

Rayat Shikshan Sansthas

**Yashavantrao Chavan Institute of Science,
Satara
(Autonomous)**

**New Syllabus For
Bachelor of Science
Part – III**

Botany

Academic Year 2023 – 2024

Yashavantrao Chavan Institute of Science, Satara (Autonomous)

Syllabus for Bachelor of Science (B. Sc.) Part – III

1. TITLE: **Botany**

2. YEAR OF IMPLEMENTATION: 2023 – 2024

3. PREAMBLE:

The B. Sc. III Botany course under autonomy will be effective from the academic year 2023 – 2024. It 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 gets 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:

1. To impart the knowledge of science is the basic objective of education.
2. To develop scientific attitude among the students and to make the students open minded, critical and curious.
3. To develop skill in practical work, experiments and laboratory materials.
4. To understand scientific terms, concepts, facts, phenomenon and their relationships.
5. To make the students aware of natural resource and environment.
6. 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.
7. 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) FIFTH SEMESTER (NO. OF PAPERS – 04)

Sr. No.	Subject Title	Theory				Paper No. & Paper Code	Practical	
		Paper No. & Paper Code	Title of Paper	No. of lectures per Week	Credits		No. of lectures Per week	Credits
1.	Botany DSC (Com.)	Paper IX: BBT 501	Genetics and Plant Breeding	06	04	Practical Paper V BBP 508 (based on BBT 501 and 502)	10	04
		Paper X: BBT502	Microbiology, Plant Pathology and Mushroom Cultivation Technology					
		Paper XI: BBT 503	Cytology and Techniques in Biology					
2.	Botany DSE (Elect.)	Paper XII: BBT 504	Advanced Botanical Skills and Horticulture I	06	04	Practical Paper VI BBP 509 (based on BBT 503 and 504)	10	04
		Paper XII: BBT 505	Advanced Botanical Skills and Biofertilizers I			Practical Paper VI BBP 509 (based on BBT 503 and 505)		
		Paper XII: BBT 506	Advanced Botanical Skills and Herbal Technology I			Practical Paper VI BBP 509 (based on BBT 503 and 506)		
3.	Skill Enhancement	SECCBT 507	Basic Numerical Skills	01	01	SECCBP 510	03	01
4.	AECC			02	02			

2) SIXTH SEMESTER (NO. OF PAPERS – 04)

Sr. No.	Subject Title	Theory				Paper No. & Paper Code	Practical	
		Paper No. & Paper Code	Title of Paper	No. of lectures per Week	Credits		No. of lectures Per week	Credits
1.	Botany DSC (Com.)	Paper XIII: BBT 601	Plant Biochemistry and Molecular Biology	06	04	Practical Paper VII BBP 608 (based on BBT 601 and 602)	10	04
		Paper XIV: BBT 602	Bioinformatics, Biostatistics and Economic Botany					
		Paper XV: BBT 603	Plant Biotechnology and Paleobotany					
2.	Botany DSE (Elect.)	Paper XVI: BBT 604	Advanced Botanical Skills and Horticulture II	06	04	Practical Paper VIII BBP 609 (based on BBT 603 and 604)	10	04
		Paper XVI: BBT 605	Advanced Botanical Skills and Biofertilizers II			Practical Paper VIII BBP 609 (based on BBT 603 and 605)		
		Paper XVI: BBT 606	Advanced Botanical Skills and Herbal Technology II			Practical Paper VIII BBP 609 (based on BBT 603 and 606)		
3.	Skill Enhancement	SECCBT 607	Entrepreneurship Development	01	01	SECCBP 610	03	01
4.	AECC			02	02			

2) Structure and titles of papers of B. Sc. Course

B. Sc. III Botany Semester V

Paper IX (BBT 501): Genetics and Plant Breeding

Paper X (BBT 502): Microbiology, Plant Pathology and Mushroom Cultivation Technology

Paper XI (BBT 503): Cytology and Techniques in Biology

Paper XII (BBT 504): Advanced Botanical Skills and Horticulture I

Paper XII (BBT 505): Advanced Botanical Skills and Biofertilizers I

Paper XII (BBT 506): Advanced Botanical Skills and Herbal Technology I

Practical Paper V BBP 508 (based on BBT 501 and 502)
Practical Paper VI BBP 509 (based on BBT 503 and 504)
Practical Paper VI BBP 509 (based on BBT 503 and 505)
Practical Paper VI BBP 509 (based on BBT 503 and 506)
Skill Enhancement Paper I SECCBT 507 Basic Numerical Skills
Ability Enhancement Compulsory Course Paper III

