



Hindi Vidya Prachar Samiti's
Ramniranjan Jhunjhunwala College of Arts, Science & Commerce
(Empowered Autonomous College)

Affiliated to

UNIVERSITY OF MUMBAI

Syllabus for the T. Y. B.Sc. (under NEP 2020)

Program: B.Sc. BOTANY

Program Code: RJSUBOT

Course Codes: Discipline specific course (DSC)

Theory

RJDSCBOT351 (Biomolecules and Cell Biology)

RJDSCBOT352 (Reproductive biology of Angiosperms)

Practicals

RJDSCBOTP351 (Biomolecules and Cell Biology)

RJDSCBOTP352 (Reproductive biology of Angiosperms)

Semester V

(Revised syllabus in alignment with the NEP 2020 facilitating the inter and multidisciplinary learning and multiple entry and exit of the students)

Level 5.5

(CBCS)

Revised and to be implemented from 2025-2026

Preamble

The National Education Policy 2020 aims at imparting skill-based learning and caters to the multiple entry and exit facility for the students thus empowering them to acquire knowledge at their pace. In the three-year UG program, the student has two exit options. Students also have the option of choosing the Honors program of four years of study in each discipline and later converting it to a five-year integrated PG degree program. As an undergraduate student, he/she learns the core subject (Major), a subject complementing the core subject (Minor), a course from another discipline (OEC or GEC), Vocational and Skill Enhancement course from the Major (VSEC). The remaining verticals under NEP 2020 are IKS (Indian Knowledge System), AEC (Ability Enhancement Course), VEC (Value Education Course) and with progressive three years of UG. A student also completes at different levels OJT (On Job Training), FP (Field Projects), CEP (Community Engagement Programme), RP (Research Project) which helps him/her in understanding their roots, application of the knowledge for the benefit of self and the society. Vertical CC (Co-curricular activities and activities related to yoga and human well-being) helps in preparing youth with good character and interpersonal relationships.

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Credit Structure for B. Sc. Semester V Major Subject: Botany as per NEP 2020

Implemented from the academic year 2025-2026 Level 5.5

Courses	Credits	Total Credits	Course Titles
Discipline Specific Course (DSC) Theory I Biomolecules and Cell Biology	4	12	RJDSCBOT351
Discipline Specific Course (DSC) Theory II Reproductive Biology of Angiosperms	4		RJDSCBOT352
DSC Practical I: (Biomolecules and Cell Biology)	2		RJDSCBOTP351
DSC Practical II: (Reproductive Biology of Angiosperms)	2		RJDSCBOTP352
Discipline Specific Elective (DSE) I Theory Palaeobotany	2	4	RJDSEBOT351
Discipline Specific Elective (DSE) I Practical Palaeobotany	2		RJDSEBOTP351
Discipline Specific Elective (DSE) II Theory Environmental Botany	2	4	RJDSEBOT352
Discipline Specific Elective (DSE) II Practical Environmental Botany	2		RJDSEBOTP352
Vocational Skill Course (VSC) Practical Systematic Botany	4	4	RJVSCBOTP351
Field Project (FP)/CEP	2	2	RJFPBOT351/ RJCEPBOT351
Total Credits	22	22	

***As per University Grid**

T.Y.B.Sc. Semester V (Botany) Syllabus

Course Code	Unit	Topic Headings	Credits	Duration	
RJDSCBOT351	Paper Title: Biomolecules and Cell Biology			4	(60 hours)
	I	Carbohydrates			
	II	Lipids			
	III	Endomembrane systems and Proteins			
	IV	Cell Division			

Course Code	Unit	Topic Headings	Credits	Duration
RJDSCBOT352	Paper Title: Reproductive Biology of Angiosperms			
	I	Palynology	4	(60 hours)
	II	Microsporogenesis		
	III	Megasporogenesis and Embryo sacs		
	IV	Fertilization, Embryo and Endosperm		

Course Code	Unit	Topic Headings	Credits	Duration
RJDSCBOTP351		Practical Title: Biomolecules and Cell Biology	2	(60 hours)

Course Code	Unit	Topic Headings	Credits	Duration
RJDSCBOTP352		Practical Title: Reproductive Biology of Angiosperms	2	(60 hours)

Course Code	Unit	Topic Headings	Credits	Duration
RJDSEBOT351 Elective Course 1	Paper Title: Palaeobotany			
	I	Introduction to Palaeobotany	2	(30 hours)
	II	Process of Fossilization		
	III	Fossil Pteridophytes		
	IV	Fossil Gymnosperms		

