. D. and Wilbins, A. D. 1971. Variations and Adaptions in Plant species. Hieman & Co. Educational Ltd. London.
10. Jones S. B. Jr. & Luchsinger, A. E. 1986. Plant Systematics, (2nd Edition) McGraw-Hill Book Co. New York.
11. Naik V. N. (1989) Taxonomy of angiosperms, Tata Mc Graw Hill Co. Ltd. New Delhi
12. Naik V. N. (1998) Flora of Marathwada, Amrut Prakashan, Aurangabad
13. Radford, A. E. 1986 Fundamentals of Plant Systematics. Harper & Raw Publications, U.S.A.
14. Solbrig. O. T. & Solbrig D.J. 1979. Population Biology and Evolution. Addison Wesley Publication Co. Inc. U.S.A.
15. Stebbins, G. L. 1974 Flowering Plant- Evolution above Species Level. Edward Arnold Ltd., London.
16. Stace, C. A. 1989. Plant Taxonomy and Biosystematics. (2nd Edition) Edward Arnold,, London.
17. Takhtajan A. L. 1997. Diversity and Classification of Flowering Plants. Columbia University Press, New York.
18. Woodland D. W. 1991. Contemporary Plant Systematics. Prentice Hall, New Jersey

Course code: BOT/MJ/OC/503

(Practical based on BOT/MJ/OC/500)

Course name: Practical - CELL AND MOLECULAR BIOLOGY

Course type: Major Mandatory Discipline Specific Course

Credit: 1, Contact Hours: 30 clock hours, 2 hours/ week

Marks: 25, Internal assessment: 10, External assessment: 15

1. To determine mitotic Index in different plant materials.
2. Karyomorphological studies from slide/photograph.
3. Induction of mitotic abnormalities through chemical treatment.
4. Demonstration of SEM and TEM organelles.
5. Demonstration of acid phosphatases and succinic dehydrogenase activity in plants.
6. Demonstration of native and SDS PAGE profiles of seed proteins.
7. Isolation of plant DNA and its quantitation by spectrophotometric method.
8. Separation of plant RNA by Agarose gel electrophoresis and visualization by ethidium bromide staining,
9. Demonstration of Western blotting.
10. Estimation of seed proteins by Lowry's method.

Course code: BOT/MJ/OC/504

(Practical based on BOT/MJ/OC/501)

Course name:

Practical - BIOLOGY & DIVERSITY OF ALGAE AND BRYOPHYTES

Course type: Major Mandatory Discipline Specific Course

Credit: 1, Contact Hours: 30 clock hours, 2 hours/ week

Marks: 25, Internal assessment: 10, External assessment: 15

Algae :

1. Morphological study of algal forms: *Microcystis*, *Oscillatoria*, *Lyngbya*, *Nostoc*, *Anabaena*, *Scytonema*, *Tolypothrix*, *Rivularia*, *Gloeotrichia*, *Cahthrix*, *Chlamydomonas*, *Pandorina*, *Eudorina*, *Volvox*, *Hydrodictyon*, *Scenedesmus*, *Pedistruium*, *Ulothrix*, *Ulva*, *Odeogonium*, *Cladophora*, *Pithophora*, *Draparnaldia*, *Draparnidiopsis*, *Coleochaete*, *Cosmarium*, *Closterium*, *Caulerpa*, *Acetabularia*, *Chara*, *Nitella*, *Botrydium*, *Vaucheria*, *Pinnularia*, *Navicula*, *Fragillaria*, *Ectocarpus*, *Diciyota*, *Fucus*, *Batrachospermum*, *Polysiphonia*, *Corallina*.
2. Collection and submission of algae.

Bryophytes:

- i. Vegetative Organization- *Marchantia*, *Riccia*, *Anihoceros*, *Porella*, *Sphagnum*, *Polytrichum*.
- ii. Anatomical Organization: *Marchantia*, *Cyalhodhim*, *Anthoceros*, *Porella*, *Sphagnum*.
- iii. Archegonia and Antheridia and their Organization: *Riccia*, *Marchantia*, *Porella*, *Anthoceros*, *Sphagnum*.
- iv. Sporophytes: *Riccia*, *Marchantia*, *Pellia*, *Porella*, *Anthoceros*, *Funaria*, *Sphagnum*, *Polytrichum*.
- v. Collection and submission of Bryophytes.
- vi. Botanical excursion of about one week duration to any botanically rich location preferably outside the State.

Course code: BOT/MJ/OC/505

(Practicals Based on BOT/MJ/OC/502)

Course name: Practical - TAXONOMY OF ANGIOSPERMS

Course type: Major Mandatory Discipline Specific Course

Credit: 1, Contact Hours: 30 clock hours, 2 hours/ week

Marks: 25, Internal assessment: 10, External assessment: 15

1. Morphology: Terminologies related to Habit and life span, root, stem, leaves, inflorescence, Flower, fruits.
2. Phytophraphy: preparation of scientific botanical description of plant specimens.
3. Study of at least 20 locally available families of flowering plants.
4. Identification of genus and species of locally available wild plants.
5. Preparation of botanical keys at generic level by locating key characters.
6. Knowledge of at least 10 medicinal plant species.
7. Knowledge of food plants (Cereals, Pulses, Fruits, Vegetables, Spices and Condiments)
8. Demonstration of the utility for secondary metabolites in the taxonomy of some appropriate genera.
9. Field trips within and around the University Campus, compilation of field notes and preparation of herbarium sheets of plants.
10. Botanical excursion of about one week duration to any botanically rich location preferably outside the State.

Course code: BOT/MJ/OC/506

Course name: Practical - HORTICULTURE TECHNIQUES

Course type: Major Mandatory Discipline Specific Course

Credit: 2, Contact Hours: 60 clock hours, 4 hours/ week

Marks: 50, Internal assessment: 20, External assessment: 30

1. Horticulture : 1.1 Introduction, Definition, Scope and importance of Horticulture
1.2. Disciplines of Horticulture, i) Pomology ii) Olericulture iii) Floriculture
iv) Ornamental horticulture v) Landscape horticulture
2. Study of Garden tools and equipment: Sprayer, Duster, Pruning knife, Sprinkler.
3. Study of propagation requirement: i) Media ii) Containers iii) Potting
iv) Repotting Practicals
4. Study of propagation methods:
 - 4.1. Sexual Propagation: Advantages and Disadvantages, Various Scarification treatments to seed
 - 4.2. Asexual /Vegetative Propagation: Advantages and Disadvantages
 - 4.3. Natural methods of vegetative propagation: Bulb, Corm, Tuber, Rhizome, Runner, Offset, Sucker
5. Artificial methods of vegetative propagation **Cutting:**
 - a) Definition b) Types of Cutting: i) Stem cutting - Soft wood cutting and Hard wood Cutting ii) Leaf Cutting iii) Root Cutting
6. Artificial methods of vegetative propagation **Layering:**
 - a) Definition b) Types of Layering: i) Simple layering ii) Compound layering iii) Air layering/ Gootee
7. Artificial methods of vegetative propagation **Budding:**
 - a) Definition b) Types of Budding – i) Shield/T – Budding ii) Patch Budding
8. Artificial methods of vegetative propagation **Grafting:**
 - a) Definition b) Types of Grafting – i) Whip grafting ii) Tongue grafting
9. Preparation of preserved products: Mix fruit Jam, Papaya Jelly, Wood apple/Guava Jelly, Lemon/Orange Squash, Tomato ketchup
10. Visit to any one Nursery Unit, Commercial orchard and Fruit processing unit

REFERENCE BOOKS

1. Azad, K. C. and Sharma, V. K. (2000). Horticulture Technology (Vol. I&II). Deep and Deep Publications, New Delhi, India.
2. Bal, J. S. (1997). Fruit growing. Kalyani Publication, New Delhi, India.

3. Bose, T. (1996). Fruit tropical and Sub tropical. Naya Pracation , Calcutta, India.
4. 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.
5. Girdhari Lal., Siddhappa, G. S. and Tandon, G. L. (1998). Preservation of fruits and vegetables. ICAR New Delhi, India.
6. Hartmann, H. T. and Kester, D. E. (1989). Plant propagation principles and practice. Prentice Hall of India (P) Ltd. New Delhi, India.
7. Khan, M. R. (1995). Horticulture and Gardening. Nirali Prakashan, Pune, India.
8. Sen, S. (1992). Economic Botany. New Central Book Agency, Calcutta, India. 9. Sharma, N. K. and Arora, S. K. (1985). New Routes to increase Brinjal production. Fmr. Parlim 20 (6) 11 - 12.
10. Sharma, V. K. (2004). Advances in Horticulture. Deep and Deep Publications, New Delhi, India.
11. Sharma, V. K. (1999). Encyclopedia of Practical Horticulture.
12. Singh, V. B. (1990). Fruits of NE Region. Wiley Eastern Limited, New Delhi, India.
13. Sonane, H. N., Deore, B. P. and Patil, S. K. (1984). Vaishali (RHR 51) A High yielding Variety of Brinjal for Maharashtra. Journal of Maharashtra Agriculture Uni. 9(3):341-342
14. Vishnu Swarup (1997). Ornamental horticulture. Macmillan Ltd. New Delhi, India.
15. Reddy, Mallikarjun and Rao, Aparna (2010). Applied Horticulture. Pacific Book International, Delhi, India.
16. Sharaf, Sandhya (2012). Green House Management of Horticulture Crops. Oxford book Co. New Delhi, India.
17. Sharon Pastor Simson, Martha C. Straus (2010). Basics of Horticulture. Oxford Book Co. New Delhi, India.
18. George, Acquaah (2008). Horticulture: Principles and Practices, 4th Ed. PHI Learning private Ltd. New Delhi, India.

Course code: BOT/DSE/OC/507

Course name: Crop Genetics and Plant Breeding – I

Course type: Discipline Specific Elective Course

Credits: 3, Contact Hours: 45 clock hours, 3 hours/ week

Marks: 75, Internal assessment: 30, External assessment: 45

Unit I: Crop genetic resources:

Importance of genetic Conservation, Global network for genetic conservation and utilization in major crops of the world. Institutes engaged in conservation and improvement of crop genetic resources.

Unit II: Food supplies, nutrition and crop breeding:

World food situation, Nutritional problems, Nutritional objectives, Contribution of M. S. Swaminathan and H. Y. Mohan Ram

Unit III: Methods of plant breeding:

Introduction, selection, Pure line selection, W. L. Johansons experiments on beans and their significance, Variety acclimatization, genetic significance of pollination methods, methods of breeding self and cross pollinated crops and asexually and vegetatively propagated crops.

Unit. IV: Incompatibility in plant breeding:

Types, nature, characteristics genetic and biochemical basis, methods of induction and overcoming, incompatibility as a tool in breeding crops.

Unit. V: Male sterility and Back cross

- i. **Male sterility:** Definition and classification, Male sex expression and chemical Induction of male sterility, perspectives.
- ii. **Back cross:** Genetic basis, Methodology in selection to character under transfer, Transfer of two or more characters, Inter-varietal. Inter-specific and intergeneric transfer.

Course code: BOT/DSE/OC/508

(Practical based on BOT/DSE/OC/507)

Course name: Practical - Crop Genetics and Plant Breeding – I

Course type: Discipline Specific Elective Course

Credits: 1, Contact Hours: 30 clock hours, 2 hours/ week

Marks: 25, Internal assessment: 10, External assessment: 15

1. Study of floral biology of different crop plants.
2. Demonstration of hybridization technique in self and cross pollinated crops.
3. Study of pollen germination and demonstration of incompatibility.
4. Demonstration of male sterility in Jowar.
5. Study of pollen fertility.
6. Study of pollen viability.
7. Karyotype analysis in crop plants such as *Tradescantia*, *Rheo*, Maize, Onion
8. Aneuploid analysis in crop plants.