B. Sc. III Botany Semester VI

Paper XIII: BBT 601 Plant Biochemistry and Molecular Biology
Paper XIV: BBT 602 Bioinformatics, Biostatistics and Economic Botany
Paper XV: BBT 603 Plant Biotechnology and Paleobotany
Paper XVI: BBT 604 Advanced Botanical Skills and Horticulture II
Paper XVI: BBT 605 Advanced Botanical Skills and Biofertilizers II
Paper XVI: BBT 606 Advanced Botanical Skills and Herbal Technology II
Practical Paper VII BBP 608 (based on BBT 601 and 602)
Practical Paper VIII BBP 609 (based on BBT 603 and 604)
Practical Paper VIII BBP 609 (based on BBT 603 and 605)
Practical Paper VIII BBP 609 (based on BBT 603 and 606)
Skill Enhancement Paper II SECCBT 607 Entrepreneurship Development
Ability Enhancement Compulsory Course Paper IV

3) 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 Equipments:

1. Microscope with digital camera
2. Trinocular Research Microscope
3. Stereo Zoom Microscope
4. Dissecting microscope
5. Laminar Air Flow
6. UV-VIS Double beam spectrophotometer
7. Refrigerated Centrifuge
8. Digital weighing balance
9. pH meter

10. Microtome
11. Autoclave
12. Hot Air Oven
13. Incubator
14. Refrigerator
15. EC meter
16. Colorimeter
17. Thermal Cycler
18. Gel Electrophoresis unit
19. Gel Documentation unit

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Theory Paper IX (BBT 501) Genetics and Plant Breeding

Course Objectives: The students will be able to....

1. Impart the basic knowledge of mendelian genetics.
2. Impart the basic knowledge of linkage, recombination and quantitative inheritance.
3. Impart the basic knowledge of variations in chromosome number and structure.
4. Impart the knowledge of crop improvement.

Unit	SEMESTER - V BBT 501 Genetics and Plant Breeding	No. of hours per unit/ Credits 45
Unit-I:	Mendelism and extra chromosomal inheritance	12
	1.1 Introduction	
	1.2 Principles of inheritance - a) Law of Dominance; b) Law of Segregation; c) Law of Independent Assortment; d) Back Cross and Test Cross	
	1.3 Gene interaction - a) Complementary gene interaction b) Supplementary gene interaction	
	1.4 Epistasis- Introduction, Dominant Epistasis, Recessive Epistasis	
	1.5 Extra-chromosomal Inheritance: Introduction, Plastid Inheritance and	

	Mitochondrial Inheritance (with classical as well as latest examples)	
Unit-II	Linkage, Recombination and Quantitative inheritance	11
	<p>2.1 Linkage: Definition, Linkage groups, types, Coupling and Repulsion Phase, significance in plant breeding</p> <p>2.2 Recombination (Crossing over): Definition, types, mechanism of crossing over, significance in plant breeding</p> <p>2.3 Quantitative inheritance:</p> <p>a) Polygene inheritance – Concept, examples 1] Kernel colour in wheat, and 2] Ear length in Maize along with latest updates</p> <p>b) Population genetics – Hardy-Weinberg’s Law</p>	
Unit – III	Variation in Chromosome Number and Structure	11
	<p>3.1 Chromosome number: Euploidy, Aneuploidy and Polyploidy</p> <p>3.2 Chromosomal structure: Deletion, Duplication, Inversion and Translocation</p> <p>3.3 Mutation: Spontaneous and Induced mutation. Types of mutagens – Physical and Chemical, Significance of mutations in plant breeding.</p>	
Unit – IV	Plant Breeding	11
	<p>4.1 Introduction, Definition, Aims and objectives</p> <p>4.2 Methods of Plant Breeding</p> <p>a) Introduction and Acclimatization</p> <p>b) Selection: i) Mass Selection; ii) Pure Line Selection; iii) Clonal Selection</p> <p>c) Hybridization techniques in Self- and Cross-pollinated crops</p> <p>d) Male Sterility and its significance</p> <p>e) Mutation Breeding: Gamma Garden</p> <p>4.3 Multiple Allelism: Introduction, Definition, Self-incompatibility in plants, significance in plant breeding.</p>	

Course outcomes: The students should be able to.....

- 1) Discuss & describe genetic basis of inheritance and extra chromosomal inheritance.
- 2) Describe and point out concept of linkage and recombination and concept of quantitative inheritance.
- 3) Explain the concepts and describe the chromosome structure and variation and explain the concept of mutation and its importance in crop improvement.
- 4) Describe and demonstrate different methods of plant breeding.