Course Code	Unit	Topic Headings	Credits	Duration
RJDSEBOTP351		Practical Title: Palaeobotany	2	(60 hours)

Course Code	Unit	Topic Headings	Credits	Duration
RJDSEBOT352 Elective Course 2	Paper Title: Environmental Botany			
	I	Plant Succession	2	(30 hours)
	II	Bioremediation and Phytoremediation		
	III	Global Environmental Change		
	IV	Biodiversity and Environmental Conservation		

Course Code	Unit	Topic Headings	Credits	Duration
RJDSEBOTP352		Practical Title: Environmental Botany	2	(60 hours)

Course Code	Unit	Topic Headings	Credits	Duration
RJVSCBOTP351		Practical Title: Systematic Botany	4	(120 hours)

Course Code	Unit	Topic Headings	Credits	Duration
RJFPBOT351		Practical Title: Field Project	2	(60 hours)

COURSE OUTCOMES (COs) B. Sc. BOTANY

SEMESTER	:	V, DISCIPLINE SPECIFIC COURSE
TITLE OF THE SUBJECT/COURSE	:	BIOMOLECULES AND CELL BIOLOGY
COURSE CODE	:	RJDSCBOT351
CREDITS	:	04
DURATION	:	60 HOURS

LEARNING OBJECTIVES	
1	Understand the basic structure of Carbohydrates. Differentiate between monosaccharide, disaccharides, and polysaccharides.
2	Compare the structures and functions of triglycerides, phospholipids, and steroids. Learn about the dietary sources and health implications of different lipids.
3	Learn the components and functions of the Endomembrane system in plant cells. Learn about the specific roles of the Endoplasmic Reticulum and Golgi complex in plant cells.
4	Learn the importance of the phases of the cell cycle, (G1, S, G2) and the M phase (mitosis and cytokinesis). Understand the significance of cell cycle in growth, development, and repair in plants.

COURSE OUTCOME NUMBER	On completing the course, the student will be able to:	PSO Addressed	BLOOMS LEVEL
CO1	Critically evaluate the roles and functions of different carbohydrates in plants and industrial applications.	1	BT Level III, IV
CO2	Apply their understanding of lipid metabolism to explain how fatty acids and glycerol are processed in biological systems.	1, 3	BT level III, IV and V
CO3	Apply their understanding of the endomembrane system to explain protein synthesis, modification, and transport processes in plant cells.	1,3	BT level III, IV and V
CO4	Compare and contrast the processes and outcomes of mitosis and meiosis, highlighting their	1,3	BT level III, IV and

	significance in organisms.		V
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B.Sc. BOTANY SEMESTER V BOTANY SYLLABUS

Course Code	Title	Credits
		4
RJDSCBOT351	Discipline Specific Course BIOMOLECULES AND CELL BIOLOGY	60 hours
Unit I: Carbohydrates 1. Classification of Carbohydrates, Stereoisomerism. 2. Structure of Glucose, Fructose, Lactose, Sucrose, Starch and Cellulose. 3. Biosynthesis and breakdown of Starch.		
Unit II: Lipids 1. Fatty acids: Nomenclature, structures of saturated and unsaturated fatty acids 2. Glycerol		
Unit III: Endomembrane systems and Proteins 1. Endoplasmic reticulum ultrastructure and significance 2. Golgi complex: Ultrastructure and significance 3. Chemical and Molecular structure of Proteins: Proteins as polymers of amino acids, primary structure of proteins, folding of polypeptide chain, secondary, tertiary and quaternary structure.		
Unit IV: Cell Division 1. Cell Cycle 2. Stages of Mitosis 3. Stages of Meiosis		

Suggested References

1. Wollheim, F. A. (2003). Molecular biology of the cell. Edited by Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter. Garland Science, 2002, published price 44£ sterling, weight 3,130 kg, illustrated ISBN 0-8153-3218-1. Scandinavian Journal of Rheumatology, 32(2), 125-125.
2. Cooper, G. M., & Hausman, R. E. The Cell: A Molecular Approach.
3. Lodish, H. F., Berk, A., Kaiser, C., Krieger, M., Bretscher, A., Ploegh, H. L., & Amon, A. (2021). Molecular Cell Biology (Vol. 1). New York: WH Freeman.

4. Lehninger, A. L., Nelson, D. L., & Cox, M. M. (2005). Lehninger Principles of Biochemistry. Macmillan.
5. Raven, P. H., Evert, R. F., & Eichhorn, S. E. (2005). Biology of plants. Macmillan.

