

SHIVAJI UNIVERSITY, KOLHAPUR.



Accredited By NAAC with 'A' Grade

**Revised Syllabus For
Bachelor of Science**

Part-II

Botany

CBCS PATTERN

Syllabus to be implemented from

June, 2019 onwards.

A] Ordinance and Regulations: (As applicable to Degree Course)

B] Shivaji University, Kolhapur
Revised Syllabus For
Bachelor of Science

1. TITLE : Subject- Botany
Optional under the Faculty of Science

2. YEAR OF IMPLEMENTATION:- Revised Syllabi (As per CBCS) will be implemented from June 2019 onwards.

3. PREAMBLE:-

[**Note :-**The Board of Studies should briefly mention foundation, core and applied components of the course/paper. The student should get into the prime objectives and expected level of study with required outcome in terms of basic and advance knowledge at examination level.]

4. GENERAL OBJECTIVES OF THE COURSE:
(as applicable to the Degree concerned)

Objectives:-

- 1) To impart knowledge of Science is the basic objective of education.
- 2) To develop scientific attitude is the major objective to make the students open minded, critical, curious.
- 3) To develop skill in practical work, experiments and laboratory materials and equipments along with the collection and interpretation of scientific data to contribute the science.
- 4) To understand scientific terms, concepts, facts, phenomenon and their relationships.
- 5) To make the students aware of natural resources and environment.
- 6) To provide practical experience to the students as a part of the course to develop scientific ability to work in the field of research and other fields of their own interest and to make them fit for society.
- 7) To The students are expected to acquire knowledge of plant and related subjects so as to understand natural phenomenon, manipulation of nature and environment in the benefit of human beings.
- 8) To develop ability for the application of the acquired knowledge to improve agriculture and other related fields to make the country self-reliant and sufficient.
- 9) To create the interest of the society in the subject and scientific hobbies, exhibitions and other similar activities.

5. DURATION

The course shall be a full time course.

6. PATTERN:-

Pattern of Examination will be Semester.

- 7. FEE STRUCTURE :-**
 As per Government /University rules.
1. Refer brochure and prospectus of concern affiliated college/institute to Shivaji University, Kolhapur.
 2. Other fee will be applicable as per rules and norms of Shivaji University, Kolhapur.

- 8. ELIGIBILITY FOR ADMISSION:**
 As per guidelines obtained from Shivaji University, Kolhapur by following rules and regarding reservations by Govt. of Maharashtra.

- 9. MEDIUM OF INSTRUCTION:**
 The medium of instruction shall be in English.

- 10. STRUCTURE OF COURSE- B. Sc. II Botany**

SECOND YEAR (SEMESTER III/IV) (NO.OF PAPERS IV)

Sr. No.	Subjects/Papers	Theory	Internal	Total Marks
1.	Paper-V	50	--	50
2.	Paper-VI	50	--	50
3.	Paper-VII	50	--	50
4.	Paper-VIII	50	--	50
	Practical -I			50
	Practical -II			50
	Total			300

- 11. SCHEME OF TEACHING AND EXAMINATION:-**

[The scheme of teaching and examination should be given as applicable to the course/paper concerned.]

SECOND YEAR - SEMESTER – III/ IV : Botany (Optional)

Scheme of Teaching and Examination

Sr. No.	Subject/Paper	Teaching Scheme (Hrs/Week)				Examination Scheme (Marks)		
		L	T	P	Total	Theory	Term Work	Total
Semester-III								
1	Paper-V	3	-	-	03	50	--	50
2	Paper-VI	3	-	-	03	50	--	50
Semester-IV								
3	Paper-VII	3	-	-	03	50	--	50
4	Paper-VIII	3	-	-	03	50	--	50
	Practical- I (annual)	-	-	4	04	-	-	50
	Practical- II (annual)	-	-	4	04	-	-	50
	Total	06	-	08	14	-	-	300

12. SCHEME OF EXAMINATION :-

- The examination shall be conducted at the end of each term for semester pattern.
- The Theory paper shall carry 50 marks.
- The evaluation of the performance of the students in theory papers shall be on the basis of Semester Examination of 50 marks.
- Question Paper will be set in the view of the /in accordance with the entire Syllabus and preferably covering each unit of syllabi.

13. STANDARD OF PASSING:-

As Prescribed under rules & regulation for each degree.