References

1. Allard A.W. *Principles of Plant Breeding*. Wiley Publications, 2010.
2. Chahal G.S., Gosal S.S. *Principles and Procedures of Plant Breeding: Biotechnological and Conventional Approaches*. New Delhi: Narosa Publishing Co., 2010.
3. Gardener J., Simmons H.J., Snustad D.P. *Principles of Genetics*. 8th ed., New York: John Wiley & Sons, 1991.
4. Gupta P.K. *Cytogenetics*. Meerut: Rastogi Publications, 2018.
5. Gupta P.K. *Genetics*. Meerut: Rastogi Publications, 1997.
6. Hartl D.L., Jones E.W. *Genetics: Principles and Analysis*. 4th ed., Massachusetts, USA: Jones and Barlett Publishers, 1998.
7. Singh B.D. *A text Book of Plant Breeding: Adynamic View Designed for Under Graduate Courses of Indian Universities*. 3rd ed., New Delhi: Kalyani Publications, 2011.
8. Singh B.D. *Cytogenetics and Plant Breeding, Cytogenetics and Plant Breeding*. New Delhi: Kalyani Publications, 2010.
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10. Singh B.D. *Plant Breeding: Principles and Methods*. New Delhi: Kalyani Publications, 2018.
11. Verma, P.S., Agarwal, V.K. S. *Cell Biology, Genetics, Evolution and Ecology*. New Delhi: Chand and Company Ltd., 2001.

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**Theory Paper X (BBT 502) Microbiology, Plant Pathology and Mushroom Cultivation
Technology**

Course Objectives: The students will be able to....

1. Impart the knowledge of microbes, microbial techniques, and industrial microbiology.
2. Impart the basic knowledge of microbial genetics.
3. Impart the knowledge of plant pathology, plant diseases and their management.
4. Impart the knowledge of mushroom cultivation, storage and its economic importance.

Unit	SEMESTER - V BBT 502 Microbiology, Plant Pathology and Mushroom Cultivation Technology	No. of hours per unit/ Credits 45
Unit-I:	Microbiology	10
	1.1 General characters of microbes: Bacteria, Viruses, Actinomycetes and Phytoplasma 1.2 Methods in Microbiology: Staining for microbes-bacteria and, PPLO, Sterilization Methods, Pure Culture Techniques 1.3 Industrial Microbiology: Applications of micro-organisms with reference to production of Antibiotics (Penicillin), Organic Acids (Lactic Acid), Alcohol (Ethyl Alcohol), Microbial Pesticides: Concept, Types and Significance	
Unit II	Microbial Genetics	10

	<p>2.1 Bacterial genome</p> <p>2.2 Recombination in Bacteria: Transformation and Transduction</p> <p>2.3 DNA and RNA viruses</p> <p>2.4 Importance of microbial genetics</p>	
Unit - III	Plant Pathology	15
	<p>3.1 Concept and Importance of Plant Pathology, General symptoms of plant diseases</p> <p>3.2 Transmission of Pathogen: Air, Seed, Soil and Water</p> <p>3.3 Methods of plant disease management: Physical, Mechanical, Chemical and Biological</p> <p>3.4 Role of quarantine in plant disease management</p> <p>3.5 Study of Plant Diseases w. r. t. pathogen, symptoms and management</p> <p>i) Grassy Shoot of Sugarcane (Phytoplasma), ii) Citrus Canker (Bacterial), iii) Yellow Vein Mosaic of Bhendi (Viral), iv) White Rust of Crucifers (Fungal) v) Early leaf spot (Tikka) disease of ground nut (Fungal)</p>	
Unit - IV	Mushroom cultivation technique	10
	<p>4.1 Introduction, History, General life cycle of mushrooms, Economic importance of mushrooms</p> <p>Types of Mushrooms: Non-edible (Poisonous) mushrooms and Edible (Non-poisonous) - Button, Oyster, Cordyceps, Shiitake and Black ear mushrooms</p> <p>4.2 Cultivation Technology: Preparation of spawn, Sterilization and preparation of mushroom bed, Spawning, Factors affecting quality of mushroom beds, Harvesting of mushrooms</p> <p>4.3 Storage: Short Term (Refrigeration), Long Term Storage (Canning, Pickles, Papads) and Drying in Salt Solutions</p> <p>4.4 Nutritional Value: Proteins, Carbohydrates, Mineral Elements, Vitamins, Crude Fiber Content of Mushrooms. Medicinal value of Mushrooms</p>	

Course Outcomes: The students should be able to.....