Suggested readings for BOT/DSE/OC/507 and BOT/DSE/OC/508

1. Plant Breeding - B. D. Singh.
2. Plant Breeding - J. R. Sharma.
3. An Introduction of plant breeding - H. K. Chaudhary.
4. Evolution of crop plants - Edited by Simmonds N. W (1986)
5. Breeding field crops - Poehlmann and Sleper.
6. Plant Breeding perspectives - Edited by Sheep and Mendnkasen.
7. Crop Breeding, P. B. Vose and S. G. Blixt
8. Genes, Chromosomes and Agriculture. Chrispels and Simmonds.
9. Principles of Genetics - Snusted and Simulants.
10. Manual of mutation breeding by FAO/IAEA.
11. Mutation Research -Aurebach.
12. Chemical mutagenesis - Fishbeiri *et al.*
13. Discussions in cytogenetics. Burnhan C. R. 1962
14. Genetics - Principles and analysis. Khush G. S. 1973
15. Genetics Principles and analysis. Haiti and Jones 1998
16. Molecular biology of the gene. Watson J. D. 1989

Course code: BOT/DSE/OC/509

Course name: Mycology and Plant Pathology-I

Course type: Discipline Specific Elective Course

Credits: 3, Contact Hours: 45 clock hours, 3 hours/ week

Marks: 75, Internal assessment: 30, External assessment: 45

UNIT - I

1. Introduction and History of Plant Pathology
2. Classification of plant diseases: Symptomology of Fungal, Bacterial, Viral and Phytoplasmal diseases.

UNIT - II

1. Plant diseases caused by phanerogamic plant parasite- *Loranthus*, *Orobanche*, *Striga* and *Cuscuta*.
2. Nematode diseases – Root knot of Tomato caused by *Meloidogyne*.
3. General account of post – harvest fungal diseases of food crops, fruits and vegetables and their management.

UNIT – III: Plant diseases caused by Bacteria, Viruses, Phytoplasma

a. Plant diseases caused by Bacteria

1. Citrus canker
2. Angular leaf spot of Cotton
3. Leaf spot of Mango
4. Gummosis of Sugarcane
5. Wilt of Tomato
6. Soft rot and Scab of Fruits.

b. Plant diseases caused by Viruses

1. Yellow vein of mosaic of Bhendi (YVMV)
2. Papaya leaf mosaic
3. Bunchy top of Banana
4. Tomato leaf curl virus (TLCV)
5. Bud necrosis of Groundnut
6. Bean common mosaic
7. Tobacco mosaic virus

UNIT – IV: Fungal Diseases of Cereals, Pulses and Oil Seeds

a. Cereals

1. Ergot of Bajra
2. Loose smut of Wheat
3. Karnal bunt of Wheat
4. Grain smut of Sorghum
5. Loose smut of Sorghum
6. Downy mildew of Bajra
7. Common smut of Maize
8. Leaf spot of Rice

b. Pulses and Oil Seeds

1. Pigeon pea wilt
2. Blight of Grams
3. Tikka disease of Groundnut
4. Rust of Groundnut
5. White rust of Mustard
6. Sunflower rust
7. Damping off of seedling

UNIT – V: Fungal diseases of Fruit, Vegetables and Cash Crops

a. Fruits

1. Downy mildew of Grapes
2. Powdery mildew of Grapes
3. Mango Anthracnose
4. Citrus Gummosis

b. Vegetables

1. Powdery mildew of Cucurbits
2. Leaf spot of Tomato
3. Leaf spot of Brinjal
4. Chili Die-back

c. Cash Crop

1. Whip smut of Sugarcane
2. Cotton wilt
3. Rhizome rot of Ginger
4. Red rot of Sugarcane

Course code: BOT/DSE/OC/510

(Practical based on BOT/DSE/OC/509)

Course name: Practical - Mycology and Plant Pathology-I

Course type: Discipline Specific Elective Course

Credits: 1, Contact Hours: 30 clock hours, 2 hours/ week

Marks: 25, Internal assessment: 10, External assessment: 15

1. Collection and preservation of diseases specimens.
2. Sick Plot: Screening for crop disease and soil fungi
3. Symptomology, histopathology of disease from Mastigomycotina, Ascomycotina, Basidiomycotina, Deuteriomycotina.
4. Investigation of Diseases prescribed in theory.
5. Principal and working of instruments, Sterilization Methods.
6. Preparation of Media, stains and Isolation of Fungi from infected plants.
7. Culture and identification of Pathogen.
8. Virulence test for pathogens.
9. Visits to fields for study of diseases.

Suggested Reading:

1. Agrios, G.N. (1969) Plant Pathology, Academic Press, New York.
2. Rangaswami, G. and A. Mahadevan (2001) Disease of crop plants in India, Printic Hall of India, Pvt. Ltd., New Delhi.
3. Gupta, V.K. and V.S. Paul (2001) Disease of vegetable crops. Kalyani Publ. Ludhiana,
4. Gupta, V.K. and S.K. Sharma (2000) Disease of fruit crops, Malyani Publ. Ludhiana.
5. Raychaudhari, S.P. and T.K. Nariani (1977), Virus and Mycoplasma disease of plants in India. Oxford and IBK Publ. Corp., New Delhi.
6. Bos L. (1999), Plant viruses, unique and intriguing pathogens. Backhugs Publ. Leiden.
7. Rangaswami, G. and S. Rajagopalan (1973), Bacterial plant pathology, T.N. Agri. Uni. Coimbatore.

Course code: BOT/DSE/OC/511

Course name: Taxonomy of Angiosperms – I

Course type: Discipline Specific Elective Course

Credits: 3, Contact Hours: 45 clock hours, 3 hours/ week

Marks: 75, Internal assessment: 30, External assessment: 45

UNIT-I: Angiosperms: Characteristic features, Secrets of success of Angiosperms.

Taxonomy: Aims and objectives, Approaches, Principles of taxonomy, functions and phases of taxonomy; taxonomy as synthetic discipline.

Keys: Types, preparation and use

UNIT-II: Phylogeny of angiosperms: monophyletic and polyphyletic origin of angiosperms, herbaceous origin hypothesis, Various theories of origin of Angiosperms, origin of monocotyledons; molecular evidence to angiosperm origin, cradle of angiosperms.

UNIT-III: Taxonomic hierarchy: it's major, minor and intraspecific categories and ranks. Species as basic unit of classification. Criteria used for classification. A brief history of Pre-Darwinian and post Darwinian systems of classification with special emphasis on Thorne's, Dahlgren's, Takhtajan's and Cronquist's systems of classification, Outline of APG IV system of Classification.

UNIT-IV: Concept of taxonomic character: Definition of character, Unit character, analytical and synthetic, qualitative and quantitative, genetically and environmentally controlled, good and bad character, character weighing, taxonomic coefficient with examples.

UNIT-V: Phylogenetic relationship: Primitive and advanced characters, monophyletic, paraphyletic and polyphyletic, homology and analogy, parallel and convergent evolution, plesiomorphic and apomorphic characters. **Cladistics:** Operational Taxonomic Units (OTU), characters and coding, measuring of similarity, cladograms.

Course code: BOT/DSE/OC/512

(Practical based on BOT/DSE/OC/511)

Course name: Practical - Taxonomy of Angiosperms – I

Course type: Discipline Specific Elective Course

Credits: 1, Contact Hours: 30 clock hours, 2 hours/ week

Marks: 25, Internal assessment: 10, External assessment: 15

1. To study variation in the population of a species.
2. Study of morphology of and general evolutionary trends in Inflorescences, flowers, stamens, carpels and fruits.
3. Study of different types of roots, stems, leaves, their modifications and evolutionary trends therein.
4. Taxonomic distribution of special units of pollen dispersal- bi celled pollen, tetrads, polyads and pollinia and pollen types.
5. Study of plant surface attributes with the help of SEM photographs.
6. Descriptions, sketching, classification and identification of at least 30 families represented in local flora.
7. Several one-day botanical excursions to botanically rich locations.
8. Botanical excursion of about one week to any botanically rich location preferable outside the State.

Course code: BOT/DSE/OC/513

Course name: ADVANCED PLANT PHYSIOLOGY AND BIOCHEMISTRY – I

Course type: Discipline Specific Elective Course

Credits: 3, Contact Hours: 45 clock hours, 3 hours/ week

Marks: 75, Internal assessment: 30, External assessment: 45

- Unit I. Plant Composition :** Structure and biochemical role of major plant constituents, carbohydrates and its derivatives, structure and classification of proteins, glycoproteins, peptidoglycans, lipids and glycoproteins, lipid and triglycerides, fatty acid, vitamins nucleic acids.
- Unit II. Pigments and metabolites:** Chlorophylls, phycobiliproteins, phenolics, sterols, alkaloids, carotenoids, phytochrome, anthocyanine, phenolics, porphyrins, organic acids, isolating these chemicals for human welfare.
- Unit III. Principles use and application** of Colorimeters, photometry flame photometers, spectrophotometry, chromatography (ion exchange, affinity, thin layer, high pressure liquid), gel filtration, electrophoresis, electro focusing and ultracentrifugation,
- Unit IV. Application of radioactive tracer technique** in biology, radioactive isotopes Autoradiography, Biophysical methods X ray diffraction, fluorescence UV, NMR and ESR Atomic absorption spectroscopy
- Unit V. Growth analysis:** Growth, growth curve, lag, log and senescence phase, growth rates AGR, RGR, NAR, LAP, LAI, CGR and LAD productivity potential of dwarf varieties, causes of dwarfism, morphological and physiological factors in relation to height. Yields of dwarf plants,

Course code: BOT/DSE/OC/514

(Practical based on BOT/DSE/OC/513)

Course Name: Practical - Advanced Plant Physiology and Biochemistry – I

Course type: Discipline Specific Elective Course

Credits: 1, Contact Hours: 30 clock hours, 2 hours/ week

Marks: 25, Internal assessment: 10, External assessment: 15

1. Estimation of B - carotene with column chromatography.
2. Estimation of reducing sugars by Folin – Wu tube.
3. Estimation of cellulose by Crampton and Maynord Method.
4. Estimation of free fatty acids.
5. Estimation of nitrates.
6. Thin layer chromatographic technique.
7. Techniques of flame photometry: estimation of sodium and potassium.
8. Estimation of gross energy by chromic acid oxidation method.
9. Estimation of N by micro – Kjeldhal methods.

Suggested Readings

1. Bajrachry D. Experiment in Plant Physiology, Narosa Publishing House, New Delhi.
2. Bidwell R. G. S., Plant physiology: Mac Millan Publishers Co., New York.
3. Borner, J. and Galston, A. W., Principles of plant physiology,
4. Hess, Plant physiology, Narosa Publishing House, New Delhi.
5. Datta, S. C., Plant Physiology, Willey Eastern Limited, Calcutta.
6. Devlin, R. M. and Hostan, F. H., Plant physiology, CBS Publishers and Distributors, New Delhi.
7. Fairley, J. L. and Kilgon, G. L., Essentials of Biological Chemistry, Earr west Press Pvt. Ltd., Delhi.
8. Goodwin T. W. & E. I. Mercer (2003) Introduction to Plant Biochemistry, CBS, New Delhi
9. Hess, D. Plant Physiology, Narosa Publishing House, New Delhi.
10. ICAR Handbook of Agriculture, ICAR, New Delhi.
11. Jayraman, J., Laboratory Manual in Biochemistry, New Age International Publishers, Mumbai.