COURSE OUTCOMES (COs). B Sc. BOTANY

SEMESTER	:	V, DISCIPLINE SPECIFIC COURSE PRACTICAL
TITLE OF THE SUBJECT/COURSE	:	BIOMOLECULES AND CELL BIOLOGY
COURSE CODE	:	RJDSCBOTP351
CREDITS	:	02
DURATION	:	60 HOURS

LEARNING OBJECTIVES	
1	Understand and perform the DNSA method for glucose and reducing sugar estimation.
2	Prepare and interpret standard calibration curve
3	Learn and execute lipid extraction from plant material using the Soxhlet apparatus. Calculate and interpret the saponification value of oils.
5	Determine and analyse alpha amino nitrogen in given samples.
6	Prepare plant root tip squashes and observe arrested metaphase.
7	Calculate and interpret the mitotic index.

COURSE OUTCOME NUMBER	On completing the course, the student will be able to:	PSO Addressed	BLOOMS LEVEL
CO1	Accurately perform and interpret assays for glucose, reducing sugars, lipids, proteins, and alpha amino nitrogen.	1	BT Level III, IV Apply draw conclusions
CO2	Extract lipids using the Soxhlet method and analyse saponification values.	1, 3	BT level III, IV and V
CO3	Estimate protein concentrations and alpha amino nitrogen using standard biochemical methods.	1,3	BT level III, IV and V
CO4	Prepare and analyse plant cell samples to observe mitotic stages and calculate the mitotic index.	1,3	BT level III, IV and V
CO5	Apply biochemical and cytological methods to real-world plant science problems, enhancing their practical and analytical skills.	1,3	BT level III, IV and V

Course Code	Discipline specific course Practical	Credits
RJDSCBOTP351	Biomolecules and Cell Biology	2
1. Standard graph for glucose by DNSA method. 2. Estimation of reducing sugars from the given plant material by DNSA method. 3. Extraction of Lipids from the given plant material using Soxhlet apparatus 4. Estimation of saponification value of the given oil sample. 5. Standard graph for BSA by Lowry's method. 6. Estimation of total soluble proteins by Lowry's method from the given plant material. 7. Determination of alpha amino nitrogen from the given plant material. 8. Squash preparation pre-treatment and observation of arrested metaphase from onion root tips. 9. Calculate the Mitotic index by squash preparation of Onion root tips.		

COURSE OUTCOMES (COs) B. Sc. BOTANY

SEMESTER	:	V, DISCIPLINE SPECIFIC COURSE
TITLE OF THE SUBJECT/COURSE	:	REPRODUCTIVE BOTANY OF ANGIOSPERMS
COURSE CODE	:	RJDSCBOT352
CREDITS	:	4
DURATION	:	60 HOURS

LEARNING OBJECTIVES

1	Identify and describe structural features of pollen grains using microscopy techniques. Perform and analyze methods for assessing pollen viability, germination, and best practices for storage.
2	Describe and identify the sequential stages of microsporogenesis in plants. Explain the process and key events involved in the development of the male gametophyte from microspores.
3	Identify and describe different types of ovules in plants. Describe the process and key events in the development of the female gametophyte from megaspores.
4	Explain the process and significance of double fertilization in flowering plants. Identify and differentiate between various types of endosperm formation in plants.

COURSE OUTCOME NUMBER	On completing the course, the student will be able to:	PSO Addressed	BLOOMS LEVEL
CO1	Apply palynological knowledge and techniques to practical problems in agriculture, environmental science, and industry.	1	BT Level III, IV Apply draw conclusions
CO2	Comprehensively explain the development process of the male gametophyte and its significance in plant reproduction.	1, 5	BT level III, IV and V Apply, analyze and evaluate
CO3	Describe the development process of the female gametophyte and understand its role in plant reproduction.	1,5	BT level III, IV and V Apply, analyze and evaluate
CO4	Accurately describe the process and importance of double fertilization in angiosperms. Students will be able to explain the mechanisms and significance of apomixis in plant reproduction.	1,5	BT level III, IV and V Apply, analyze and evaluate

Course Code	Title	Credits 4
RJDSCBOT352	Discipline Specific Course: REPRODUCTIVE BIOLOGY OF ANGIOSPERMS	60 hours
Unit I: Palynology 1. Pollen Morphology: Polarity, size and shape, pollen aperture, exine ornamentation, excrescences, NPC system of pollen classification and Pollen calendar. 2. Pollen viability, germination and storage. 3. Application of Palynology in honey Industry, coal and oil exploration, aerobiology and allergies.		
Unit II: Microsporogenesis 1. Internal structure of anther, types of tapetum, stages of Microsporogenesis. 2. Development of male gametophyte		
Unit III: Megasporogenesis 1. Types of Ovules. 2. Stages of Megasporogenesis. 3. Development of female gametophyte and types of Embryo sacs.		
Unit IV: Fertilization, Embryo and Endosperms 1. Double Fertilization. 2. Development of Embryo-<i>Capsella</i> type. 3. Types of Endosperms. 4. Apomixis.		

Suggested References

1. Agashe, S. N. (2019). *Pollen and Spores: Applications with special emphasis on Aerobiology and allergy*. CRC Press.
2. Steeves, T. A., & Sawhney, V. K. (2017). *Essentials of Developmental Plant Anatomy*. Oxford University Press.
3. SS, B., Bhatnagar, S. P., & Dantu, P. K. (2015). *The Embryology of Angiosperms*. Vikas Publishing House.
4. Doust, J. L., & Doust, L. L. (Eds.). (1988). *Plant Reproductive Ecology: Patterns and Strategies*. Oxford University Press, USA.

COURSE OUTCOMES (COs) B. Sc. BOTANY

SEMESTER	:	V DISCIPLINE SPECIFIC COURSE
TITLE OF THE SUBJECT/COURSE	:	REPRODUCTIVE BOTANY OF ANGIOSPERMS
COURSE CODE	:	RJDSCBOTP352
CREDITS	:	2
DURATION	:	60 HOURS

LEARNING OBJECTIVES

1	Analyze and describe the pollen morphology.
2	Analyze pollen content in honey samples to understand plant-pollinator interactions.
3	Study the stages of microsporogenesis and megasporogenesis using permanent slides to understand plant reproductive processes.
4	Identify and describe different types of ovules in plants.

COURSE OUTCOME NUMBER	On completing the course, the student will be able to:	PSO Addressed	BLOOMS LEVEL
CO1	Students will accurately describe the pollen morphology of specified plants	1	BT Level III, IV Apply draw conclusions
CO2	Students will competently assess and interpret pollen viability results.	1, 5	BT level III, IV and V Apply, analyze and evaluate
CO3	Students will identify and describe stages of microsporogenesis, megasporogenesis, and embryo development using slides.	1,5	BT level III, IV and V Apply, analyze and evaluate
CO4	Students will effectively mount embryos of <i>Citrus</i> , <i>Ricinus</i> , Maize and describe their structures.	1,5	BT level III, IV and V Apply, analyze and evaluate

Course Code	Discipline Specific Course Practical Title	Credits
RJDSCBOTP352	Reproductive Biology of Angiosperms	2
1. Study of Pollen morphology (NPC Analysis) of the following using Chitale's method: <i>Hibiscus</i>, <i>Datura</i>, <i>Ipomoea</i>, <i>Ocimum</i>, <i>Pancratium/Crinum</i> 2. Determination of Pollen viability using TTC method in the given plant material. 3. Study of Pollen germination in varying concentrations of Sucrose in the given plant material. 4. Pollen analysis from honey sample. 5. Study of stages of Microsporogenesis, Megasporogenesis and embryo development with the help of permanent slides. 6. Study of types of Ovules in the given plant materials. 7. Mounting of Embryo: <i>Citrus</i>, <i>Ricinus</i>, Maize.		

Teaching Learning Process

The teaching learning process in the learning outcomes-based curriculum framework in the subject of Botany is designed to develop the cognitive skills of every learner. The post graduate courses offer the requisite skills for professions and jobs in Botany. All courses have practicals as an integral part which promotes the learner to acquire the requisite skills for employment by experiential learning. An interesting combination of teaching learning processes is adopted in which the teacher and learners are actively involved.

Some of the salient teaching learning processes are

- ✓ Class lectures
- ✓ Presentations
- ✓ Group Discussion, workshops
- ✓ Peer teaching and learning
- ✓ Kinesthetic learning
- ✓ Flipped classroom, project-based learning, quiz, seminars, exhibitions, posters
- ✓ Practical experimental design planning, analysis, interpretation, application of knowledge gained, field projects, mini projects.
- ✓ Technology enabled self-learning.
- ✓ Internships, On job training
- ✓ Project work, scientific writing

The effective teaching strategies would address the requirements of learners to learn at their own pace. The teaching pedagogy adopted to ensure inculcate higher order skills in the learner. The entire program is also designed to foster human values, environmental consciousness for an equitable society. The teaching learning processes adopted would aim at participatory pedagogy.

Scheme of Examinations

1. Internal examination 40 marks by MCQ / Assignment / Project / Survey / Presentation / Seminar.
2. One External (Semester End Examination) of 60 marks. Duration: 2 hours.
3. Two Practical Examination at the end of Semester consisting of 50 marks each with minimum 20 marks for passing.
4. Minimum marks for passing Semester End Theory and Practical Exam are 40%.
5. Students must appear for the Semester End Examination to be able to complete total credits for a given Semester.
6. For any KT examinations, there shall be Examination on Demand and students must register for the same.
7. Four field projects for study of flora, identification of Genus and Species, plant authentication are compulsory.
8. Field work with submission of field report of quality can be considered under 20 marks internal.
9. A candidate will be allowed to appear for the practical examinations if he/she submits a certified Journal of T.Y.B.Sc. DSC Botany or a certificate from the Head of the Department/Institute to the effect that the candidate has completed the practical course of T.Y. B.Sc. DSC Botany as per the minimum requirements.
10. In case of loss of journal, a candidate must produce a certificate from the Head of the Department /Institute that the practical for the academic year were completed by the student. However, such a candidate will be allowed to appear for the practical examination, but the marks allotted for the journal (if any) will not be granted.
11. HOD's decision, in consultation with the Principal, shall remain final and abiding to all.

Evaluation and Assessment

(Based on the centralized guidelines given by EC under NEP 2020)

Evaluation (Theory): Total marks per course - 100

Internal Examination- 40 marks

External- Semester End Examination – 60 marks

Question paper covering all units and topics.

Two Practicals, Evaluation of Practical per Semester - 50 marks

There will be continuous evaluation for Practicals - 20 marks

Key to set effective Question paper

Question	Remember	Understand	Apply & Analyse	Evaluate & Create	Total Marks- Per Unit
Unit 1	04	04	04	03	15
Unit 2	04	04	04	03	15
Unit 3	04	04	04	03	15
Unit 4	04	04	04	03	15
-TOTAL- Per objective	16	16	16	12	60
% WEIGHTAGE	26.66	26.66	26.66	20	100%

Mapping of the course to Local/ Regional/National/International relevance

The diversity existing in the Plant kingdom is unparalleled ranging from single cell to the tallest tree living on this planet. Plants represent the unique organism which fulfils the energy needs of all other organisms. With their unique metabolic capacity, they can carry out biosynthesis of complex biomolecules at ambient temperature and pressure without polluting the surroundings, in fact help in obviating climate change. All courses contribute towards SDG 4 i.e. Quality Education

Class	Course Name	Course Code	Local relevance	Regional relevance	National relevance	International relevance
T.Y.B.Sc Botany Major	Biomolecules and Cell Biology	RJDSCBOT351	✓	✓	✓	✓
T.Y.B.Sc Botany Major	Reproductive Botany of Angiosperms	RJDSCBOT352	✓	✓	✓	✓
T.Y.B.Sc Botany Major	Biomolecules and Cell Biology Reproductive Botany of Angiosperms	RJDSCBOTP351 RJDSCBOTP352	✓	✓	✓	✓

Mapping of the course to Employability/ Entrepreneurship/Skill development

The courses in Botany have been designed to impart one or more skills to make students employable.

Class	Course Name	Course Code	Topic focusing on Employability/ Entrepreneurship/ skill development	Employability/ Entrepreneurship/ Skill development	Specific activity
T.Y.B.Sc. Botany Major DSC	Biomolecules and Cell Biology	RJDSCBOT351 RJDSCBOT352	All topics Domain Knowledge	Employability skills for teaching, research and Industry	Concepts
T.Y.B.Sc. Botany DSC	Reproductive Botany of Angiosperms	RJDSCBOT P351& 352	All topics Domain Knowledge	Employability skills for teaching, research and Industry	All Practicals

Integration of Cross cutting Issues

Class	Course Code	Cross Cutting Issues
T.Y.B.Sc. Botany Major DSC	RJDSCBOT351 RJDSCBOT352 RJDSCBOTP351 RJDSCBOTP352	Ethics, Environment and Sustainability UNSDG 4, 13,15 NEP 2020 Interdisciplinary