- 1) Discuss about microbes, Microbial techniques and different application of microbes in industries.
- 2) Solve the problem related microbial genetics and discuss application of microbial genetics.
- 3) Define concepts regarding chromosome structure and variation and explain the concept of mutation and its importance in crop improvement.
- 4) Identify plant diseases discuss their management.
- 5) Setup mushroom cultivation, storage and predicts its economic importance

References

1. Plant Pathology Agrios. G. N..Academic Press London. 1997.
2. Economics of mushroom cultivation. National Centre for Mushroom Research and Training, Solan, India. Anonymous, 1991
3. Cultivation Technology and Technical standards of components of Integrated Button Mushroom Unit, Protected Production under NHB Scheme. National Horticulture Board. Anonymous, 2011
4. Mushroom cultivation the past and the present of oyster mushroom. Kerteszetes Szoleszet. Balazs, S. 1985.
5. Introduction to the Bacteria. Clifton, McGraw Hill Co., New York. 1958
6. Laboratory Manual in Microbiology. Cunasekaran P New Age International Pvt. Ltd. 1995.
7. An Introduction to Recombinant DNA Techniques: Basic Experiments in Gene Manipulation. Hackett. P.B. Fuchs. J.A. and Messing J.W. The Benjamin /Cummings Publishing Co., Inc., Menlo Park California. 1988.
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10. Plant Protection. Mehta P.R. and Verma,
11. Theory and Practice in Experimental Bacteriology Meynell, E and Meynell, G.G. University Press, Cambridge. 1970

12. Old R.W. and Primrose, S.B. 1989. Principles of Gene Manipulation. Old R.W. and Primrose, S.B. Blackwell Scientific Publications. Oxford. UK. 1989
13. Microbiology. Peicar and Reid,
14. Diseases of Crop Plants in India. Rangswamy, G. and Mahadevan A. 1999.
15. Mushroom Cultivation in India. Suman B C and Sharma V P, 2007

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Theory Paper XI (BBT 503) Cytology and Techniques in Biology

Learning Objectives :The students will be able to....

1. Impart the basic knowledge of cell biology.
2. Impart the knowledge of techniques used in biological studies.

Unit	SEMESTER - V (BBT 503) Cytology and Techniques in Biology	No. of hours per unit/ Credits
Unit-I:	Cell as a unit of life 1.1 The Cell Theory, Prokaryotic and Eukaryotic cell (Ultrastructure) 1.2 Nucleus: Ultrastructure and role, Nuclear Envelope, Nuclear Pore Complex, DNA Packaging in Eukaryotes. 1.3 Mitochondria and Chloroplasts – Ultrastructure and Role. 1.4 Ribosomes – Prokaryotic and Eukaryotic ribosomes, structure and role	12
Unit II	Sub Cellular Structures and Cell Membrane 2.1. ER, Golgi body and Lysosomes: Structure and Role, 2.2 Peroxisomes and Glyoxysomes: Structure and Role. 2.3 Cell membrane – Structure, Lipid bilayer, Fluid Mosaic Model, Role.	10
Unit - III	Cell Cycle and Cell division 3.1 Cell cycle and its phases 3.2 Cell division: Mitosis and Meiosis with their significance.	10

	3.3 Apoptosis and autophagy	
Unit – IV	Instrumentation & Techniques in Biology	13
	4.1 Principles of microscopy, Light, Phase contrast and Electron microscopy (EM) – SEM and TEM.	
	4.2 Spectrophotometry, Micrometry, Photomicrography, Flow-cytometry	
	4.3 Chromatography Techniques: Paper chromatography, Thin layer chromatography, column chromatography	

Learning Outcomes: The students should be able to.....

1. Describe and summaries ultrastructure of cell.
2. Define concepts regarding roles of cell organelles.
3. Discuss the concepts and explain the cell cycle.
4. Understand and apply all the techniques studied.

References

1. Molecular Biology of Cell; Alberts B et al 6th edition; Garland Science, Taylor and Francis, New York. (2014)
2. Text Book of Experimental Biology. Aneja KR
3. Molecular Cell Biology; Charlothe JA Addison. Wesley Publ. Company. 1986
4. Cooper GM and RE Housemen (2015) The Cell: Molecular Approach; Cooper GM and RE Housemen 7th edition. (2015)
5. Cell and Molecular Biology De Robertis and De Robertis (VIII), B.I. Waverly Pvt. Ltd., New Delhi. (1997)
6. Cell and Molecular Biology, Dupraw EJ Academic Press, London. (1970)
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Theory Paper XII (BBT 504) Advanced Botanical Skills and Horticulture I

Learning Objectives: The students will be able to....

1. Impart the knowledge of advanced skills required in plant sciences.
2. Impart the basic knowledge of Horticulture and nursery management.