12. Lehninger, A. L. Principles of Biochemistry, CBS Publishers and Distributors, New Delhi.
13. Mertz, E. T., Vakils, Elementary Biochemistry, Fetter and Simsons Pvt Ltd. Mumbai.
14. Mukharji S., A. K. Ghosh, Plant Physiology, New Central Book Agencies, Kolkatta.
15. Mukharji, S. and Ghosh, A. K. Plant Physiology. New Central Book Agencies, Kolkatta.
16. Mungikar, A. M. Bibliography of leaf protein in Marathwada University.
17. Nels R. Lersten (2014) Flowering Plant Embryology, Wiley, New Delhi
18. Noggle G. R. and Fritz, G. S., Introductory plant physiology, Prentice Hall, USA.
19. Noggle, G. R. and Fritz, G. S. Introductory plant physiology, Prentice Hall, U. S. A.
20. Pandey S. N. & Sinha B. K., Plant Physiology, Vikas Publishing House, New Delhi
21. Pine, N. W. (1971) Leaf protein, its preparation, quality and use, Blackwell Scientific Publ. U. K.
22. Salisbury F. N. and C. W. Ross, Plant physiology: CBS Publishers and Distributors, New Delhi.
23. Slyter, R. O. Plant Water Relationships, Academic Press, New York.
24. Telek, H. and Graham, LT. (1983) Leaf protein concentrates, AVI, Publishing Co., USA.
25. Vaidya, V. G., Sahasrabudhe, K. R. and Khupse, V. S. Crop production and field experimentation Continental Prakashan, Pune - 30.
26. Wilkins M. B., Advanced plant physiology, English Language Book Society, London.

Course Code: BOT/DSE/OC/515

Course Name: Plant Diversity and Conservation – I

Course type: Discipline Specific Elective Course

Credits: 3, Contact Hours: 45 clock hours, 3 hours/ week

Marks: 75, Internal assessment: 30, External assessment: 45

Unit 1: Introduction:

Biodiversity history and concept, Origin and evolution of diversity, Importance of Biodiversity, Revision of ecosystem: organization, structure, function and energetics.

Unit: 2 Types of Diversity:

- a. Genetic diversity: Concept, definition, importance and factors.
- b. Species diversity: Concept, definition, estimation and plant global status special reference to India, taxonomic procedure, taxa delimitation.
- c. Ecosystem diversity: Definition, Types, Forest ecosystem types (Tropical, Subtropical, temperate and alpine).

Unit 3: Agricultural and cropland diversity: Agricultural and cropland diversity concept, Crop domestication, Nicolai Nuclear centres and regional centers of crop origin, Germ-plasm, India's status for primary and secondary agricultural crops.

Unit 4: Diversity Distribution: Mega diversity regions, Endemism concept and its types, World Hots spots, Western Ghats and Eastern Himalayas.

Unit 5: Biogeography: Scope and importance, types ; Phytogeographical realms, Estimation of known floras and faunas.

Course Code: BOT/DSE/OC/516

(Practical based on BOT/DSE/OC/515)

Course Name: Practical - Plant Diversity and Conservation – I

Course type: Discipline Specific Elective Course

Credits: 1, Contact Hours: 30 clock hours, 2 hours/ week

Marks: 25, Internal assessment: 10, External assessment: 15

1. Study of biodiversity indices.
2. Qualitative structure of plant community using visual characters.
3. Demonstrate the gradual floristic change in two different types of adjacent plant communities.
4. Demonstrate the gradual change of abundance and frequency of different species in a transitional zone following the belt transects method.
5. Determine the ground cover flora of an area by quadrat sampling.
6. Determine the relative frequency of different herbaceous species growing in an area.
7. Determine the Importance Value Index for different species growing in a herbaceous plant community.
8. Submission of Short tour or field visit or Excursion report

Course Code: BOT/DSE/OC/517

Course Name: Seed Technology – I

Floral Biology, Seed Development and Maturation.

Course type: Discipline Specific Elective Course

Credits: 3, Contact Hours: 45 clock hours, 3 hours/ week

Marks: 75, Internal assessment: 30, External assessment: 45

Objective: To refresh the basic knowledge of seed development and structures and apprise students with its relevance to production of quality s

UNIT I

- **Floral biology** - structure and functions in relation to pollination mechanisms.
- **Sporogenesis:** microsporogenesis and megasporogenesis.
- **Gametogenesis** - development of male and female gametes and their structures; effect of environmental factors on floral biology.
- **Fertilization** – embryo sac structure, process, barriers to fertilization, incompatibility and male sterility, factors affecting fertilization.

UNIT II

- **Embryogenesis** - development of typical monocot and dicot embryos.
- Endosperm development, modification of food storage structures with reference to crop plants.
- Different types of embryos, endosperm and cotyledons; development and their structure in representative crop plants with reference to food storage;
- External and internal features of monocot and dicot seed; seed coat structure and development in representative crop plants.

UNIT III

- **Apomixis** – identification, classification, significance and its utilization in different crops for hybrid seed production.
- **Polyembryony** – types and significance; haplontic and diplontic sterility, causes of embryo abortion, embryo rescue and synthetic seeds.

UNIT IV

- **Pollination Biology** – Androecium- structure of stamen, Gynoecium-structure of carpel, Types of Pollination, Mechanism of pollination.

UNIT V

Seed as a basic input in agriculture - seed development in cultivated plants; classification of crop plants in relation to mode of reproduction; concept and importance of genetic purity in seed production; seed production in self- and cross- pollinated crops

Course Code: BOT/DSE/OC/518
Course Name: Practical - Seed Technology – I
(Practical based on BOT/DSE/ 517)
Course type: Discipline Specific Elective Course
Credits: 1, Contact Hours: 30 clock hours, 2 hours/ week
Marks: 25, Internal assessment: 10, External assessment: 15

1. Studies on floral morphology of some important field crop plants
2. Emasculation and pollination studies in Maize and Cotton.
3. Study of floral biology of monocots and dicots.
4. Micro-sporogenesis and mega-sporogenesis.
5. Study of pollen grains - pollen morphology, pollen germination and pollen sterility
6. Study of types monocot and dicot embryos
7. Study of external and internal structures of monocot and dicot seeds; seed coat structure,
8. Preparation of seed albums and identification.
9. Identification of weed seeds.
10. Visit of seed production plots of field crops and vegetables.

References:

1. Handbook of Agriculture- Indian Council of Agricultural Research, New Delhi
Umaraniet. al. 2006. Experimental Seed Science and Technology, Agrobios, Jodhpur
2. Singh, 2009. Plant Breeding: Principles and Methods. Kalyani Publishers, New Delhi Agrawal,
2005. Seed Technology. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi
3. Reddy, 2008. Principles of crop production. Kalyani Publishers, New Delhi
4. Pandey, 2010. A text book of Botany. S. Chand and Company Ltd., New Delhi
5. Santra and Chatterjee, 2007. College Botany, New Central Book Agency (P) Ltd., Kolkata
6. Dutta, 1983. A Class book of Botany, Oxford University Press, Calcutta.
7. Plant breeding-B. D Singh.
8. Bhojwani, S. S. and Bhatnagar, S. P. 1999. The Embryology of Angiosperm. Vikas Publ.
9. Chhabra, A. K. 2006. Practical Manual of Floral Biology of Crop Plants. Deptt. of Plant
Breeding, CCS HAU, Hisar.

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Course Code: BOT/RM/OC/549

Course Name: Research Methodology

Course type: Research Methodology Course

Credits: 4, Contact Hours: 60 clock hours, 4 hours/ week

Marks: 100, Internal assessment: 40, External assessment: 60

Course Objectives:

1. To define research and describe the research process and research methods
2. To understand qualitative research and methods used to execute and validate qualitative research
3. To know how to apply the basic aspects of the research process in order to plan and execute a research project.
4. To provide insight into the processes that lead to the publishing of research.
5. To be able to present, review and publish scientific articles

Course Outcomes:

Students will be able to -

1. understand and explain research process
2. do systematic literature survey, formulation of a research topic, study design, analysis and interpretation of data.
3. to design a research approach for a specific research issue of their choice.
4. select a suitable analytical method for a specific research approach.
5. demonstrate a good understanding of how to write a research report.
6. critically assess published quantitative research with regard to the statistical methods and approaches adopted
7. create a research document for implementation research project

Course Contents:

Part – 1 (02 credit: 30 Contact Hours)

Unit - I: Research Fundamentals and Identification of Research Problem: (10 Hrs.)

Research Fundamentals

Introduction: Definition, objectives of the research, characteristics of the research, what makes people to do research, importance of research, Qualitative and Quantitative Research: Qualitative research - Quantitative research - Concept of measurement, causality, generalization, and replication. Merging the two approaches.

Identification of Research Problem

Defining the research problem: Identification of research problems, selection of research problem, facts one should know regarding selection of research problem, the process of research problem definition, some facts involved in defining research problem, Research Design: Concept and Importance in Research - Features of a good research design - Exploratory Research Design - concept, types and uses, Descriptive Research Designs - concept, types and uses. Experimental Design: Concept of Independent & Dependent variables, Case Studies,

Unit - II: Formulation of Research Problem

(10 Hrs.)

Formulation of the problems: steps involved in defining a problem, formulation of the problems, Formulation of hypothesis: Concept of hypothesis, hypothesis testing, developing the research plan: implementation, interpreting and reporting the findings, Importance of hypothesis in decision making, Case Studies. Interpretation of Data. Measurement: Concept of measurement- what is measured? Problems in measurement in research- Validity and Reliability. Levels of measurement Nominal, Ordinal, Interval, Ratio.

Unit – III : Research Report and Proposal Writing

(10 Hrs.)

Introduction, research proposal writing: costing, the research proposal, rationale for the study, research objectives, research methodology, target respondents, research Centres, sample size and sample composition, sampling procedures, research project execution, research units; An insight into research report and proposal, research project synopsis, research report writing : types of research reports, guidelines for writing reports; Steps in writing report, report presentation, typing the report, documentation and bibliography, formatting guidelines for writing a good research report / research paper, Paper Writing- Layout of a Research Paper, Journals in Computer Science, Impact factor of Journals, When and where to publish ? Ethical issues related to publishing, Plagiarism and Self-Plagiarism. Case Studies.

Part – II (02 credit : 30 Contact Hours)

Presentations, case studies, Assignments, Tutorials based on Unit I to III **(30 Hrs.)**

Students are expected to do the Followings

- i) Select Broad topic of Research Project (to be implemented from second semester onwards)
- ii) Read the Basic concepts / fundamentals of broad topic
- iii) Identify 10 SCOPUS / WEB OF SCIENCE Indexed Journals related to broad topic
- iv) Search and download 20 research articles from above research Journals
- v) Do systematic review of above 20 research articles
- vi) While doing review of each of above mentioned 20 research articles, students are expected prepare notes on following points
 - a) What are the objectives of the research article?
 - b) What methodology has been adopted?
 - c) What are prominent results?
 - d) How these results of relevant to the latest development of the subject?
 - e) What is novelty of research article?
 - f) What are prominent shortcomings of this research a presented in this research article?

g) What are your plans to address those shortcoming?

- vii) Draft the fine-tuned title of research project
- viii) Draft hypothesis
- ix) Draft Objectives and Methodology
- x) Draft expected outcome of the research project

At the end of the assignment, students are expected to prepare a report having following points

- i) Fine-tuned title of Research Project
- ii) Fundamental aspects of the fine-tuned research topic
- iii) Hypothesis
- iv) Objectives
- v) Methodology
- vi) Detailed Experimental plan
- vii) Expected outcome
- viii) References

References:

1. Research Methodology by Dr. S. L. Gupta, Hitesh Gupta; International Book House Pvt Ltd (**2013**), ISBN-10: 8191064278, ISBN-13: 978-8191064278
2. Basic Research Methods-Gerard Guthrie SAGE Publications, India, Pvt Ltd, New Delhi (**2010**), ISBN-10: 8132104579, ISBN-13: 978-8132104575
3. Research Methodology-methods and techniques By C. R. Kothari, New Age International Publishers (**2011**) ISBN 978-81-224-1522-3
4. Principles of Research Methodology- Phyllis G. Supino, Jeffrey S. Borer; Springer, Verlag New York (**2012**), ISBN-ebook: 1461433592, ISBN (Hardcover): 978-1461433590
5. Research Design Qualitative, Quantitative. and Mixed Methods Approaches- John W. Creswell; SAGE Publications Ltd, UK (**2011**), ISBN-9780857023452
6. Research Methodology -A Step-by-Step Guide for Beginners- Ranjit Kumar; Sage Publications Ltd. (**2010**), ISBN- 1849203016.
7. Scientific Writing and Communication- Angelika Hofmann; Oxford University Press, US (**2010**), ISBN-13-: 978-0 199947560, ISBN-10: 01 99947562
8. Writing Science: How to Write Papers That Get Cited and Proposals That Get Funded- Joshua Schimel, Oxford University Press, (**2011**), ISBN: 9780199760237
9. Handbook of Scientific Proposal Writing- A. Yavuz Oruc; CRC Press, Taylor & Francis group (**2011**), ISBN: 9781439869185

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**DR. BABASAHEB AMBEDKAR MARATHWADA UNIVERSIT,
AURANGABAD**

M. Sc. BOTANY SYLLABUS FOR OTHER CENTERS AS PER NEP-2020

Illustrative Credit distribution structure for Two year programme with Multiple Entry and Exit option

Class: M. Sc. I year

Semester: II Semester

Course code: BOT/MJ/OC/550

Course Name: Course Name: CYTOLOGY AND GENETICS

Course type: Major Mandatory Discipline Specific Course

Credits: 3, Contact Hours: 45 clock hours, 3 hours/ week

Marks: 75, Internal assessment: 30, External assessment: 45

Unit I: Chromatin organization

- i) Chromosome structure and packaging of DNA.
- ii) Nucleosome organization, DNA Structure (A, B and Z forms)
- iii) Organization of centromere and telomere.
- iv) Karyotype analysis and the banding patterns.
- v) Special types of chromosomes- Polytene, Lampbrush, B-chromosome and sex chromosomes.

Unit II: Structural and Numerical alterations in chromosomes

- i) The origin, meiosis and breeding behaviour of duplication, deficiency, inversion, translocation heterozygotes, haploids, aneuploids and autopolyploids.
- ii) The allopolyploids and evolution of major crop plants.

Unit III: Mutation

- i) Historical perspective
- ii) Spontaneous and induced mutations
- iii) Physical and chemical mutagens
- iv) Mode of action and molecular basis of gene mutations
- v) Transposable elements and mutation induced by transposons
- vi) Applications of various mutation techniques
- vii) Role of mutations in crop improvement programme

Unit IV: DNA damage and repair mechanism

- i) Fine structure of gene, cis- trans-test, introns and their significance in RNA splicing
- ii) DNA damage and repair mechanism
- iii) Initiation of cancer at cellular level. Proto-oncogenes and oncogenes

Unit V: Genetics of prokaryotic and eukaryotic organelles

- i) Phage and Bacterial Genetics — mapping of the bacteriophage genome, genetic recombination in phage, transformation, transduction and conjugation in bacteria
- ii) Genetics of mitochondria and chloroplast, cytoplasmic male sterility.
- iii) Regulation of gene expression in prokaryotes and eukaryotes.

Suggested Reading:

1. Alberts, B. Bray, D. Lewis, J. Raff, M. Roberts, K. and Watson, J. D. 1989. Molecular Biology (Ed.) Garland Publishing Inc. New York.
2. Atherly, A. G., Girton, J. R. and Mc Donald, J. F. 1999. The Science of Genetics. Saunders College USA.
3. Burnham, C. R. 1962. Discussions in Cytogenetics, Burgess Publishing Co., Minnesota.
4. Busch. H. and Rothblum, L. 1982 Volume X. The cell nucleus: DNA part A, Academic Press.
5. Hartl, D. L. and Jones E. W. 1998. Genetics: Principles and Analysis (4th Ed.) Jones and Barew Publishers, Massachusetts, USA.
6. Khush, G. S. 1973. Cytogenetics of Aneuploids, Academic Press, New York, London.
7. Karp, G. 1999. Cell and Molecular Biology; Concepts and Experiments, John Wiley and Sons Inc. USA.
8. Lewin, B. 2000. Genes VII. Oxford University Press, New York, USA. Lewis, R. 1997. Human Genetics: Concepts and applications (2nd Ed), WCB, McGraw Hill, USA.
9. Malacinski, G. M. and Friefelder, D. 1998. Essentials of Molecular Biology (3rd Ed.), John and Bartlet Publishers Inc. London. Russel, P. J. 1998. Genetics (5th Ed) The Benjamin / Cummings Publishing Company, Inc. USA.
10. Powar C. B. (2016) Essentials of Cytology, Himalaya Publishing House, New Delhi
11. Sen Sumitra, Dipak Kumar Kar and B. M. Johri (2005) Cytology and Genetics, Alpha Science Publications
12. Sharma A. K. and Sharma Archana (2016) Chromosome Techniques, Theory and Practice, Butterworth Publication
13. Snustad, D. P. and Simmons, M. J. 2000. Principles of Genetics (2nd Ed.), John Wiley and Sons Inc. USA.

BOT/MJ/OC/551

Plant Development and Reproduction

Course type: Major Mandatory Discipline Specific Course

Credits: 3, Contact Hours: 45 clock hours, 3 hours/ week

Marks: 75, Internal assessment: 30, External assessment: 45

Plant Development

- Unit I.**
- i. Meristems:** Organization of shoot and root apical meristem, various theories, Cytological and Molecular analysis of SAM, control of tissue differentiation especially Xylem and Phloem.
 - ii. Tissue systems:** Differentiation and functions of different tissue systems such as epidermis, parenchyma, chlorenchyma, sclerenchyma, laticifers and glands.
 - i. Organ determination:** Leaf, stem, root etc.
- Unit II.**
- i. Vascular tissues:** Origin, structure and functions Xylem and Phloem elements and their taxonomic significance, Wood development in relation to Environment.
 - ii. Leaf:** Growth and differentiation, differentiation of epidermis (with special reference to stomata and trichomes) and mesophyll.
 - iii. Root:** Initiation and development; lateral roots, root hair, root microbe Interaction.

Plant Reproduction

- Unit III.**
- i. Flower:** Structure and development
 - ii. Pollination:** Types of pollination, attractions and rewards of pollination, pollination mechanism and vectors, breeding systems, structure of pistil, pollen interaction and fertilization.
- Unit IV.**
- i. Male gametophyte:** Structure of anthers, micro-sporogenesis, role of tapetum, male sterility, pollen germination, pollen tube growth and development, pollen storage, pollen allergy, pollen embryos.
 - ii. Female gametophyte:** Ovule development, megasporogenesis, organization of the embryo sac. Structure of the embryo sac.
- Unit V.**
- i. Seed development and fruit growth:** Double fertilization, Endosperm development, Embryogenesis, Ultra-structure and nuclear cytology; Development of dicot and monocot embryos, poly-embryony, apomixes, embryo culture.
 - iv. Fruit development and seed dispersal mechanisms.**

Suggested readings:

- Bhojwani and Bhatnagar (2000) The Embryology of Angiosperms, S. Chand Pub. New Delhi
- Burjes, J. (1985). "An Introduction to Plant cell development Cambridge University Press, Cambridge.
- Carlquist S (2001). Comparative Wood Anatomy, Springer-Verlag, Germany.
- Chopra, V. L. (2001), 'Plant Breeding, Field Crops', Oxford, BH Pvt. Ltd, New Delhi.
- Chopra, V. L. (2001), 'Plant Breeding; theory and practice', Oxford I BH Pvt. Ltd.
- Cutler D. F. (1978). Applied Plant Anatomy, Longman, United Kindom
- Cutter E. G. (1978) Plant Anatomy, Part I & II, Edward Arnold, United Kingdom.
- Cutter, E. G. 1978 Plant Anatomy - Experiments and interpretations' Part I and II, Edward Arnold
- Dickinson W. C. (2000).Integrative Plant Anatomy, Harcourt Academic Press, USA.
- Esau, K, 1965. "Plant Anatomy" (Second edition; 7th reprint 1991), Wiley Eastern, New Delhi.
- Fahn, A. 1974, Plant Anatomy, Pergmon Press, USA & UK.
- Fahn, A. 1977, Plant Anatomy' (3rd edition, 1982).Pergamon Press, Oxford.
- Forster, A. S. 1960. 'Practical plant anatomy D.vanNostrandcompany.Inc.
- Fosket D. E. 1994, Plant, Growth and Development: A Molecular Approach, Academic Press.
- Foskt D. E. 1994 'Plant growth and development' - A molecular approach Academic Press, Santiago.
- Fritsch F. E. 1935, 1945, The Structure and Reproduction of Algae Vols.I and II.Cambridge University Press, Cambridge, UK.
- Frugis Givoanna, 2020, Plant Development and Organogenesis: From basic principles to advanced research, M D P I
- Hopkins W. G., 2006, The Green World: Plant Development, Chelsea House Publication
- Howell S. H., 1998, Molecular Genetics of Plant Development, Cambridge University Press.
- Howell, S. H., 1998, Molecular genetics of plant development, Cambridge University Press, Cambridge.
- Hyndon, R,F. 1990, Plant Development - The Cellular Basis Univ. Hyman, London.
- improvement Cambridge University Press. Cambridge.

Leyser O. and Day S. 2003, Mechanism of Plant Development, Blackwell Press

Maheshwari P., 2000, An introduction to the Embryology of Angiosperms,

Mauseth J. D., 1988, Plant Anatomy, The Benjamin/ Cummings Publisher, USA

Metcalf and Chalk, 1950, Anatomy of Dicotyledons vol. I & II, Clarendon Press.

Murphy, T. M. and Thompson, W. F. 1988, Molecular plant development, Prentice Hall, New Jersey.

Nair M. N. B., 1998, Wood Anatomy and Major Uses of Wood, Faculty of Forestry, University of Putra Malaysia, Malaysia. 11

Nels R. Lersten, 2014, Flowering Plant Embryology, Wiley, New Delhi

Pandey A. K., 2010, Introduction to Embryology of Angiosperms,

Procton, M. and Yeo, P., 1973, 'The pollination of flowers', William Collins Sons, London.

Raghavan V., 1997, Molecular Embryology of Flowering Plants. Cambridge University Press.

Raghavan V. 2000, Developmental Biology of Flowering Plants, Springer, Netherlands

Raghavan, V., 1999, Developmental Biology of flowering plants', Springer Verlag, New York.

Raven, P. H., Evert, R. F. and Eichhorn, S. E. 1992 'Biology of Plants' (5th Edition), New York.

Richards A. J., 1986, Plant Breeding System, George Allen and Unwin.

Roberts, L. W., 1976, Cyto-differentiation in plants, Cambridge University Press, Cambridge.

Shivanna K. R., 2003, Pollen Biology and Biotechnology, Science Publishers.

Shivanna, K. R. and John, B. M., 1985, 'The angiosperm pollen structure and function', Willey Eastern Ltd., New York.

Shivanna, K. R. and Rangaswamy, N. S., 1992, 'Pollen Biology: A laboratory manual', Springer Verlag, Berlin.

Shivanna, K. R. and V. K. Sawhney, (Ed) 2005, 'Pollen Biotechnology for crop production and Improvement, Cambridge University Press.

Sleeves, T. A. and Sussex, L. M. 1989, 'Patterns in plant development (7th edition) Cambridge Press, Cambridge.

Course Code: BOT/MJ/OC/552

Course Name: Biology and Diversity in Fungi and Microbes

Course type: Major Mandatory Discipline Specific Course

Credits: 3, Contact Hours: 45 clock hours, 3 hours/ week

Marks: 75, Internal assessment: 30, External assessment: 45

Fungi:

Unit I. a) Fungi - General characteristics in fungi. (Ultrastructure and Reproduction).

General account and outline of Classification (Ainsworth 1973)

b) Economic importance of fungi –

Fungi in Agriculture (Biopesticides and Biofertilizers), Fungi in medicine

Fungi in industry, Fungi as source of food (SCP, Mushrooms).

Unit II: Fungi as plant pathogens

- General account of different groups and type study of fungi as pathogen.

- Mastigomycotina -*Phytophthora, Albugo*.
- Zygomycotina - *Rhizopus, Mucor*.
- Ascomycotina -*Claviceps, Erysiphae*,
- Basidiomycotina -*Puccinia, Ustilago*,
- Deuteromycotina - *Alternaria, Aspergillus, Penicillium, Fusarium, Cercospora, Helminthosporium*.

Bacteria:

Unit- III.

a) General characters, ultrastructure, classification, Koch's postulates,

- Archaeobacteria and Eubacteria.
- Economic importance of Bacteria,
- Role of bacteria in nitrogen fixation, Role of agrobacterium in GM crops.
- Bacteria as plant pathogens: Citrus canker, Angular leaf spot of Cotton. Soft rot of fruits.

Unit –IV Phytoplasma :

a) Phytoplasma: General Account, ultrastructure and economic importance

b) Phytoplasma as plant pathogens: Grassy shoot of Sugarcane, Little leaf of Brinjal, Sesamum phyllody

Unit- V Virus :

a) General account, ultrastructure, Transmission and multiplication of viruses.

b) Economic importance of viruses.

c) Virus carrying human diseases (HIV, COVID-19, SARI).

d) Viruses as plant pathogens: Tomato / Chilli leaf curl virus, Papaya leaf mosaic Virus, Yellow vein mosaic virus of Bhindi.

Suggested Reading:

1. U. Sinha and Sheela Shrivastava (1985) An Introduction to Bacteria, Vikas Publishing House Pvt. Ltd., New Delhi.

2. Burgey's Manual of Systematic Bacteriology, Vol. 1-4(1986-1989) Williams & Wilkins, Baltimore.
3. J. P, Verma (1992) The Bacteria, Malhotra Publishing House, New Delhi,
4. A. J. Salle (1974) Fundamental Principles of Bacteriology, Tata McGraw Hill Publishing Co. Ltd., New Delhi.10.
5. K. G. Hardy (1987) Plasmids - a Practical Approach, IRL Press, Oxford, Washington D.C.
6. Bruce A. Voyles (2002) The Biology of Viruses, McGraw Hill, Boston.
7. Luria S. E., J. E. Darnel!, D. Baltimore & A. Campbell (1978) General Virology, John Wiley & Sons, New York.
- 8) E. W. Mester, C.E. Roberts, M.M. Pearsall and B. J.Mc Carth- General Microbiology, Holt, Renhart & Winston, New York.
9. Powar & Daginawala (2004) General Microbiology Vol. II, Himalaya Publishing House, Mumbai.
10. R. F. Boyd (1984) General Microbiology, Times Mirror/Mosby College Publishing St. Louis.
11. S. B. Biswas & Amrita Biswas (1993) An Introduction to Viruses, Vikas Publishing House Pvt. Ltd., New Delhi.
12. V. K. Gupta & M. K. Behl (1994) Indian Plant Viruses & Mycoplasma, Kalyani Publishers, Ludhiana.
13. S. P. Raychoudhari & T. K. Nariani (1977) Virus & Mycoplasma Diseases of plants in India, Oxford & IBH Publishing Co., New Delhi.
14. K. B. Deshpande & P. B, Papadiwal (1979) A Laboratory course in Bacteriology, COSIP-ULP -Botany Publication, Marathwada University, Aurangabad.
15. P. B. Papdiwal (1980) Biotechniques, COSIP- ULP - Botany Publication, Marathwada University, Aurangabad.
16. Alexopoulous C.J., C.W.Mims & M. Blakwel (1996) - Introductory Mycology, John Wiley & Sons Inc.
17. Dube H. C. (1994) - An Introduction to Fungi ,Vikas Publishing House, New Delhi.
- 18) Sharma P. O. (2000) - Microbiology and plant pathology, Rastogi Publication, New Delhi.
19. Mukadam D. S. (1997) The Illustrated Kingdom of Fungi, Aksharganga Publication, Aurangabad.
20. Mukadam D. S. (2004) - Modern Topics in Fungi, Saraswati Printing Press, Aurangabad.
21. Rangaswami G. & A. Mahadevan (2001) - Diseases of Crop Plants in India., Prentice Hall of India, New Delhi.

Course Code: BOT/MJ/OC/553

(Practical based on BOT/MJ/550)

Practical - Cytology and Genetics

Course type: Major Mandatory Discipline Specific Course

Credit: 1, Contact Hours: 30 clock hours, 2 hours/ week

Marks: 25, Internal assessment: 10, External assessment: 15

1. Induction of polyploidy in plants using colchicine. Different methods of application of colchicine.
2. Isolation of biochemical mutants following physical and chemical mutagenic
3. Isolation of chlorophyll mutants following physical and chemical mutagenic treatments.
4. Isolation of morphological mutants following physical and chemical mutagenic treatments.
5. Karyotype analysis in any two plant species.
6. Meiosis of complex translocation heterozygotes.
7. Meiotic behavior of monosomy in plants & its effect.
8. Meiotic behavior of trisomy in plants and its effect.
9. Mitotic/ meiotic chromosomal behaviour in mutagen treated materials.
10. Orcein and Feulgen staining of the polytene chromosomes of Chironomus larvae.
11. Study of chromosome pairing and disjunction in translocation heterozygote.
12. Utilization of banding technique for identification of chromosomes in karyotype.

BOT/MJ/OC/554

(Practicals Based on BOT/MJ/OC/551)

Practical - Plant Development and Reproduction

Course type: Major Mandatory Discipline Specific Course

Credit: 1, Contact Hours: 30 clock hours, 2 hours/ week

Marks: 25, Internal assessment: 10, External assessment: 15

1. Dermatology - trichomes and stomata and leaf anatomy of *Nerium*, *Terminalia* etc.
2. Mechanical tissues (Collenchyma, Sclerenchyma, Stone cells and Xylem), Secretary tissues (Mucilage Canals, Resin canals, Nectaries, and oil glands), laticifers (Latex cells and Vessels).
3. Vascular tissues and its constituents by sections and maceration, wood anatomy, TS, TLS and RLS
4. Abnormal secondary growth in *Dracaena*, *Bignonia*, *Aristolochia*, *Achyranthus*, *Nyctanthus*, *Salvadora*, *Beta*, *Mirabilis*, *Tinospora*.
5. Study of microsporogenesis and gametogenesis in sections of anthers.
6. Examination of modes of anther dehiscence and collection of pollen grains for
7. Microscopic examination (maize, grasses, *Crotolaria*, *Tradescantia*, *Brassica*, *Petunia*, *Solanum* etc.)
8. Test for pollen viability using stains and *in vitro* pollen germination using hanging drop and sitting drop cultures, suspension culture and surface culture.
9. Estimation of percentage and average pollen tube length *in vitro*
10. Pollen storage, pollen pistil interaction, *in vitro* pollination.
11. Study of ovules and embryo sacs.
12. Field study of types of flowers and pollination mechanism. .
13. Study of nuclear and cellular endosperms.

Course Code: BOT/ MJ/OC/ 555

(Practical based on BOT/MJ/OC/ 552)

Course Name: Practical - Biology and Diversity in Fungi and Microbes.

Course type: Major Mandatory Discipline Specific Course

Credit: 1, Contact Hours: 30 clock hours, 2 hours/ week

Marks: 25, Internal assessment: 10, External assessment: 15

01. Principal and working of instruments, Sterilization Methods.
02. Preparation of Media, stains and Isolation of Bacteria and Fungi from soil and infected plant tissues.
03. Gram staining of bacteria.
04. Morphology and Taxonomy of following fungi - *Albugo*, *Phytophthora*, *Mucor*, *Rhizopus*, *Plasmopara*, *Sclerospora*, *Taphrina*, *Claviceps*, *Chaetomium*, *Puccinia*, *Ustilago*, *Agaricus*, *Polyporus*, *Ganoderma*, *Cyathus*, *Lycoperdon*, *Geaster*, *Alternaria*, *Aspergillus*, *Penicillium*, *Helminthosporium*, *Cercospora*, *Curvularia*, *Fusarium*, *Rhizoctonia*, *Colletotrichum*.
05. Growth of Fungi on liquid and solid media — *Fusarium* and *Alternaria*.
06. Study of bacterial plant diseases - Citrus canker, Angular leaf spot of cotton, soft rot of fruits.
07. Study of Phytoplasma diseases - Little leaf of Brinjal, Sesamum phyllody, Grassy shoot of sugarcane.
08. Study of viral plant diseases - Papaya mosaic virus (PMV), Tomato leaf curl virus (TLCV), Yellow vein mosaic virus of Bhindi (YVMV), Tobacco Mosaic Virus (TMV).
09. Collection and submission of fungal, bacterial, phytoplasma and viral diseases of plants.

BOT/MJ/OC/556

Practical - BOTANICAL TECHNIQUES

Course type: Major Mandatory Discipline Specific Course

Credit: 2, Contact Hours: 60 clock hours, 4 hours/ week

Marks: 50, Internal assessment: 20, External assessment: 30

Unit I: Microscopy: Compound Microscope and its parts, their functions; Light Microscopy, Phase contrast Microscopy, flow cytometry and confocal microscopy in karyotype analysis. Principles, instrumentation, working and applications of - Fluorescence microscope, TEM, SEM; Biological sample preparation for electron microscopy SEM and TEM. Micrometry.

Unit II: Stains and Staining: Preparation and use of various stains used in botanical studies - Saffranine, Crystals Violet, Light Green, Erythrosine, Acetocarmine, Fuchsin, Basic Fuchsin, Lactophenol, Cotton Blue, Iodine, Sudan IV, Fluoroglucinol, Carbol fuchsin etc. Sectioning and Maceration, Microtomy and Histochemistry.

Unit II: a) Ethical and Legal issues in Research: Legal permissions for collection of biological material from Local Biodiversity committees, Forest Department, State Biodiversity Board and National Biodiversity Authority.

b) Plant Collection and Preservation - Plant collection techniques, Voucher specimens, Herbarium techniques, Liquid preservation, Authentication of specimens, etc.

c) Sampling of Plant materials for Phytochemistry, DNA finger printing, Tissue Culture, Cytological, pathological studies etc.

Unit IV: Laboratory Techniques: Principles, instrumentation, working and applications of - UV-VIS spectrophotometry; IR (infra-red) spectrophotometry; Spectrofluorometry; Luminometry; Atomic spectrophotometry; Mass spectrometry; ESR (electron spin resonance) and NMR (nuclear magnetic resonance), Ultracentrifugation, TLC, fractionation, Electrophoresis, PCR, GISH, FISH techniques.

Unit V: Biostatistics: Calculation of mean, variance, standard deviation, standard error, coefficient of variation and to use 't' test for comparing two means related to ecological data. Hypothesis testing: Theory of errors – Type I and Type II errors, Null Hypothesis, z-test, Test of significance. lay out of field experiments.

Introduction to ANOVA, One-way & two way ANOVA, Dunett's test. Randomized Block Design and Latin Square. (5 problems to be solved in each category)

Suggested Readings:

1. Bauman R. P. Absorption Spectroscopy. John Wiley, New York Dixon R.N. Spectroscopy and Structure. Mathuen, London Sacks R.D. Emission Spectroscopy. John Wiley, New York.
2. Bell R. J. Introductory Fourier Transform spectroscopy. Academic Press, New York. Colthup N. B., Daly L. H. and Wiberley S.E. Introduction to Infra-red and Raman Spectroscopy 2nd Ed. Academic Press. New York.
3. Dean J. and Rains T. Flame emission and atomic absorption. Dekker, New York. Brech F. Analysis in instrumentation. Vol. 6. Plenum, New York.
4. Grob R. L. Modern Practices of Gas Chromatography. 2nd Ed. John Wiley, New York.
5. Guilbault G. G. Practical Fluorescence: Theory, methods and Techniques. Dekker, New York.
6. Hames B. D. and Rickwood D. Gel electrophoresis of Proteins: A practical Approach 2nd Ed. IRL Press, Oxford.
7. Jensen William A. 2015, Botanical histochemistry- Principles and Practice-Agri-Horti Press New Dehli.
8. Kolthoff I. M. and Elving P. J. Treatise on analytical Chemistry, Wiley Interscience, New York.
9. Mungikar, A. M. (2003) Biostatistical Analysis. Saraswati Printing Press. Aurangabad.
10. Paterson D. D. 2008, Statistical Techniques in Agricultural research, J.V. Publishing House Jodhpur.
11. Pesez M and Bartos J. Colorimetric and Fluorometric Analysis of Organic Compounds and drugs, Dekker, New York. Becker R.S. Theory and interpretation of fluorescence and phosphorescence, Wiley interscience, New York.
12. Plummer David T. An Introduction to Practical Biochemistry-Third Edition- Tata Macgraw Hill. *Tata McGraw Hill*, New Delhi, 1990.
13. Senger R. S. Gupta Shalini, Sharma A. K., 2011, Laboratory Manual On Bioechnology- Studium Press India PVT LTD, New Dehli-2000
14. Sharma, B. K. Principal of analytical chemistry, Merut Publication, Merut.
15. Simpson C. F. Techniques in liquid chromatography, Wiley-Heyden, New York.

16. Watson I. J. Introduction to Mass spectroscopy, Raven, New York. Giddings J.C. Principles and Theory, Dynamics of Chromatography Part I Dekker, New York.
17. Willard H. F., Merritt L. L., Dean, J. A. and Settle F. A. Instrumental Method of analysis. CBS Publishers and distribution, New Delhi.
18. Williams D. A. R. and Mowthorpe D. J. Nuclear Magnetic Resonance Spectroscopy. John Wiley, New York.

Course Code: BOT/DSE/OC/557

Course Name: Crop Genetics and Plant Breeding – II

Course type: Discipline Specific Elective Course

Credits: 3, Contact Hours: 45 clock hours, 3 hours/ week

Marks: 75, Internal assessment: 30, External assessment: 45

Unit I: Heterosis breeding:

Historical aspects, Interbreeding depression, Homozygous and heterozygous balance, Genetic basis of inbreeding, Genetic and physiological basis of heterosis, Heterosis and plant breeding.

Unit II: Mutation Breeding:

Mutagenesis, mutagens, Physical mutagens, ionizing and non-ionizing radiations, radio-sensitivity, cytological and genetic effects, chemical mutagens, mutagenic compounds, mode of action, molecular basis of mutations, mutagenic treatment schedules, Screening of mutation in population, mutation frequency, Frequency and spectrum of mutants, micro and macro mutants, mutagenic effectiveness and efficiency, environmental mutagenesis repair mechanism, Ames test, *In vitro* site directed mutagenesis.

Unit III: Resistance breeding:

- i) **Disease resistance** - nature, mechanism of resistance, methodology problems and achievements.
- ii) **Insect resistance:** Nature, mechanism of resistance, methodology, problem and achievements.
- iii) **Drought resistance:** Importance, types, nature of resistance methods and examples.

Unit IV: Distant Hybridization:

Importance, Interspecific, intergeneric gene transfers, methodology, problem and remedial measures, Man-made species.

Unit V: Seed production and distribution:

Introduction variety evaluation, variety maintenance, availability of new varieties, seed production and regulation, seeds industry development. Breeding crops with

special reference to Marathwada region like wheat, Jowar, Bajra, Cotton, Groundnut, Safflower *etc.*

Suggested Reading:

1. Plant Breeding - B. D. Sitigi.
2. Plant Breeding - J. R. Sharma.
3. An Introduction of plant breeding - H. K. Chaudhary.
4. Evolution of crop plants -Edited by Simmonds N. W (1986)
5. Breeding field crops - Poehlmann and Sleper.
6. Plant Breeding perspectives - Edited by Sheep and Mendnkasen.
7. Crop Breeding, P. B. Vose and S. G. Blixt
8. Genes. Chromosomes and Agriculture. Chripels and Simmonds.
9. Principles of Genetics - Snusted and Simulants.
10. Manual of mutation breeding by FAO/IAEA.
11. Mutation Research -Aurebach.
12. Chemical mutagenesis - Fishbeiri et al.
13. Discussions in cytogenetics. Burnhan C. R. 1962 -
14. Genetics - Principles and analysis. Khush G. S. 1973 -
15. Genetics Principles and analysis. Haiti and Jones 1998 -
16. Molecular biology of the gene. Watson J. D. 1989

Course Code: BOT/DSE/DSE/558

(Practical Based on BOT/DSE/557)

Course Name: Practical - Crop genetics and Plant breeding-II

Course type: Discipline Specific Elective Course

Credits: 1, Contact Hours: 30 clock hours, 2 hours/ week

Marks: 25, Internal assessment: 10, External assessment: 15

1. Induction of polyploidy in crop plants.
2. Study of seed protein profile by native and SDS-PAGE.
3. Estimation of leaf proteins, seed proteins in diploids and polyploids.
4. Designing of field experiments.
5. Mutagenesis: Introduction of mutations through physical / Chemical mutagenic treatments and raising M1 & M2 generations. Assess in the effect of mutagens on different M1 parameters.
6. Study of mutagenesis data published in different journals and arriving at logical conclusions by providing theoretical reasons.
7. Report submission and deposition of rare seeds of wild plants from your area during practical exams.

Course Code: BOT/DSE/OC/559

Course Name: MYCOLOGY AND PLANT PATHOLOG – II

Course type: Discipline Specific Elective Course

Credits: 3, Contact Hours: 45 clock hours, 3 hours/ week

Marks: 75, Internal assessment: 30, External assessment: 45

Applied Mycology

UNIT – I: Diversity of Fungi

1. Diversity of Fungi – General account
2. Fungi in diversified habitats – soil water and air
3. Fungi on plant surface – Phyllosphere and Rhizosphere
4. Biology of some important fungi: *Saccharomyces*, *Aspergillus*
5. Isolation, identification, selection and strain improvement of some useful fungi.

UNIT – II: Biofertilizers

1. Glomeromycota – Recent trends in Mycorrhizal taxonomy
2. Isolation and multiplication of mycorrhizae; role in crop productivity and forestry.
3. Phosphate solubilizing fungi (PSF)

UNIT – III: Mushroom

1. General account of Oyster, White button, Paddy straw, Morels, Truffles and Poisonous mushrooms.
2. Cultivation and economics of *Agaricus bisporus*, *Pleurotus*
3. Medicinal and nutritional value of edible and poisonous mushrooms.
4. Effect of environmental, nutritional and chemical factors on mushroom cultivation (intensive and extensive cultivation methods).

UNIT – IV: Fungi as Biopesticides

1. Application of Biotechnology in disease management
2. VA Mycorrhiza
3. Fungi in plant disease control
4. Selection, production and formulation of fungal biopesticides and commercial use of biocontrol agents.
5. Exploitation of biocontrol agents by genetic manipulation

UNIT – V: Fungal Biotechnology

1. Fermentation methods and biomass production of fungi, growth kinetics, fermenter system scale up, fermentation processes.
2. Yeast genome – genetic analysis of yeast; Baker's yeast, food and feed yeasts Glycerol and adhesive, bio-polymer from yeasts.

3. General account of production and application of industrial fungal enzymes (amylases, cellulases, pectinases and chitinases).
4. General account of production and application of primary metabolites (Vitamins and Proteins).
5. General account of production and application of secondary metabolites (antibiotics, mycotoxins, pigments and alkaloids).
6. Environmental and regulatory aspects of using genetically modified microbes in the field.

Course Code: BOT/DSE/OC/560

(Practical based on BOT/ DSE/OC/ 559)

Course Name: Practical - MYCOLOGY AND PLANT PATHOLOGY – II

Course type: Discipline Specific Elective Course

Credits: 1, Contact Hours: 30 clock hours, 2 hours/ week

Marks: 75, Internal assessment: 30, External assessment: 45

1. Collection and preservation of diseases specimens.
2. Preparation of Media, stains and isolation of Bacteria from infected plant.
3. Investigation of diseases caused by Bacteria, Phytoplasma, Viruses.
4. Study of Non parasitic diseases.
5. Virulence test for pathogens.
6. Production and assay of macerating enzymes.
7. Production and assay of polygalacturonase, cellulolytic enzymes, amylase.
8. Study of toxin production.
9. Effect of toxin on Seed Germination, Leaf Necrosis, Seedling.
10. Extraction and estimation of pigments in healthy and diseased plants.
11. Visits to fields for study of diseases.

Course Code: BOT/DSE/OC/561

Course Name: Taxonomy of Angiosperms – II

Course type: Discipline Specific Elective Course

Credits: 3, Contact Hours: 45 clock hours, 3 hours/ week

Marks: 75, Internal assessment: 30, External assessment: 45

UNIT-I: Species: Various concepts of species, Plant speciation: allopatric/ abrupt/ sympatric/ hybrid/ apomictic speciation and isolation mechanism. Types of speciation: quantum, catastrophic, local, geographic and phyletic. Causes of variation in population, ecotypes and ecads, evolution and differentiation of species, adaptive radiations.

UNIT-II: Botanical Nomenclature: Principles of Plant Nomenclature; Scientific names: legitimate and illegitimate names, autonym, homonym, synonym, basionym, tautonym, alternative name, ambiguous name, superfluous name, naked name, conserved name, rejected name; procedure to describe new taxon; Latin diagnosis and description, effective and valid publication, coining of generic names and specific epithets; citation of names of author(s); Scientific Journals in plant taxonomy.

UNIT-III: Taxonomic evidences: Morphology, micro-morphology, ultrastructure systematics- SEM and TEM studies, anatomy, embryology, palynology, cytology, ecology, population biology, phyto-chemistry, molecular biology and numerical taxonomy.

UNIT-IV: a) **Herbarium:** History, Objectives and function of an herbarium, Types of herbaria, role of herbarium in Systematics, Floristics, Teaching, Research, Assessment and documentation of phyto diversity and Public Education, pests in herbarium and its control. Contribution of "BAMU" Herbarium.

d) **Botanic Gardens:** Definition, criteria, history and role of botanic gardens, special types of botanic gardens: Arboretum, Pineatum, Orchidarium, Bambusetum, Fernary. Important Botanic Gardens in India and World.

UNIT-VI: Comparative account on distribution, floral morphology, interrelationships of families belonging to the following order as per APG IV system of classification:

- | | | | |
|----------------|----------------|-----------------|-----------------|
| a) Nymphaeales | b) Magnoliales | c) Arecales | d) Asparagales, |
| e) Liliales | f) Poales | g) Zingiberales | h) Ranunculales |
| i) Fabales | j) Rosales | | |

Suggested Reading:

1. AHMEDULLAH, M., AND M. P. NAYAR. 1987. Endemic Plants of the Indian Region. Vol. I. Botanical Survey of India. Howrah.
2. BHOJWANI, S. S. AND BHATNAGAR, S. P. 1984. Embryology of Angiosperms. Vikas Publ. House, New Dehli.
3. BILGRAMI, K. S. AND J. V. DOGRA. 1990. Phyto-Chemistry and Plant Taxonomy. New Delhi, CBS Publishers
4. CRONQUIST, A. 1988. The Evolution and Classification of Flowering Plants (2nd ed.) Allen Press, U. S. A.
5. DANIEL, M. 2009. Taxonomy: Evolution at work. Narosa Publishing House Pvt. Ltd. New Delhi.
6. DAVIS, P. H., AND V. H. HEYWOOD. 1991. Principles of Angiosperm Taxonomy. Today and Tomorrow Publications, New Delhi
7. DOBSON, A. P. 1996. Conservation and Biodiversity. Scientific American Library. New York, U. S. A.
8. ERDTMAN, G. 1986. Pollen Morphology and Plant Taxonomy: Angiosperms An Introduction to Palynology. Netherland, E. J. Brill, Leiden.
9. FORMAN, L. AND D. BRIDSON. 1989. The Herbarium Handbook. Royal Botanic Gardens, Kew, U. K.
10. GRAHAM, L. E. 1993. Origin of Land Plants. John Wiley & Sons. Inc. New York.
11. GREUTER, W, (Ed.) 2007. International Code of Botanical Nomenclature. (VIENNA CODE) Koeltz Vesentific Books. Germany.
12. GROOMBRIDGE, B, (Ed.) 1992. Global Biodiversity: Status of the Earth's Living Resources. Chapman and Hall. London.
13. HENRY, A. N., M. CHANDRABOSE. 1980. An Aid to International Code of Botanical Nomenclature. Today & Tomorrow's Printers and Publishers. New Delhi.
14. HEYWOOD, V. H. 1995. Global Biodiversity Assessment. Cambridge University Press, Cambridge, U. K.

15. HUTCHINSON, J. 1973. The Families of Flowering Plants. 3rd Edition. Oxford University Press. Oxford.
16. JAIN, S. K. and R. R. RAO. 1977. A Handbook of Field and Herbarium Methods. Today and Tomorrow's Printers and Publishers, New Delhi.
17. JOHRI, B. M. 1994. Botany in India: History and Progress. Vol-I. Oxford & IBH Publishing Co. Pvt. Ltd. New Delhi.
18. JONES, S. B., AND A. E. LUCHSINGER. 1987. Plant Systematics. 2nd Edition. McGraw-Hill Book Company. New York.
19. JUDD, W. S, C. S. CAMPBELL, E. A, KELLOG, P. F. STEVENS AND N. J. DONOGHUE. 2008. Plant Systematics. Sinauer Associates, INC, Publishers. Sunderland, Massachusetts, USA.
20. LAWRENCE, G. H. M. 1951. Taxonomy of Vascular Plants. The Macmillan Company. New York.
21. MABBERLEY, D. J. 2005. The Plant-Book, A portable dictionary of the vascular plants. Cambridge University Press, United Kingdom
22. MANILAL, K. S. AND M. S. MUKTESH KUMAR [ed.] 1998. A Handbook of Taxonomic Training. DST, New Delhi.
23. MINELLI, A. 1993. Biological Systematics: The State of the Art. London, Chapman & Hall.
24. MONDAL, A. K. 2005. Advanced Plant Taxonomy. New Central Book. Agency Pvt. Ltd. Kolkata.
25. MOORE, R., W. D. CLARK, K. R. STERN AND D. VODOPICH. 1995. Botany: Plant Diversity. Wm. C. Brown Publishers. London.
26. NAIK, V. N. 2000. Taxonomy of Angiosperms. Tata McGraw-Hill Publishing Company Limited, New Delhi.
27. Nair, P. K. K. 1966. Pollen morphology of Angiosperms. Periodical Expert Book Agency, New Delhi.
28. NAYAR, M. P., 1996. "Hot Spots" of Endemic plants of India, Nepal and Bhutan. Tropical Botanic Garden and Research Institute, Thiruvananthapuram, India.
29. NAYAR, M. P., AND R. K. SASTRY. 1987-1990. Red Data Book on Indian Plants. Vols. I - III. Botanical Survey of India. Howrah.
30. QUICKE, D. L. J. 1993. Principles and Techniques of Contemporary Taxonomy. Chapman and Hall. London.

31. RADFORD, A. E., W. C. DICKISON, J. R. MASSEY, AND C. R. BELL. 1974. Vascular Plant Systematics. Harper & Row. New York.
 32. RAVEN, P. H., R. F. EVERT, AND S. E. EICHHON. 1992. Biology of Plants. 5th Edition. Worth Publishers. New York.
 33. SANTAPAU, H. AND H. A. HENRY. 1994. A dictionary of the flowering plants in India, CSRI, New Delhi.
 34. SHARMA A. AND A. SHARMA. 1980. Chromosome Technique: Theory and Practices (3rd ed.) Butterworths, London.
 35. SHIVANNA, K. R. AND N. S. RANGASWAMY. 1992. Pollen Biology- A Laboratory Manual. Springer-Verlag
 36. SIMPSON, M. G. 2006. Plant Systematics. Elsevier Academic Press, California, USA.
 37. SINGH, G. 2005. Plant Systematics – Theory and Practice. Oxford and YBH Publishing Co. Pvt. Ltd., New Delhi.
 38. SIVARAJAN, V. V. 1989. Introduction to Principles of Plant Taxonomy. Oxford and IBH Publishing Co. New Delhi.
 39. SOLTIS, D. E., P. S. SOLTIS, P. K. ENDRESS AND M. W. CHASE. 2005. Phylogeny and Evolution of Angiosperms. Sinauer Associates, Inc, Massachusetts, USA.
 40. STACE, C. A. 1989. Plant Taxonomy and Biosystematics. Edward Arnold, London.
 41. STUESSY, T. F. 2002. Plant Taxonomy. Bishen Singh Mahendra Pal Singh, Dehra Dun, India.
 42. SUBRAMANIAM, N. S. 1995. Modern Plant Taxonomy. Vikas Publishing House. New Delhi.
 43. TAKHTAJAN, A. 1997. Diversity and Classification of Flowering Plants. Bishen Singh and Mahendra pal Singh, Dehra Dun, India.
 44. TAYLOR, D. V. AND L. J. HICKEY. 1997. Flowering Plants: Origin, Evolution and Phylogeny. CBS Publishers & Distributers, New Delhi.
 45. WILEY, E. O. 1981. Phylogenetics: The Theory and Practice of Phylogenetic Systematics. New York, John Wiley & Sons.
- <https://academic.oup.com/botlinnean/article/181/1/1/2416499>
- [https://en.wikipedia.org/wiki/APG_IV_system#:~:text=The%20APG%20IV%20system%20of,Angiosperm%20Phylogeny%20Group%20\(APG\).](https://en.wikipedia.org/wiki/APG_IV_system#:~:text=The%20APG%20IV%20system%20of,Angiosperm%20Phylogeny%20Group%20(APG).)

Course Code: BOT/DSE/OC/562

(Practical based on BOT/ DSE/OC/ 561)

Course Name: Practical - Taxonomy of Angiosperms – II

Course type: Discipline Specific Elective Course

Credits: 1, Contact Hours: 30 clock hours, 2 hours/ week

Marks: 25, Internal assessment: 10, External assessment: 15

1. Description of species based on many specimens to study intraspecific variation.
2. Study of morphology and general evolutionary trends in flowers, stamens and carpels of primitive families viz. Magnoliaceae, Papaveraceae, Nymphaeaceae, Lauraceae
3. Study of different types of ovules, placentation and evolutionary trends therein
4. Exercises on nomenclature problems: Author citation, principle of priority, transfer of taxa, effective and valid publication.
5. Semi-permanent pollen preparations by acetolysis method and study of different pollen morphotypes.
6. Study of plant surface attributes with the help of SEM photographs.
7. Descriptions, sketching, classification and identification of at least 30 families represented in local flora.
8. Classification and identification of at least 5 species of some of the genera like *Alysicarpus*, *Amaranthus*, *Cassia*, *Chlorophytum*, *Commelina*, *Cyperus*, *Euphorbia*, *Indigofera*, *Leucas*, *Sida*, *Solanum* etc.
9. Several One-day botanical excursions to botanically rich locations.
10. Botanical excursion of about one week to any botanically rich location preferable outside the State.

Course Code: BOT/DSE/OC/563

Course Name: Advanced Plant Physiology and Biochemistry – II

Course type: Discipline Specific Elective Course

Credits: 3, Contact Hours: 45 clock hours, 3 hours/week

Marks: 75, Internal assessment: 30, External assessment: 45

Unit I Photosynthesis and plant productivity C3, C4 and CAM pathways and photorespiration in relation to crop productivity, soil and water conservation methods, weed biology herbicides, biological weed control, intensive cropping, zero tillage use of plant growth regulators and bio-fertilizers in agriculture, Nitrogen use efficiency, optimum economic dose of nitrogen fertilizers green manuring.

Unit II. Biomass : The concept of Biomass, Biomass production, Utilization of biomass as a energy agricultural. Residue and their management HDEF energy forests energy crapping hydro carbon, plants biomathylation biogas, biogas plants, biogas production from soils city wastes.

Unit III. The practice of green manuring and preparation of compost NADEP and other methods, Utilization of solid wastes for composting recent trends in solid waste management and production sources.

Unit IV. Green crop fractionation: The GGF system and advantages of GCF. Mechanical fractionation, plants suitable for GCF, Machinery recommended for mechanical fractionation, products, pressed crop residue (PCR) Juice, leaf protein concentrate and deproteinized Juice (DPJ)

Unit V. Green Crop Fractionation: Use of PCR in animal nutrition preparation of silage, silage fermentation, use of leaf juice as a milk replacer, Preparation of LPC, chloroplastic and cytoplasmic LPC, Nutritive value of LPC, and its suitability in human nutrition as a sources of protein and vitamin - A, preservation of LPC, DPJ as a replacer of tissue culture media, LPC compared with algal protein SCP, the possibility of increasing protein productivity through green crop fractionation. Bidkin Process.

Suggested Readings:

1. Bajrachry D. Experiment in Plant Physiology, Narosa Publishing House, New Delhi.
2. Bidwell R. G. S., Plant physiology: Mac Millan Publishers Co., New York.
3. Bormer, J. and Galston, A. W., Principles of plant physiology,
4. Hess, Plant physiology, Narosa Publishing House, New Delhi.

5. Datta, S. C., Plant Physiology, Willey Eastern Limited, Calcutta.
6. Devlin, R. M. and Hostan, F. H., Plant physiology, CBS Publishers and Distributors, New Delhi.
7. Fairley, J. L. and Kilgon, G. L., Essentials of Biological Chemistry, Earr west Press Pvt. Ltd., Delhi.
8. Goodwin T. W. & E. I. Mercer (2003) Introduction to Plant Biochemistry, CBS, New Delhi
9. Hess, D. Plant Physiology, Narosa Publishing House, New Delhi.
10. ICAR Handbook of Agriculture, ICAR, New Delhi.
11. Jayraman, J., Laboratory Manual in Biochemistry, New Age International Publishers, Mumbai.
12. Lehninger, A. L. Principles of Biochemistry, CBS Publishers and Distributors, New Delhi.
13. Mertz, E. T., Vakils, Elementary Biochemistry, Fetter and SimsonsPvt Ltd. Mumbai.
14. Mukharji S., A. K. Ghosh, Plant Physiology, New Central Book Agencies, Kolkatta.
15. Mukharji, S. and Ghosh, A. K. Plant Physiology. New Central Book Agencies, Kolkatta.
16. Mungikar, A. M. Bibliography of leaf protein in Marathwada University.
17. Nels R. Lersten (2014) Flowering Plant Embryology, Wiley, New Delhi
18. Noggle G. R. and Fritz, G. S., Introductory plant physiology, Prentice Hall, USA.
19. Pandey S. N. & Sinha B. K., Plant Physiology, Vikas Publishing House, New Delhi
20. Pine, N. W. (1971) Leaf protein, its preparation, quality and use, Blackwell Scientific Publ. U. K.
21. Salisbury F. N. and C. W. Ross, Plant physiology: CBS Publishers and Distributors, New Delhi.
22. Slyter, R. O. Plant Water Relationships, Academic Press, New York.
23. Telek, H. and Graham, L. T. (1983) Leaf protein concentrates, AVI, Publishing Co., USA.
24. Vaidya, V. G., Sahasrabuddhe, K. R. and Khupse, V. S. Crop production and field experimentation Continental Prakashan, Pune - 30.
25. Wilkins M. B., Advanced plant physiology, English Language Book Society, London.

Course Code: BOT/DSE/OC/564

(Practical based on BOT/DSE/OC/563)

Course Name: Practical - Advanced Plant Physiology and Biochemistry – II

Course type: Discipline Specific Elective Course

Credits: 1, Contact Hours: 30 clock hours, 2 hours/ week

Marks: 25, Internal assessment: 10, External assessment: 15

1. Estimation of crude protein, crude fat and crude fiber.
2. Estimation of ash acid soluble / insoluble ash, Nitrogen free extracts and total carbohydrates.
3. Estimation of cell wall constituents, ADF, NDF, cellulose, hemicellulose, lignin etc.
4. Estimation of calcium by titration method.
5. Estimation of phosphorus by SubbaRao and Fiske Method,
6. Growth analysis: AGR, RGR, NAR, LAR, LAI, CGR and LAD.
7. The process of GCF and extractability of dry matter and Nitrogen.
8. Preparation of LPC, by heat coagulation, acid coagulation and fermentation.
9. Preparation of cytoplasmic and chloroplastic LPC by differential heat coagulation.
10. Preparation of TCM using DPJ and Inoculation of explant.

Course Code: BOT/DSE/OC/565

Course Name: Plant Diversity and Conservation – II

Course type: Discipline Specific Elective Course

Credits: 3, Contact Hours: 45 clock hours, 3 hours/ week

Marks: 75, Internal assessment: 30, External assessment: 45

Unit 1: Concept of Plant Taxonomy: Aims, Scope, Concept, Origin and evolution of plants in relation to Geological time scale. Salient features of Angiosperms, Comparative study with Gymnosperms.

Unit 2: Diversity of Cryptogams: Diversity of Algae (Nostoc, Spirogyra, Oedogonium, Chara), Fungi (Saccharomyces sps, Agaricus, Penicillium, Aspergillus), Lichen (Foliose, Crustose and Fruticose), Bryophytes (Marchantia, and Funaria) and Pteridophytes (Psilotum, Lycopodium, Equisetum):

Unit 3: Diversity of Phanerogams: Diversity of Gymnosperms and Angiosperms, Insectivorous plants, Poisonous plants, Epiphytic plants, Halophytic plants and Hallucinogenic Plants.

Unit 4: Plant Diversity of Marine & Estuarine ecosystems: Ecological zones, community organization, productivity, nutrient cycling and dynamics, upwelling and down welling of nutrients; mangroves, coral reefs and sea grasses.

Unit 5: Aquatic plant diversity: Ecosystem services and restoration Landscape ecological concepts; fresh water and coastal ecosystems. Coastal regulation zone (CRZ), Remote sensing and GIS in aquatic ecosystem management and conservation, climate change and aquatic ecosystem response. International conventions & protocols: Ramsar Convention, Convention on Biological Diversity, Ramsar sites in India.

Suggested Reading:

1. Choudhary H. J., S. K. Murthy, Plant Diversity and Conservation in India. Bishen Singh Mahendra Pal Singh Publishers, Dehradun.
2. Cole, A. J. 1969, Numerical Taxonomy. Academic Press. London.
3. Daris, P. H, and Heywood, V. H. 1973, Principles of Angiosperms' Taxonomy. Robert E. Krieger Pub. Co. New York.

4. Glover, D. M. and Hames, B. D. (Eds.) 1995. DNA cloning I: A practical approach, Core techniques, first edition, TASIRL Press al Oxford University Press, Oxford.
5. Grant, V. 1971 Plant Speciation, Columbia, University Press, New York.
6. Grant, W. F. 1984. Plant Biosystematic , Academic Press, London.
7. Hackett, P. B., Funchs, J. A. and Messing, J. W. 1998. An Introduction to recombinant DNA techniques: Basic experiments in gene manipulation. The Benjamin Cummings Publishing Company, Inc. Memno Park, California.
8. Harrison, H. J. 1971, New concepts in Flowering Plant Taxonomy. Hieman Educational Book Ltd., London.
9. Heslop-Harrison, J. 1967 Plant Taxonomy. English Language Book Soc. & Edward Arnold Pub. Ltd.
10. Jones, A. D. and Wilbins, A. D. 1971 Variations and Adaptions in Plant species. Hieman & Co. Educational Ltd. London
11. Mungikar A. M. (2008) An Introduction to Biometry, Saraswati Printing Press, Aurangabad.
12. Mungikar, A. M. 2003. Biostatistical Analysis. Saraswati Printing Press. Aurangabad.
13. Naik V. N. (1989) Taxonomy of angiosperms, Tata Mc Graw Hill Co. Ltd. New Delhi
14. Naik V. N. (1998) Flora of Marathwada, Amrut Prakashan, Aurangabad.
15. Nair M. N. B. (1998). Wood Anatomy and Major Uses of Wood, Faculty of Forestry, University of Putra Malaysia, Malaysia. 11
16. Parihar N. S. (1991) Bryophytes, Central Book Dept., Allahabad.
17. Radford, A. E., 1986, Fundamentals of Plant systematics. Harper & Raw Publicaations, U.S.A.
18. Sharma O. P. (2018), A text Book of Algae, Tata Mc Graw Hill, New Delhi
19. Shaw, C. H. (Ed.) 1988. Plant Molecular Biology: A Practical Approach. IRL Press, Oxford.
20. Shivanna K. R. (2003) Pollen Biology and Biotechnology, Science Publishers.
21. Shivanna, K. R. and Johri, B. M. (1985), 'The angiosperm pollen structure and function', Willey Eastern Ltd., New York.
22. Shivanna, K. R. and Rangaswamy, N. S. (1992), 'Pollen Biology: A laboratory manual', Springer Verlag, Berlin.

23. Smith G. M. (1950). The fresh water algae of the United states, McGrawHill Hoc Co., New York.
24. Soibrig, O. T. & Solbrig D. J., 1979. Population Biology and Evolution. Addison Wesley Publicating Co. Inc. U.S.A.
25. Stace, C. A., 1989, Plant Taxonomy and Biosystematics (2nd Edition) Edward Arnold, London.
26. Stebbins, G. L. 1974 Flowering Plant- Evolution Above Species Level Edward Arnold Ltd, London.
27. Takhtajan A. L. 1997. Diversity and Classification of Flowering Plants. Columbia University Press, .New York.
28. Davis U. K. Heywood, V.H. and Moore, D.M. 1984 Current concepts in Plant Taxonomy, Academic Press, London.
29. Woodland D.W. 1991. Contemporary Plant Systematics, Rentice Hall, New Jersey.

Course Code: BOT/DSE/OC/566

(Practical based on BOT/DSE/OC/565)

Course Name: Practical - Plant Diversity and Conservation – II

Course type: Discipline Specific Elective Course

Credits: 1, Contact Hours: 30 clock hours, 2 hours/ week

Marks: 25, Internal assessment: 10, External assessment: 15

1. Starch test, Cellulose Test, Tannin Test, Saponin, Alkaloids test, flavonoids test, Legnin Test.
2. Study of Cryptogams from nearby localities at least two examples from following groups (Algae, Fungi, Lichen, Bryophytes and Pteridophytes)
3. Study of Phanerogams from nearby localities.
4. Study of Family upto floral formula & diagram: Papavaraceae, Apocynaceae, Fabaceae, Rubiaceae, Asteraceae, Solanaceae, Verbenaceae, Euphorbiaceae, Liliaceae and Orchidaceae.
5. Submission of Herbarium Sheet.

Course Code: BOT/DSE/OC/567

Course Name: SEED TECHNOLOGY – II

Course type: Discipline Specific Elective Course

Credits: 3, Contact Hours: 45 clock hours, 3 hours/ week

Marks: 75, Internal assessment: 30, External assessment: 45

Seed Physiology & Hybrid Seed Production

Objectives:

- To familiarize the students with Physiology of seed development and maturation
- To learn various conventional and non-conventional hybrid Seed Production technologies.
- To learn the principles and need for the production of hybrid seeds particularly in field crops.

A: Seed Physiology

UNIT I

- Introduction, importance of seeds, seed structure and function, chemical composition of seed
- Physiological and biochemical changes during seed maturation assimilate movement to seeds, storage of carbohydrate, protein and fats in seeds and biosynthesis.
- Desiccation tolerance and sensitivity in relation to seed longevity, LEA protein.
- Hormonal regulation of seed development.

UNIT II

- Seed germination, factors influencing, breakdown and mobilization of stored products, carbohydrate, fat, protein, respiration and pathways of interconversion, control process in the mobilization of food reserve, hormonal control of germination.
- Seed dormancy, different types, environmental influences, mechanism and control including phytochrome, methods of breaking seed dormancy.
- Factors influencing loss of seed viability during storage, physiological and biochemical changes associated with seed ageing.

B: Hybrid Seed Production

UNIT – III

- Basic concept of hybrid seed production - Definition of variety and its type; Selection of site for seed production; Sowing, row spacing, fertilizer and irrigation.
- Techniques of hybrid seed production - emasculation and crossing: use of self-incompatibility, modification of sex; types of male sterility
- Pre requisites for hybrid seed production; mechanisms and management of pollination in autogamous and allogamous crops.

UNIT – IV

- Heterosis: definition, expression and estimation of hybrid vigour; utilization of heterosis in agricultural, horticultural for crop improvement.
- GMS – Introduction and its use in hybrid seed production. CMS- Introduction and its use in hybrid seed production. C-GMS- Introduction, seed production of A, B and R-Lines.
- Isolation, planting ratio and seed rate, Rouging and pollen shedders. Devices for hybrid seed production. Manual Emasculation and hand / insect pollination.

UNIT – V

Hybrid seed production of 1) **Maize** 2) **Cotton** with respect to following points -

- i) Source of seed
- ii) Selection of field (Land requirement)
- iii) Isolation,
- iv) Sowing
- v) Cultural practices (Fertigation, Irrigation, plant protection)
- vi) Rouging
- vii) Harvesting and threshing.

References:

1. Handbook of Agriculture- Indian Council of Agricultural Research, New Delhi
2. Singh, 2009. Plant Breeding: Principles and Methods. Kalyani Publishers, New Delhi
3. Agrawal, 2005. Seed Technology. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi
4. Reddy, 2008. Principles of crop production. Kalyani Publishers, New Delhi
5. Pandey, 2010. A text book of Botany. S. Chand and Company Ltd., New Delhi
6. Santra and Chatterjee, 2007. College Botany, New Central Book Agency (P) Ltd., Kolkata
7. Plant breeding-B. D Sing.
8. Basra, A.S. 2000. Heterosis and Hybrid Seed Production in Agricultural Crops. Food Product Press.
9. Singhal, N.C. 2003. Hybrid Seed Production. Kalyani Publishers.

Course Code: BOT/DSE/568


(Practical based on BOT/DSE/567)

Course Name: Practical - Seed Technology – II

Course type: Discipline Specific Elective Course

Credits: 1, Contact Hours: 30 clock hours, 2 hours/ week

1. Proximate analysis of chemical composition of seed.
2. Methods of testing viability; kinetics of seed imbibition and solute leakage.
3. Seed germination and dormancy breaking methods.
4. Seed invigoration and priming treatments; accelerated ageing and controlled deterioration tests
5. Enzymatic activities and respiration during germination and effect of accelerated ageing
6. Vigour testing methods etc.
7. Study the Field inspection at various stages.
8. Study of the methods of hybrid seed production in major agricultural and horticultural crops.
9. Study of maintenance of A, B and R lines and production of breeder seed.
10. Study of the stable diagnostic characteristics of parental lines and their hybrids.
11. Field visit for procure the knowledge of some terminology used in Hybrid technology- isolation-requirement for a crop, Rouging, harvesting and threshing


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