14. NATURE OF QUESTION PAPER AND SCHEME OF MARKING:

(Unit wise weightage of marks should also be mentioned)

- Q. 1. Multiple choices questions (10-questions) --- 10 Marks
 Q.2. Attempt **any two** of the following.
 (Essay type/Broad answer questions) ---- 20 Marks
 Q.3. Write short notes (**any four**) --- 20 Marks

15. EQUIVALENCE IN ACCORDANCE WITH TITLES AND CONTENTS OF PAPERS- (FOR REVISED SYLLABUS)

(Introduced from June 2019 onwards)

Old Syllabus (Semester pattern)		Revised Syllabus (Semester pattern)		
Paper No.	Title of Old Paper	Semester No	Paper No.	Title of New Paper
V	Algae, Fungi, Bryophytes and Industrial applications	Semester- III	V	Embryology of Angiosperms
VI	Plant Physiology, Ecology and Horticulture		VI	Plant Physiology
VII	Pteridophytes, Gymnosperm, Angiosperm and Anatomy	Semester- IV	VII	Plant Anatomy
VIII	Cytogenetics and Utilization of Plant Resources		VIII	Plant Metabolism

16. SPECIAL INSTRUCTIONS, IF ANY.

SEMESTER- III
Botany Paper V: DSC C13: EMBRYOLOGY OF ANGIOSPERMS
CREDITS: 2, LECTURE PERIOD: 3 PER WEEK- LECTURE HOURS: 2.4 PER
WEEK, MARKS: 50

UNIT	SUB-UNIT	TOPICS	LECTURE PERIOD
1	STRUCTURAL ORGANIZATION OF FLOWER, POLLINATION AND FERTILIZATION		22
	1.a: Organization of flower	1.1: Concept of flower as a modified Shoot, structure of typical flower. 1.2: Structure of typical androecium, Structure of tetrasporangiate anther and pollen grain. 1.3: Structure of typical gynoecium: Structure of a typical ovule, Types of ovules.	10
	1.b: Pollination and Fertilization	1.4: Definition, Types and mechanism in Anemophily (<i>Zea mays</i>), Entomophily (<i>Calotropis</i>) and Hydrophily (<i>Vallisneria</i>) 1.5: Microsporogenesis, pollen germination and male gametophyte 1.6: Megasporogenesis, structure of embryo sac: Monosporic (<i>Polygonum</i>) and Bisporic (<i>Allium</i>), female gametophyte. 1.7: Fertilization: Entry of pollen tube, double fertilization and triple fusion. Significance of double fertilization.	12
2	Embryo and Endosperm Development; Polyembryony and Apomixis		23
	2.a: Embryo and Endosperm Development	2.1: Structure and development of embryo in Monocotyledons. 2.2: Structure and development of embryo in Dicotyledons. 2.3 Development of endosperm, Types of endosperm- Nuclear, Helobial and Cellular	12
	2.b: Polyembryony and Apomixis	2.4: Polyembryony: Introduction, Types of polyembryony- True polyembryony (Cleavage and Adventive), False polyembryony. Causes of polyembryony, Significance of polyembryony. 2.5: Apomixis: Introduction, Causes of apomixes and Types: Gametophytic and Sporophytic, Significance of apomixis.	11
	TOTAL		45

SEMESTER- III
Botany Paper VI: DSC C14: PLANT PHYSIOLOGY
CREDITS: 2, LECTURE PERIOD: 3 PER WEEK- LECTURE HOURS: 2.4 PER
WEEK, MARKS: 50

UNIT	SUB-UNIT	TOPICS	LECTURE PERIOD
1	PLANT WATER RELATIONSHIP AND MINERAL NUTRITION		22
	1.a: Plant water relationship	1.1: Introduction, Physiological importance of water. 1.2: Water transport process: Mechanism of water absorption: active and passive absorption theories, water transport through xylem and tracheids. 1.3: Transpiration: Definition, Types of transpiration, Mechanism of stomatal movement, Starch-sugar hypothesis, Factors affecting transpiration, Significance of transpiration.	12
	1.b: Mineral nutrition	1.4: Introduction, Macro and Micronutrients 1.5: Criteria of essentiality 1.6: Mineral nutrient uptake- Passive uptake (Diffusion), Active uptake (Carrier Concept) 1.7: Role and Deficiency Disorders of Macronutrients (P, K, Ca, Mg) and Micronutrients (Fe, Mn) in plants and its recovery.	10
2	PHOTOSYNTHESIS, GROWTH AND DEVELOPMENT		23
	2.a: Photosynthesis	2.1: Introduction 2.2: Photosynthetic pigments- (Chlorophylls, Carotenoids and Phycobilins) 2.3: Mechanism of Photosynthesis: a) Light reaction- Photolysis of water, Photosystem I and Photosystem II, Electron transport and Photophosphorylation- Cyclic and Non-cyclic. b) Dark reaction: C ₃ , C ₄ and CAM pathways of carbon fixation. 2.4: Significance of photosynthesis	11
	2.b: Growth and Development	2.6: Definition, Region of growth, Phases of growth, growth curve, Grand period of growth. 2.7: Plant growth regulators: Discovery, site of synthesis, Physiological (Practical applications) roles of growth regulators –	12

		<p>Auxins, Gibberellins and Abscisic acid.</p> <p>2.8: Plant responses to light and temperature –</p> <p>a) Photoperiodism: Concept, Definition, Photoperiodic classification of plants- LDP, SDP, DNP.</p> <p>b) Mechanism of photoperiodism: Photoperiodic induction, perception of stimulus, role of Phytochrome, flowering hormone-Floregin concept, significance of photoperiodism.</p> <p>2.9: Vernalization: Concept, mechanism, site of vernalization and its significance.</p>	
	TOTAL		45

SEMESTER- IV
Botany Paper VII: DSC D13: PLANT ANATOMY
CREDITS: 2, LECTURE PERIOD: 3 PER WEEK- LECTURE HOURS:
2.4 PER WEEK, MARKS: 50

UNIT	SUB-UNIT	TOPICS	LECTURE PERIOD
1	ORGANIZATION OF HIGHER PLANT BODY AND TISSUES		22
	1.a: Organization of higher plant body	1.1: The Plant organs 1.2: Development of plant body 1.3: Internal organization	10
	1.b: Meristematic and Permanent Tissue	1.4: Meristem: a) Introduction, Characteristics and Classification of meristems based on position b) Theories of structural development- i) Apical cell theory ii) Histogen theory iii) Tunica Corpus theory. 1.5: Permanent tissue: i) Simple tissue- Parenchyma, Collenchyma and Sclerenchyma ii) Complex tissue: Xylem and Phloem 1.6: Types of Vascular bundles	12
2	PRIMARY AND SECONDARY STRUCTURE OF PLANT BODY AND TISSUE SYSTEMS		23
	2.a: Primary and secondary structure of plant body	2.1: Primary structure of Monocotyledon and Dicotyledon root, stem and leaf. 2.2: Normal secondary growth in Dicotyledon root and stem. 2.3: Anomalous secondary growth in <i>Bignonia</i> (Dicot.) and <i>Dracaena</i> (Monocot.) stem. 2.4 : Periderm and Lenticel	12
	2.b: Tissue systems	2.5 : Epidermal tissue system 2.6: Secretory tissue system 2.7: Mechanical tissue system	11
	TOTAL		45

SEMESTER- IV
Botany Paper VIII: DSC D14: PLANT METABOLISM
CREDITS: 2, LECTURE PERIOD: 3 PER WEEK- LECTURE HOURS:
2.4 PER WEEK, MARKS: 50

UNIT	SUB-UNIT	TOPICS	LECTURE PERIOD
1	ENZYMES AND NITROGEN METABOLISM		22
	1.a: Enzymes	1.1 : Introduction 1.2 : Classification and Nomenclature of enzymes 1.3 : Structure and properties of enzymes 1.4 : Mechanism of enzyme action- Lock and Key hypothesis and Induced fit hypothesis. 1.5: Factors affecting enzyme activity- temperature and pH. 1.6: Enzyme inhibition	12
	1.b: Nitrogen Metabolism	1.7: Introduction 1.8: Biological Nitrogen Fixation- Asymbiotic and Symbiotic 1.9: Mechanism of Nitrogen Fixation 1.10: Nitrate reduction 1.11: Ammonia assimilation 1.12: nif genes	10
2	RESPIRATION, SEED DORMANCY AND GERMINATION		23
	2.a: Respiration	2.1: Introduction 2.2:Types of respiration 2.3:Glycolysis 2.4: Formation of Acetyl Co A 2.5: TCA cycle 2.6: ETS in mitochondria 2.7: Fermentation	12
	2.b: Seed Dormancy and Germination	2.8: Concept of dormancy 2.9: Causes of dormancy 2.10: Methods of breaking of seed dormancy. 2.11: Seed germination- Introduction and types (Epigeal, Hypogeal and Viviparous). 2.12: Factors affecting seed germination 2.13: Biochemical changes during seed germination.	11
	TOTAL		45

PRACTICALS IN BOTANY
B.Sc. Part – II
(To be implemented from June 2019)

Botanical excursions –

One teacher along with a batch not more than 20 students is taken for Botanical excursions to places of botanical interest, one in each term. If there are female students in a batch of sixteen, one additional lady teacher is permissible for excursion. Each excursion will not be more than 3 days during college working days. T.A. and D.A. for teachers and non teaching staff participating in the excursions should be paid as per the rules. The tour report duly certified by the concerned teacher and the head of the department should be submitted at the time of practical examination.

Details of Practical Examination

B. Sc. II Botany Practical – I and II are to be covered in 25 practicals each. These practicals are to be performed by the students. Each practical is to be supplemented by permanent slides, preserved / fresh specimens / materials, charts, herbarium sheets, wherever necessary.

Every candidate must produce a certificate from Head of the Department in his / her college stating that he / she has completed practical course in a satisfactory manner as per the lines laid down by academic council on the recommendations of Board of Studies in Botany. The student should record his / her observations and report of each experiment should be written in the Journal.

The Journal is to be signed periodically by teacher in charge and certified by Head of the Department at the end of the year. Candidates have to produce their certified journal and tour reports at the time of practical examination. A candidate will not be “**allowed to appear**” for the practical examination without a certified journal, otherwise a candidate must produce a separate certificate of his / her regular attendance for practical course and completion of the same signed by the concerned teacher and Head of the Department.

Total Marks for practical 100 Marks

- a) Practical – I - 50 Marks
- b) Practical – II - 50 Marks

The practical course is to be covered in 50 practicals .The practical course should be divided into practical no. I which will comprise 25 practicals based on Paper No. V & Paper No.VI where as the practical No. II will comprise 25 practicals based on Paper No.VII & VIII. The practical No I will carry 50 marks & practical II will also carry 50 marks. The practical examination will be conducted at the end of semester IV on two successive days.

Each practical examination (Practical I and II) should be of maximum 5 hours duration and shall test a candidate in respect of following –

- i. Identification and preparation of temporary and permanent slides.
- ii. Practical study of external and internal structures of different plants as per the syllabus.
- iii. Understanding of principles of the experiments.
- iv. Identification and setting of Physiological experiments.
- v. Recording of observations and conclusions.
- vi. Identification and understanding of the practicals conducted with respect to development of plants.
- vii. Spotting of the specimens as per the syllabus.
- viii. Submission of the tour report.

Practical- I

- 1) Study of structure of stomata and determination of stomatal density.
- 2) Study of stomatal and cuticular transpiration by cobalt chloride paper method.
- 3) Study of role and deficiency symptoms of P, K, Ca, Mg.
- 4) Estimation of Chlorophylls by Colourometric / Spectrophotometric method.
- 5) Separation of photosynthetic pigments by ascending paper chromatography.
- 6) Study of Kranz leaf anatomy in C₄ plants.
- 7) Estimation of TAN value in CAM plants.
- 8) Analysis of vegetative growth (any suitable method).
- 9) Effect of different concentrations of Auxins (IAA) on seed germination (any suitable dicot seeds).
- 10) Effect of different concentrations of Gibberellic acid (GA) on seed germination (any suitable monocot seeds).
- 11) Study of evolution of oxygen during photosynthesis.
- 12) Study of effect of light intensity on photosynthesis.
- 13) Demonstration of ascent of sap in plants (*Impatiens* sp. and *Polyanthus tuberosa*).
- 14) Detection of Calcium, Phosphate, Potassium and Iron in the plant tissue by biochemical tests.
- 15) Demonstration of Endo-osmosis and Exo-osmosis.
- 16) Determination of sugar percentage by hand refractometer.
- 17) Study of permeability of plasma membrane by using different concentrations of organic solvent.
- 18) Study of typical flower and its parts (floral whorls with their functions).
- 19) Study of young / mature anther by permanent slide.
- 20) Study of germination of pollen grains.
- 21) Detection of pollen fertility by staining technique.
- 22) Study of types of ovules (by permanent slide or photograph).
- 23) Study of dicotyledon and monocotyledon embryo (by permanent slide or photograph).
- 24) Dissection of embryo / endosperm from developing seeds (*Grevellia / Cucumis*).

Practical- II

- 1) Study of shoot and root apex by permanent slides.
- 2) Study of simple tissues.
- 3) Study of complex tissues.
- 4) Study of primary structure of dicot and monocot root
- 5) Study of primary structure of dicot and monocot stem
- 6) Study of normal secondary growth in dicot stem (*Annona* / *Moringa* / Sunflower) by temporary double stained preparation.
- 7) Study of anomalous/abnormal secondary growth in *Bignonia* (Dicot stem).
- 8) Study of anomalous/abnormal secondary growth in *Dracaena* (Monocot stem).
- 9) Study of periderm and lenticels (by permanent slides)
- 10) Double stained permanent micro preparation of any suitable material.
- 11) Study of anatomy of porous (ring porous & diffused porous) and non porous wood.
- 12) Maceration technique.
- 13) Study of Epidermal tissue system.
- 14) Study of Mechanical tissue system.
- 15) Study of Secretary tissue system.
- 16) Study of following anatomical peculiarities viz., aerenchyma, sunken stomata, multiple epidermis, stellate hairs, glandular hairs, nectaries, I-girdles.
- 17) Study of excretory products viz., Cystolith, Sphaeroraphides, Raphides in plants.
- 18) Determination of rate of respiration during seed germination by Ganong's respirometer.
- 19) Breaking of seed dormancy by mechanical and chemical scarification.
- 20) Study of effect of pH on Catalase enzyme activity.
- 21) Study of effect of temperature on Malate dehydrogenase enzyme activity.
- 22) Janus green B staining technique for mitochondria.
- 23) Demonstration of fermentation.
- 24) Study of biofertilizers.
- 25) Separation of Amino acids by Thin Layer chromatography.

Plant Physiology and Metabolism

1. Hopkins, W. G. 1995. Introduction to Plant Physiology. John Wiley & Sons, Inc., New York, USA.
2. Moore, T. C. 1989. Biochemistry and Physiology of Plant Hormones. (2nd edition). Springer – Verlag, New York, USA.
3. Salisbury, F.B. and Ross, C. W. 1992. Plant Physiology. (4th edition). Wadsworth Publishing Co., California, USA. 19
4. Taiz, L. and Zeiger, E. 1998. Plant Physiology. (2nd edition) Sinauer Associates, Inc., Publishers, Massachusetts, USA.
5. R.C. Grewal – Plant Physiology. Campus Books International 483/24, Prahiad street Ansari Road, Darya ganj, New Delhi – 110002.
6. V.K. Jain – Fundamentals of Plant Physiology. S. Chand & Company Ltd. Ramnagar, New Delhi – 110055.
7. Salisbury Ross – Plant Physiology. CBS, Publishers & Distributions 485/ Jain Bhawan, Bhole Nath Nagar, Shahdara, New Delhi – 110032.
8. Devlin & Witham – Plant Physiology. CBS Publishers & Distributors 485, Jain Bhawan, Bhole Nath Nagar, Shahdara, New Delhi – 110032.
9. G. Ray Noggle / G. Fritz- Introductory Plant Physiology. Prentice Hall of India Ltd. New Delhi – 110001.
10. V.Verma. Text Book of Plant Physiology. Emkay Publications., B-19, East KrishnaNagar, Delhi-1100051.
11. V.I. Paladin. Plant Physiology. Arihant Publishers. Jaypur, (India)
12. Dr. S. Sundara rajan- Physiology of Transport in Plants. Anmol Publications, Pvt. LTD. New Delhi.110002.
13. D.O.hall & K.K. Rao. Photosynthesis. Edward Arnold, East Street, Baltimore, Mary-land- 21202,U.S.A.
14. Bidwell, R.G.S. 1974. Plant Physiology. Macmillan P ub. Co., N.Y.
- 15.Devlin, R.M. and F.H. Witham. 1983. Plant Physiology. Willard Grant Press. U.S.A.
- 16.Hans-Walter Heldt. 1997. Plant Biochemistry and Molecular Biology. Oxford University Press, New York. Usa.
17. Jain, V.K. (2000): Fundamentals Of Plant Physiology ,S.Chand&Co, New Delhi.
18. Pandey, S.N. (1991): Plant Physiology, Vikas Publishing House (P) Ltd., New Delhi, India.
19. Verma, V. (2007): Text Book of Plant Physiology. Ane Books India, New Delhi.
20. Nobel, P.S. 2009. Physicochemical and Environmental Plant Physiology.4th edition Academic Press, UK
21. Taiz, L. and Zeiger, E. 2006. Plant Physiology. 4th Edition. Sinauers Associates, Saunders land, Massachusetts, USA
22. Helgi OPik, Stephen A. Rolfe, Arthur J. Willis. 2005. The Physiology of Flowering Plants, Cambridge University Press, UK
23. Kirkham, M.B. 2004. Principles of Soil and Plant Water Relations. Elsevier, Amsterdam, Netherlands.
24. Dennis, D.T., Turpin, D.H., Lefebvre, D.D. and Layzell, D.B. 1997. Plant Metabolism. 2nd Edition. Longman Group, U.K.
25. Fitter, A. and Hay, R.K.M. 2001. Environmental Physiology of Plants. Academic Press, UK.
26. Emil Tmog, Mineral Nutrition of Plants. Oxford and IBH Publishing House, Bombay/ New Delhi.
- 27.S. Sundara rajan- Plants Physiology. Anmol Publications, Pvt. LTD.New Delhi.110002.

Angiosperm Anatomy and Embryology

1. P.C. Vashista. - Plant Anatomy. Pradip Publications, Opposite Sitla mandir, Jalandhar-144008.
2. B.P.Pandey - Plant Anatomy. S.Chand & Company,LTD. Ram Nagar, New Delhi.110055.
3. A.C.Datta. - Botany For Degree Students. Press-Delhi, Bombay, Madrass
4. Carlquist, S. 1998.- Comparative Wood Anatomy: Systematic, Ecological and Evolutionary Aspects of dicotyledonous Wood.Springer – Verlag, Berlin.
5. Culter, E.G. 1969. Part I.- Cells and Tissues. Edward Arnold, London.
6. Culter, E.G. 1971. Part II- Organs.- Plant Anatomy: Experiment and Interpretation. Edward Arnold, London.
7. Esau, K. 1977. - Anatomy of Seed Plants. 2nd edition, John Wiley and Sons, New York.
8. Fahn, A. 1974. - Plant Anatomy. 2nd edition. Pergamon Press, Oxford.
9. Lyndon, R.F. 1990. - Plant Development: The Cellular Basis. Unwin Hyman, London.
10. Mauseth, J.D. 1988.- Plant Anatomy. The Benjamin/Cummings Publishing Company Inc., Metro Park, California, USA.
11. Nair, M.N.B. 1998. - Wood Anatomy and Major Uses of Wood. Faculty of Forestry, Universiti Putra Malaysia, 43400 Serdang, Selangor D.E., Malaysia.
12. Rahvan, V. 2000.- Developmental Biology of Flowering Plants. Springer- verlag, New York.
13. Raven, P.H., Evert, R.F.and Eichhorn, S.E. 1999. - Biology ofPlants. 5th edition. W.H., Freeman and Co., Worth Publishers, New York.
14. Steeves, T.A. and Sussex, I.M. 1989. - Patterns in Plant Development. 2nd edition. Cambridge University, Press, Cambridge.
15. Thomas, P. 2000. - Trees: Their Natural History. Cambridge University Press, Cambridge.
16. Chandurkar P. J. Plant Anatomy. Oxford and IBH publication Co. New Delhi 1971
17. Greulach V A and Adams J E Plant- An introduction to Modern Biology. Toppen Co. Ltd, Tokyo,
18. Eams and Mc Daniel. An Introduction to Plant Anatomy. McGraw –Hill Book Co. Ltd and Kogakusha Co, Tokyo, Japan
19. Adriance S Foster. Practical Plant Anatomy. D Van Nostrand Co. INC, Newyork
20. Pijush Roy. Plant Anatomy. New Central Book Agency Ltd, Kolkata
21. Pandey S N and Ajanta Chadha. Plant Anatomy and Embryology.Vikas Publishing House,Pvt, Ltd, New Delhi
22. Bhojwani S S and Bhatnagar S P. An Embryology of Angiosperms.
23. Maheshwari P. An introduction to Embryology of Angiosperms.
24. Nair P K K. Essentials of Palynology.
25. S. C. Datta. Systematic Botany. New Age International Publishers, New Delhi. (2015).