Unit	SEMESTER – V (BBT 504) Advanced Botanical Skills and Horticulture I	No. of hours per unit/ Credits 45
Unit-I	Intellectual Property Rights	12
	1.1 Introduction to Intellectual Property Right (IPR): Concept and kinds. Economic importance. IPR in India and World: Genesis and scope, some important examples. IPR and WTO (TRIPS, WIPO).	
	1.2 Patents: Objectives, Rights, Patent Act 1970 and its amendments. Procedure of obtaining patents, working of patents, Infringement.	
	1.3 Copyrights: Introduction, Works protected under copyright law, Rights, Transfer of Copyright, Infringement.	
Unit- II	The art of scientific writing and its presentation	11
	2.1 Data Collection and maintenance: Maintaining laboratory record, Tabulation and generation of graphs, Imaging of tissue specimens and application of scale bars, the art of field photography	

	<p>2.2 Scientific writing: Numbers, units, abbreviations and nomenclature used in scientific writing, writing references, scientific writing and ethics</p> <p>2.3 Data presentation: PowerPoint presentation, Poster presentation</p> <p>2.4 Plagiarism: Introduction to copyright-academic misconduct/plagiarism</p>	
Unit - III	Introduction to Horticulture and Floriculture	11
	<p>3.1 Introduction, Importance and divisions of horticulture</p> <p>3.2 Floriculture: Introduction; a) Cultivation and management of important cut flowers: Rose, <i>Gerbera</i>; b) Flower arrangement, packing, storage, transportation and marketing of cut flowers</p> <p>3.3 Pomology: Introduction; a) Cultivation and management of important fruit plants: Grapes, Mango; b) Fruit preservation technology: Physical methods (drying, freezing and heat); Chemical (sugar, salt, chemical preservatives); c) Fruit processing: Jam, Jelly, Squash, Pulp, Pickles</p>	
Unit - IV	Nursery management	11
	<p>4.1 Definition, objectives and scope, Infrastructure for nursery</p> <p>4.2 Propagation practices: Sexual and Asexual propagation</p> <p>a) Sexual – Seed sowing and transplantation of seedlings, advantages and disadvantages of sexual propagation</p> <p>b) Vegetative – i) Cutting – Definition, stem cutting (hard wood and soft wood cutting), use of PGR's for rooting</p> <p>ii) Layering – Definition, Simple layering, Air layering</p> <p>iii) Grafting – Definition, Whip grafting, Approach grafting</p> <p>iv) Budding – Definition, T-budding, Patch budding</p> <p>c) Propagation of specialized vegetative structure – Bulbs, Corms, Tubers, Rhizomes</p>	

Learning outcomes: The students would be able to.....

1. Understand the examples and describe the importance of IPR.
2. Summaries the experimental data and apply in scientific writing.
3. Understand the techniques of horticulture and describe its applications.

4. Understand recognize the techniques and apply in nursery management.

References

1. Textbook on intellectual property rights, Acharya, N.K., Asia Law House. (2001)
2. Gardening in India. Bose, T.K., Mukherjee, D., Oxford & IBH Publishing Co., New Delhi. (1972)
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5. Intellectual Property Rights: Ganguli, P., Unleashing the Knowledge Economy, Tata McGraw-Hill. ., (2001)
6. Understanding Trips: Managing Knowledge in Developing Countries, Guru, M., Rao, M.B., Sage Publications. (2003)
7. Introduction to Horticulture, Kumar, N., Rajalakshmi Publications, Nagercoil. (1997)
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10. Intellectual Property: Patents, Trademarks and Copyright in a Nutshell, Miller, A.R., Davis, M.H., West Group Publishers. (2000)
11. Floriculture in India. Randhawa, G.S., Mukhopadhyay, A., Allied Publishers. (1986)
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Theory Paper XII (BBT 505) Advanced Botanical Skills and Biofertilizers I

Learning Objectives: The students will be able to....

1. Impart the knowledge of advanced skills required in plant sciences.
2. Impart the basic knowledge of biofertilizers and biocontrol.

Unit	SEMESTER - V (BBT 505) Advanced Botanical Skills and Biofertilizers I	No. of hours per unit/ Credits 45
Unit-I	Intellectual Property Rights	12
	1.1 Introduction to Intellectual Property Right (IPR): Concept and kinds. Economic importance. IPR in India and world: Genesis and scope, some important examples. IPR and WTO (TRIPS, WIPO).	
	1.2 Patents: Objectives, Rights, Patent Act 1970 and its amendments. Procedure of obtaining patents, working of patents, Infringement.	
	1.3 Copyrights: Introduction, Works protected under copyright law, Rights, Transfer of Copyright, Infringement.	
Unit- II	1.4 Trademarks: Objectives, Types, Rights, Protection of goodwill, Infringement, Passing off, Defenses, Domain name	11
	The art of scientific writing and its presentation	
	2.1 Data Collection and maintenance: Types of data, Maintaining a laboratory record, Tabulation and generation of graphs, Imaging of tissue specimens and application of scale bars, the art of field photography	

	<p>2.2 Scientific writing: Numbers, units, abbreviations and nomenclature used in scientific writing, writing references, scientific writing and ethics</p> <p>2.3 Data presentation: PowerPoint presentation, Poster presentation, Presentation of data in research articles.</p> <p>2.4.Plagiarism:Introduction to copyright, academic misconduct/plagiarism</p>	
Unit - III	Introduction of Biofertilizers	11
	<p>3.1 Introduction, History, types and importance of biofertilizers</p> <p>3.2 Classification of biofertilizers (based on microorganisms used in biofertilizers production)</p> <p>3.3 Nitrogen cycle in nature and its importance</p> <p>3.4 Process of nodule formation, Role of Nif and Nod gene in Biological Nitrogen Fixation</p> <p>3.5 Enzyme nitrogenase and its component</p> <p>3.6 Biochemistry of nitrogen fixation</p> <p>3.7 Isolation and mass multiplication of – <i>Rhizobium</i></p>	
Unit - IV	Biocontrol	11
	<p>. 4.1 Bio-control: Introduction, sources and advantages.</p> <p>4.2 Important commercial products – Source, preparation and uses of Pyrethrins, Azadirachtin, Nicotine, <i>Trichoderma</i>, <i>Trichogramma</i></p> <p>4.3 Strategies of marking and Registration with CIB of bioagents and biopesticides</p> <p>4.4 Importance of <i>Verticillium/ Beauveria/ Metarhizium/ Nomuraea/ Paecilomyces/ Hirsutella thompsoni</i> as biopesticides and their mass production</p>	

Learning outcomes: The students would be able to.....

1. Understand the examples and describe the importance of IPR.
2. Summaries the experimental data and apply in scientific writing.
3. Categories the biofertilizers and apply in horticultural and agricultural purposes
4. Recognize the plants used for biocontrol and understand the mode of applications

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Theory Paper XII (BBT 506) Advanced Botanical Skills and Herbal Technology I

Learning Objectives: The students will be able to....

1. Impart the knowledge of advanced skills required in plant sciences.
2. Impart the basic knowledge of herbal technology.

Unit	SEMESTER - V (BBT 506) Advanced Botanical Skills and Herbal Technology I	No. of hours per unit/ Credits 45
Unit-I	Intellectual Property Rights	12
	1.1 Introduction to Intellectual Property Right (IPR): Concept and kinds. Economic importance. IPR in India and world: Genesis and scope, some important examples. IPR and WTO (TRIPS, WIPO). 1.2 Patents: Objectives, Rights, Patent Act 1970 and its amendments. Procedure of obtaining patents, working of patents, Infringement. 1.3 Copyrights: Introduction, Works protected under copyright law, Rights, Transfer of Copyright, Infringement. 1.4 Trademarks: Objectives, Types, Rights, Protection of goodwill, Infringement, Passing off, Defenses, Domain name.	
Unit-II	The art of scientific writing and its presentation	11
	2.1 Data Collection and maintenance: Types of data, Maintaining a laboratory record, Tabulation and generation of graphs, Imaging of tissue specimens and application of scale bars, the art of field photography	

	<p>2.2 Scientific writing: Numbers, units, abbreviations and nomenclature used in scientific writing, writing references, scientific writing and ethics</p> <p>2.3 Data presentation: PowerPoint presentation, Poster presentation, Presentation of data in research articles.</p> <p>2.4.Plagiarism:Introduction to copyright, academic misconduct/plagiarism</p>	
Unit - III	Herbal Medicines	11
	<p>3.1 Definition, Importance of herbal medicines</p> <p>3.2 Classification of crude drugs – Taxonomical (Morphological, Anatomical) and Chemical</p> <p>3.3 Identification, authentication, collection, processing and storage of medicinal plants.</p> <p>3.4 Introduction to general methods of extraction, isolation and purification of phytoconstituents.</p>	
Unit - IV	Pharmacognosy	11
	<p>4.1 Pharmacognosy: Introduction and Definition</p> <p>4.2 Medicinal uses of Tulsi, Ginger, Methi, Amla.</p> <p>4.3 Adulteration of drugs of natural origin: Evaluation by Morphological, Microscopic, Chemical, Physical, Chromatographical, Spectrophotometric techniques.</p>	

Learning outcomes: The students would be able to.....

1. Understand the examples and describe the importance of IPR.
2. Summarize the experimental data and apply in scientific writing.
3. Discuss & describe herbal medicines.
4. understand the basics and applications of pharmacognosy.

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Theory Paper I (SECCBT 507) Basic Numerical Skills

Learning Objectives: The students will be able to....

1. Impart the basic knowledge of mathematics.
2. Impart the knowledge of application of mathematics in biological studies.

Unit	SEMESTER - V (SECCBT 507) Basic Numerical Skills	No. of hours per unit/ Credits
Unit-I	Basics of Mathematics 1.1 Number systems: Natural numbers, Whole Numbers, Integers, Rational numbers, Irrational numbers, Real Number, Even Numbers, Odd Numbers, Prime Numbers, Composite Numbers, Perfect Numbers. 1.2 Rules of calculation: Division on numbers, Rules of Divisibility, factors and multiples, VBODMAS Rule, Basic formulae for real numbers. 1.3 H.C.F and L.C.M. 1.4 Unitary Method	8
Unit-II	Fractions, Decimal System and Roots 2.1. Fractions: Concept and types, Addition, subtraction, multiplication and division of fractions 2.2 Decimal System: Concept, types, recurring and non- recurring decimals, Addition, subtraction, multiplication and division of decimals. 2.3 Powers and Roots	3
	Probability, Average and percentage	3

Unit – III	3.1 Probability: concept, types, application in biological sciences 3.2 Average: Concept, types, applications in biological sciences 3.3 Percentage: Concept, applications in biological sciences	
Unit – IV	Logarithms, Factorials, Absolute value, Matrices and Venn Diagrams 4.1 Logarithms and Anti- Logarithms: Concept, applications in biological sciences 4.2 Factorials: Concept, applications in biological sciences 4.3 Absolute Value: Concept, applications in biological sciences 4.4 Matrices: Concept, applications in biological sciences 4.5 Venn Diagrams: Concept, applications in biological Sciences	6

Learning Outcomes: The students should be able to.....

1. Understand the basic mathematical concepts.
2. Define concepts of mathematics.
3. Apply mathematical concepts in his academics.
4. Formulate and solve problems in plant science using mathematical concepts.

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Practical Paper V (BBP 508: based on theory paper BBT 501 and 502)

Learning objectives: The students will be able to....

1. Give practical knowledge to students about different concepts in genetics.
2. Give the practical knowledge about various processes in plant breeding.
3. Give the practical knowledge of Microbial techniques (culture media, soil dilution, inoculation and staining).
4. Impart the knowledge of plant diseases, symptoms and causal organism.

Section	SEMESTER - V (BBP 508: based on theory paper BBT 501 and 502)	No. of hours per unit/ Credits 45
Section-I	<p style="text-align: center;">Practical's based on Theory paper BBT 501</p> <ol style="list-style-type: none"> 1. Genetic examples on Linkage. 2. Genetic examples on Crossing over 3. Genetic examples on Polygene inheritance 4. Determination of chromosome count in PMCs in <i>Allium</i> / <i>Cyanotis</i>. 5. Detection of meiotic anomalies in chromosomes in <i>Tradescantia</i>. 6. Preparation of idiogram by using karyotype or chromosomal photographs. 	

	<p>7. Methods of emasculation</p> <p>8. Breeding techniques in a) Malvaceae b) Fabaceae c) Poaceae</p> <p>Study of World map to show Vavilov's centers of origin of cultivated plants.</p> <p>9. Visit to Krishi Vidnyan Kendra/ Seed Company and submission of visit reports.</p>	
Section-II	Practical's based on theory paper BBT 502	
	<p>1. Preparation and sterilization of culture media –PDA (slants and plates).</p> <p>2. Isolation and separation of soil fungi by serial dilution method.</p> <p>3. Methods of inoculation - on slants and plates.</p> <p>4. Study of different types of stains: Cotton blue, Dien's stain, Gram's stain and other stains.</p> <p>5. Study of plant diseases - Grassy Shoot disease of Sugarcane,</p> <p>6. Citrus Canker and Yellow Vein Mosaic of Bhendi.</p> <p>7. Study of plant diseases - White Rust of Crucifers and Early leaf spot (Tikka) disease of ground nut.</p> <p>8. Seed treatment by dipping and seed dressing.</p> <p>9. Demonstration of Mushroom Cultivation.</p> <p>10. Demonstration of Harvesting and Storage of mushrooms.</p> <p>11. Submission of local plant /crop diseases (any ten).</p>	

Learning Outcomes: Student should be able to.....

1. Understand the knowledge about genetic problems.
2. Practice basic techniques in cytology.
3. Study plant breeding and identify the centers of origin of cultivated plants.
4. Understand the knowledge about basic techniques in genetics and plant breeding.

5. Study companies and research centers and perform microbial techniques (culture media, soil dilution, inoculation and staining).
6. List plant diseases, symptoms and causal organism.
7. Understands knowledge about collection and identification of plant pathological specimens in fields.
8. Understands knowledge about seed treatment by seed dipping and seed dressing.

References:

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Practical Paper VI BBP 509 (based on BBT 503 and 504)

Learning objectives: The students will be able to....

1. Give practical knowledge to students about different techniques in cell biology.
2. Give the practical knowledge about various techniques used in plant sciences.
3. Give the practical knowledge about various techniques in horticulture.
4. Give the knowledge of scientific writing and presentations.

Section	SEMESTER – V BBP 509 (based on BBT 503 and 504)	No. of hours per unit/ Credits 45
Section-I	Practical's based on Theory paper BBT 503	
	<ol style="list-style-type: none"> 1. Preparation of percent (%), molar (M), normal (N) and PPM solutions. 2. Study of the photomicrography technique and submission of photomicrograph. 3. Study of cell structure in Onion, <i>Hydrilla</i> leaf and <i>Spirogyra</i> filament. 4. Study of cell division (mitosis/ meiosis) and preparation of permanent cytological slides. 5. Study of separation of biomolecules using paper chromatography/ Column Chromatography. 6. Use of dialysis to separate smaller molecules from larger 	

	<p>molecules.</p> <ol style="list-style-type: none"> 7. Micrometry technique. 8. Isolation of mitochondria from plants. 9. Study of Beer and Lambert's Law. 10. Visit to Instrumentation laboratory (CFC) and submission of report. 	
Section-II	Practical's based on theory paper BBT 504	
	<ol style="list-style-type: none"> 1. Study of budding technique – Patch and T-budding 2. Study of layering technique – Air layering 3. Study of Grafting technique – Whip and Approach 4. Garden implements (Any five) – Garden shear, sickle, cutter, shovel, budding knife, secateurs, water can, pruning scissors, sprayer, spade 5. Study of ornamental plants – Rose, Gerbera, Marigold 6. Study of hedge and edge plants. 7. Study of indoor plants. 8. Poster presentation on defined topics. 9. Technical writing on topics assigned. 10. Visit to nursery (Separate handwritten report to be submitted by student) 	

Learning Outcomes: The students should be able to.....

1. Understand the preparation of different types of solutions.
2. Apply the basic cytological and anatomical techniques.
3. Identify different horticultural practices.
4. Understand the scientific writing and communication skills.

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Practical Paper VI BBP 509 (based on BBT 503 and 505)

Learning objectives: : The students will be able to....

1. Give practical knowledge to students about different techniques in cell biology.
2. Give the practical knowledge about various techniques used in plant sciences.
3. Give the practical knowledge about various techniques in horticulture.
4. Give the knowledge of scientific writing and presentations.

Section	SEMESTER - V BBP 509 (based on BBT 503 and 505)	No. of hours per unit/ Credits 45
Section-I	Practical's based on Theory paper BBT 503	
	<ol style="list-style-type: none"> 1. Preparation of percent (%), molar (M), normal (N) and PPM solutions. 2. Study of the photomicrography technique and submission of photomicrograph. 3. Study of cell structure in Onion, <i>Hydrilla</i> leaf and <i>Spirogyra</i> filament. 4. Study of cell division (mitosis/ meiosis) and preparation of permanent cytological slides. 5. Study of separation of biomolecules using paper chromatography/ Column Chromatography. 6. Use of dialysis to separate smaller molecules from larger 	

	<p>molecules.</p> <p>7. Micrometry technique.</p> <p>8. Isolation of mitochondria from plants.</p> <p>9. Study of Beer and Lambert's Law.</p> <p>10. Visit to Instrumentation laboratory (CFC) and submission of report.</p>	
Section-II	Practical's based on theory paper BBT 505	
	<ol style="list-style-type: none"> 1. Poster presentation on defined topics. 2. Technical writing on topics assigned. 3. Study of nitrogen fixing organisms. 4. Media used for biofertilizers, Biopesticides and bioagents production. 5. Isolation of <i>Rhizobium</i> from root nodules. 6. Estimating the efficiency of <i>Rhizobium</i> through pot culture experiments 7. Mass production of <i>Verticillium/ Beauveria/ Metarhizium/ Nomuraea/ Paecilomyces/ Hirsutella thompsoni/ Trichoderma</i> 8. Estimating the efficiency of <i>Trichoderma</i> through pot culture experiments 9. Methods of application of biofertilizers, Biopesticides and bioagents 10. Quality control tests for the biofertilizers, Biopesticides and bioagents 11. Visit to biofertilizers production company (Separate handwritten report to be submitted by student) 	

Learning Outcomes: The students should be able to.....

1. Understand the preparation of different types of solutions.
2. Apply the basic cytological and anatomical techniques.

3. Apply different techniques used in production and know application of biofertilizers and biocontrol agents.
4. Understand the scientific writing and communication skills.

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Practical Paper VI BBP 509 (based on BBT 503 and 506)

Learning objectives: The students will be able to....

1. Give practical knowledge to students about different techniques in cell biology.
2. Give the practical knowledge about various techniques used in plant science.
3. Give the practical knowledge about pharmacological techniques.
4. Give the practical knowledge of phytochemical analysis.

Section	SEMESTER – V BBP 509 (based on BBT 503 and 506)	No. of hours per unit/ Credits 45
Section -I	Practical's based on Theory paper BBT 503	
	<ol style="list-style-type: none"> 1. Preparation of percent (%), molar (M), normal (N) and PPM solutions. 2. