

Rayat Shikshan Sanstha's  
**Sadguru Gadage Maharaj College, Karad**  
**(Autonomous)**

**Syllabus under Autonomy**

**For**

**B. Sc. II (Botany)**

**Academic Year 2020 – 2021**

Rayat Shikshan Sanstha's  
**Sadguru Gadage Maharaj College, Karad (Autonomous)**  
**Syllabus for Bachelor of Science (B. Sc.) Part – II**

1. TITLE: **Botany**
2. YEAR OF IMPLEMENTATION: **2020 – 2021**
3. PREAMBLE:

The B. Sc. Botany course under autonomy has been prepared keeping in view the unique requirements of B. Sc. Botany students. The contents have been drawn up to accommodate the widening horizons of the discipline of biological sciences. The emphasis is to provide students the latest information along with due weightage to the concepts of classical botany so that they are able to understand and appreciate the current interdisciplinary approaches in the study of plant sciences and its role in societal development. The course content also lists new practical exercises so the students get a hands on experience of the latest techniques that are currently in use. The course will also inspire students to pursue higher studies in botany, for becoming an entrepreneur and enable students to get employed in plant based industries.

4. GENERAL OBJECTIVES OF THE COURSE:
  - To impart the knowledge of science is the basic objective of education.
  - To develop scientific attitude among the students and to make the students open minded, critical and curious.
  - To develop skill in practical work, experiments and laboratory materials.
  - To understand scientific terms, concepts, facts, phenomenon and their relationships.
  - To make the students aware of natural resource and environment.

- To enable the students to acquire knowledge of plants and related subjects so as to understand nature and environment in the benefit of human beings.
- To develop ability for the application of acquired knowledge to improve agriculture and related fields to make the country self-reliant.

5. DURATION: **01 year**

6. PATTERN: **CBCS Semester**

7. MEDIUM OF INSTRUCTION: **English**

8. STRUCTURE OF COURSE:

**1) THIRD SEMESTER (NO. OF PAPERS – 02)**

Sr. No.	Subject Title	Theory					Practical	
		Paper No. & Paper Code	Title of Paper	No. of lectures per week	Credits		No. of lectures Per week	Credits
1.	Botany	Paper V: BBT 301	Embryology of Angiosperms	6	4	Practical Paper – III BBP303	8	4
		Paper VI: BBT302	Plant Physiology					

**2) FOURTH SEMESTER (NO. OF PAPERS – 02)**

Sr. No.	Subject Title	Theory					Practical	
		Paper No. & Paper Code	Title of Paper	No. of lectures per week	Credits		No. of lectures Per week	Credits
1.	Botany	Paper VII: BBT 401	Plant Anatomy	6	4	Practical Paper – IV BBP 403	8	4
		Paper VIII: BBT 402	Plant Metabolism					

### **3) Structure and titles of papers of B. Sc. Course**

#### **B. Sc. II Semester III**

Paper V: Embryology of Angiosperms

Paper VI: Plant Physiology

Botany Practical III: Practical's based on Theory Paper V and VI

#### **B. Sc. II Semester IV**

Paper VII: Plant Anatomy

Paper VIII: Plant Metabolism

Botany Practical IV: Practical's based on Theory Paper VII and VIII

### **4) Other Features:**

#### **A) LIBRARY:**

Reference books, Text books, Journals, Periodicals available in Institute and Departmental Library. (Separate reference lists are attached along with the respective course syllabus)

#### **B) SPECIFIC EQUIPMENTS:**

a) Computer, LCD projector, Visualizer, Smart Board

b) Laboratory Equipment's:

1. Microscope with digital camera
2. Digital weighing balance
3. pH meter
4. Microtome
5. Autoclave
6. Hot Air Oven
7. Incubator
8. Refrigerator
9. Stereo zoom microscope
10. Dissecting microscope

### 5). Evaluation Structure for B. Sc. II

#### Semester III

	ESE	Internal Exam		Practical			Submission	Total
		ISE-I	ISE-II		Exam	Journal	Seminar + Student Performance	
Paper V	30	5	5	Practical- III(A)	25	5	5	150
Paper VI	30	5	5	Practical IV(A)	25	5	5	

#### Semester IV

	ESE	Internal Exam		Practical			Submission	Total
		ISE-I	ISE-II		Exam	Journal	Industrial visit/Educational Tour + Student Performance	
Paper V	30	5	5	Practical- III(A)	25	5	5	150
Paper VI	30	5	5	Practical IV(A)	25	5	5	

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**Semester III**

**Theory Paper V: BBT 301- Embryology of Angiosperms**

**Learning objectives:**

1. To impart the basic knowledge of flower structure in angiosperms.
2. To impart basic knowledge about processes of pollination and fertilization.
3. To impart the basic knowledge of Embryo development.

**Total Lectures 45**

**Unit I: Structural Organization of Flower**

**10**

Concept of flower as a modified Shoot, structure of typical flower, structure of typical androecium, types of anther, adhesion, cohesion, adalphy, epipetalous, epiphylous, structure of tetrasporangiate anther and pollen grain, structure of gynoecium; parts of carpel, syncarpus, apocarpus, types of style; structure of ovule, types of ovules.

**Unit II: Pollination and Fertilization**

**12**

Definition, types and mechanism in Anemophily (*Zea mays*), Entomophily (*Calotropis*) and Hydrophily (*Vallisneria*), structure of tetrasporangiate anther (Microsporogenesis), pollen germination and male gametophyte; megasporogenesis, structure of embryo sac: Monosporic (*Polygonum*) and Bisporic (*Allium*); fertilization: Entry of pollen tube (Chalazogamy, mesogamy, porogamy), double fertilization and triple fusion. Significance of double fertilization

**Unit III: Embryo and Endosperm Development**

**12**

Structure and development of embryo in Monocotyledons and Dicotyledons. Development of endosperm, Types of endosperm- Nuclear, Helobial and Cellular

**Unit IV: Polyembryony, Apomixis and Parthenocarpy**

**11**

Polyembryony: Introduction, Types - True polyembryony (Cleavage and Adventive), False polyembryony. Causes of polyembryony, Significance of polyembryony; Apomixis –

Introduction causes of Apomixis, Types – Gamatophytic & Sporophytic, Significance of Apomixis w.r.t. parthenocarpy.

**Learning Outcomes:**

1. The students will understand and will be able to describe the functions of angiosperm flower.
2. The students will learn to define concepts regarding pollination and fertilization in angiosperms.
3. The students will understand the process of Embryo developments and the variations found in the process.
4. The students learn to write answers and brief notes about embryology of angiosperms.

**References:**

1. Raghvan, V. 2000.- Developmental Biology of Flowering Plants. Springer- Verlag, New York.
2. Raven, P.H., Evert, R.F. and Eichhorn, S.E. 1999. - Biology of Plants. 5th edition. W.H., Freeman and Co., Worth Publishers, New York.
3. Steeves, T.A. and Sussex, I.M. 1989. - Patterns in Plant Development. 2nd edition. Cambridge University, Press, Cambridge.
4. Thomas, P. 2000. - Trees: Their Natural History. Cambridge University Press, Cambridge.
5. Greulach V A and Adams J E Plant- An introduction to Modern Biology. Toppen Co. Ltd, Tokyo.
6. Bhojwani S S and Bhatnagar S P. An Embryology of Angiosperms.
7. Maheshwari P. An introduction to Embryology of Angiosperms.
8. Nair P K K. Essentials of Palynology.
9. S. C. Datta. Systematic Botany. New Age International Publishers, New Delhi. (2015).

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**Bachelor of Science (B. Sc.) Part – II: Botany**

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**Semester III**

**Theory Paper VI: BBT 302- Plant Physiology**

**Learning Objectives:**

1. To impart the basic knowledge of different plant water relationships.
2. To impart the basic knowledge aspects of plant nutrition.
3. To impart the basic knowledge of photosynthesis.
4. To impart the basic knowledge of processes involved in growth and development in plants.

**Total Lectures 45**

**Unit I Plant water relationship**

**11**

Structure and physicochemical properties of water; Role of water in plant life; Forms of water in soil; Root hair as water absorbing part of the plant – movement of water in plant; Water transport processes (Mechanism of water absorption: active and passive absorption theories, water transport through xylem and tracheids); Transpiration: Definition, types, mechanism of stomatal movements, significance of transpiration, Anti-transpirants, Guttation; Ascent of Sap- Introduction, concept, theories (cohesion of water theory; Root pressure theory);

**Unit II Mineral nutrition**

**11**

Introduction; Essential elements (Macro and Micronutrients); criteria of essentiality; Mineral nutrient uptake - Passive (Diffusion), Active (Carrier Concept); Mineral deficiencies and plant disorders; role of deficiency symptoms of N, P, K, Mn, Zn, Cobalt treating nutritional deficiencies; Role of essential elements in agriculture and horticulture

**Unit III Photosynthesis**

**12**

Introduction; ultra-structure of chloroplast; photosynthetic pigments - (Chlorophylls, Carotenoids and Phycobilins); Mechanism of photosynthesis: a) Light reaction - Photolysis of

water, Photosystem I and II, Photophosphorylation - Cyclic and Non-cyclic; b) Dark reaction: C<sub>3</sub>, C<sub>4</sub> and CAM pathways of carbon fixation. Significance of photosynthesis.

#### **Unit IV Growth and development**

**11**

Growth: Introduction; Definition, Region of growth, Phases of growth, growth curve, Grand period of growth

Plant growth regulators: Introduction and definition; Discovery, site of synthesis, Physiological (Practical applications) roles of growth regulators – Auxins, Cytokinins, Gibberellins, Ethylene and Abscisic acid.

Reproductive growth: Concept of photoperiodism; SDP, LDP, Day neutral plants; concept of vernalization

#### **Learning Outcomes:**

1. The students learn about the processes involved in water uptake and utilization in plants.
2. The students learn the role of minerals in plants.
3. The students learn the basics of the processes involved in photosynthesis.
4. The students learn the mechanisms of growth and development in plants.

#### **References:**

1. Hopkins, W. G. 1995. Introduction to Plant Physiology. John Wiley & Sons, Inc., New York, USA. (Unit I)
2. Salisbury, F. B. and Ross, C. W. 1992. Plant Physiology. (4th edition). Wadsworth Publishing Co., California, USA. 19 (Unit I, II, III, IV)
3. Taiz, L. and Zeiger, E. 1998. Plant Physiology. (2nd edition) Sinauer Associates, Inc., Publishers, Massachusetts, USA. (Unit I, II, III, IV)
4. Grewal R.C. – Plant Physiology. Campus Books International 483/24, Prahiad street Ansari Road, Daryaganj, New Delhi – 110002. (Unit I, III)
5. Jain V.K. Fundamentals of Plant Physiology. S. Chand & Company Ltd. Ramnagar, New Delhi – 110055. (Unit I, III, IV)
6. Verma V. Text Book of Plant Physiology. Emkay Publications., B-19, East Krishna Nagar, Delhi-1100051. (Unit II)
7. Bidwell, R.G.S. 1974. Plant Physiology. Macmillan P ub. Co., N.Y. (Unit III)
8. Hopkins, W. G. 1995. Introduction to Plant Physiology. John Wiley & Sons, Inc., New York, USA. (Unit III)

9. Pandey, S.N. (1991): Plant Physiology, Vikas Publishing House (P) Ltd., New Delhi, India. (Unit IV)

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**Bachelor of Science (B. Sc.) Part – II: Botany**

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**Semester III**

**Practical Paper III: BBP 303- Practicals based on Theory Paper V and VI**

**Learning Objectives:**

1. To give practical knowledge to students about identification of plants around them.
2. To give the practical knowledge about morphological and anatomical variations in plants.
3. To participate students in experiential learning with these practicals.

**Practicals**

**Group A based on Paper V**

1. Study of typical flower and its parts (floral whorls with their functions). Study of simple tissues and complex tissues.
2. Study of young / mature anther by permanent slides and slide preparations.
3. Study of germination of pollen grains.
4. Detection of pollen fertility by staining technique.
5. Study of types of ovules (by permanent slide or photograph).
6. Study of dicotyledon and monocotyledon embryo (by permanent slide or photograph).
7. Dissection of embryo / endosperm from developing seeds (*Grevillia / Cucumis*).
8. Study of types of Gynoecium in angiosperms.
9. Mechanisms of pollination in angiosperms.
10. Study of parthenocarpic fruits.

**Group B based on Paper VI**

11. Study of stomatal and cuticular transpiration by cobalt chloride paper method.
12. Study of role and deficiency symptoms of P, K, Ca, Mg.
13. Estimation of Chlorophylls by Colorimetric / Spectrophotometric method.
14. Separation of photosynthetic pigments by paper chromatography.
15. Study of Kranz leaf anatomy in C4 plants.

16. Analysis of vegetative growth (any suitable method).
17. Demonstration of Ascent of sap
18. Study of evolution of oxygen during photosynthesis.
19. Study of effect of light intensity on photosynthesis
20. Study of permeability of plasma membrane by using different concentrations of organic solvent.

**Learning Outcome:**

1. Student shall know the embryological features of angiospermic plants.
2. Student shall learn to describe the plants and identification of plant families.
3. Students will be able to learn the effect of plant growth regulators on plants growth.
4. Students will be able to learn the different physiological processes.

**Books Recommended:**

1. Bendre A (2010) Practical Botany, Rastogi Publications
2. Pande BP, Modern Practical Botany, Vol. I, S Chand Publishers
3. Pande BP, Modern Practical Botany, Vol. II, S Chand Publishers
4. Wallis CJ (1966) Practical Botany for Advanced Level and Intermediate Students (5<sup>th</sup> Ed.), William Heinemann Medical Books Ltd.
5. Lawrence George H. M. 1951 Taxonomy of Vascular Plants. Oxford and IBH Publ. Co. Pvt. Ltd. New Delhi.
6. Singh G 2000. Angiosperm systematics: Theory and Practice. S. Chand Publications, New Delhi.

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**Semester IV**

**Theory Paper VII: BBT 401- Plant Anatomy**

**Learning objectives**

1. To make students aware about the basic concepts of anatomy.
2. To understand anatomical framework of angiosperms.
3. To make the students aware about the different types of tissue systems in plants.
4. To understand the concept of primary and secondary growth in plants.

**Total Lectures 45**

**Unit 1: Organization of higher plant body**

**08**

Development of plant body

The Plant organs

Internal organization of the plant body

**Unit 2: Meristematic and Permanent Tissue**

**12**

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.

Permanent tissue:

i) Simple tissue- Parenchyma, Chlorenchyma, Collenchyma and Sclerenchyma

ii) Complex tissue: Xylem and Phloem; types of Vascular bundles

iii) Special tissues: Secretary tissues

**Unit 3: Tissue systems****12**

A) Epidermal tissue system: Structure and Function; Uniseriate and multiple; epidermal outgrowths-unicellular, multicellular, glandular and non-glandular; stomata- structure, types and function.

B) Secretary tissue system: Glandular and laticiferous

C) Mechanical tissue system: Principles involved in distribution of mechanical tissues; distribution of mechanical tissue in leaf, stem and root of dicot and monocot.

**Unit 4: Primary and secondary structure of plant body****12**

Primary structure of root, stem and leaf of Monocotyledon and Dicotyledon.

Normal secondary growth in Dicotyledon root and stem – introduction and need; structure and function of periderm (bark and lenticels)

Anomalous secondary growth; definition and causes; Anomalous secondary growth in Bignonia (Dicot.) and Dracaena (Monocot.) stem.

**Learning outcomes**

1. The students learn to explain morphological and anatomical features of angiosperm.
2. The students will be able to describe the different anatomical features of plants.
3. The students will be able to identify the different types of tissue systems in plants.
4. The students will be able to identify the different stages of growth in plants.

**References:**

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. Chandurkar P. J. Plant Anatomy. Oxford and IBH publication Co. New Delhi 1971
13. Eams and Mc Daniel. An Introduction to Plant Anatomy. McGraw –Hill Book Co. Ltd and Kogakusha Co, Tokyo, Japan.
14. Adriance S Foster. Practical Plant Anatomy. D Van Nostrand Co. INC, New York
15. Pijush Roy. Plant Anatomy. New Central Book Agency Ltd, Kolkata
16. Pandey S N and Ajanta Chadha. Plant Anatomy and Embryology. Vikas Publishing House, Pvt, Ltd, New Delhi

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**Semester IV**

**Theory Paper VIII: BBT 402- Plant Metabolism**

**Learning Objectives:**

1. To impart the basic knowledge of different aspects of enzymology.
2. To impart basic knowledge of mechanisms on nitrogen metabolism in plants.
3. To impart the knowledge of concepts in respiration in plants.
4. To impart the basic knowledge of seed dormancy and germination in plants.

**Total Lectures 45**

**Unit I: Enzymes**

**11**

Introduction, definition Structure and properties of Enzyme; Classification and nomenclature of enzymes; Mechanism of enzymes catalysis and inhibition -a) Lock and key hypothesis, b) Induced fit Hypothesis; Factor affecting enzyme activity: a) Temperature; b) pH; c) Substrate Concentration

**Unit II: Nitrogen Metabolism**

**11**

Introduction of Nitrogen Metabolism; Biological nitrogen fixation, non-symbiotic and symbiotic nitrogen fixation; Nitrogen assimilation; Enzymes involved in Nitrogen fixation

**Unit III: Respiration**

**11**

Respiration: Introduction, structure of mitochondrion, types of respiration, Glycolysis, Formation of Acetyl Co A, TCA cycle, ETS in mitochondria, ATP synthesis and inhibitors of respiration

**Unit IV: Seed Dormancy and Germination**

**12**

Concept of dormancy, Causes of dormancy, Methods of breaking of seed Dormancy, Seed germination- Introduction and types (Epigeal, Hypogeal and Viviparous); Factors affecting seed germination, Biochemical changes during seed germination

**Learning Outcomes:**

1. The students learn to explain the concept of plant metabolism.
2. The students learn to write answers and brief notes about the role of enzymes in plant physiology.
3. The students learn the concepts of respiration in plants.
4. The students learn to explain the concepts of seed dormancy and germination in plants.

**References:**

1. Hopkins, W. G. 1995. Introduction to Plant Physiology. John Wiley & Sons, Inc., New York, USA. (Unit I, III)
2. Moore, T. C. 1989. Biochemistry and Physiology of Plant Hormones. (2nd edition). Springer – Verlag, New York, USA. (Unit I, III)
3. Salisbury, F. B. and Ross, C. W. 1992. Plant Physiology. (4th edition). Wadsworth Publishing Co., California, USA. 19 (Unit I, II, III, IV)
4. Taiz, L. and Zeiger, E. 1998. Plant Physiology. (2nd edition) Sinauer Associates, Inc., Publishers, Massachusetts, USA. (Unit I, II, III, IV)
5. Grewal R.C. – Plant Physiology. Campus Books International 483/24, Prahiad street Ansari Road, Darya ganj, New Delhi – 110002. (Unit I, III)
6. Jain V.K. Fundamentals of Plant Physiology. S. Chand & Company Ltd. Ramnagar, New Delhi – 110055. (Unit I, III, IV)
7. Bidwell, R.G.S. 1974. Plant Physiology. Macmillan P ub. Co., N.Y. (Unit III)
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**Semester IV**

**Practical Paper IV: BBP 403- Practicals based on Theory Paper VII and VIII**

**Learning Objectives:**

1. To give practical knowledge to students about anatomical features of plants.
2. To give the practical knowledge about various physiological processes.
3. To participate students in experiential learning with these practicals.

**Practicals:**

**Group A based on Paper VII**

1. Study of shoot and root apex by permanent slides.
2. Study of simple tissues and complex tissues.
3. Study of epidermal tissue system.
4. Study of mechanical tissue system.
5. Study of secretory tissue system.
6. Double stained permanent micro preparation of any suitable material.
7. Study of primary structure of dicot and monocot stem.
8. Study of primary structure of dicot and monocot root.
9. Studies of normal secondary growth in dicot stem (Annona / Moringa / Sunflower) by temporary double stained preparation.
10. Study of anomalous/abnormal secondary growth in Bignonia (Dicot stem).
11. Study of anomalous/abnormal secondary growth in Dracaena (Monocot stem).

**Group B based on Paper VIII**

1. Study of effect of pH on dehydrogenase enzyme activity.
2. Study of effect of temperature on catalase enzyme activity.
3. Study on nitrogen fixing microorganisms (demonstration).
4. Study of nitrate reductase enzyme activity.

5. Effect of Red and far red light on growth of plants.
6. Study of breaking seed dormancy by mechanical and chemical scarification.
7. Determination of rate of respiration during seed germination by Ganong's respirometer.
8. Janus green B staining technique for mitochondria.
9. Separation of amino acids by TLC

### **Learning outcomes**

The students shall learn:

1. Student shall know the anatomical features (tissue systems, normal secondary growth, abnormal secondary growth) of plants.
2. Students will be able to learn the effect of plant growth regulators on plants growth.
3. Students will be able to learn the different physiological processes.
4. Enzyme activity and its regulation.
5. Nitrogen metabolism in plants.
6. Photophysiology of plants.

### **References:**

1. Sadasivam and Manickam: Biochemical Methods. New Age International Publishers.
2. Bendre A (2010) Practical Botany, Rastogi Publications.
3. Pande BP, Modern Practical Botany, Vol. I, S Chand Publishers.
4. Pande BP, Modern Practical Botany, Vol. II, S Chand Publishers.
5. Wallis CJ (1966) Practical Botany for Advanced Level and Intermediate Students (5<sup>th</sup> Ed.), William Heinemann Medical Books Ltd.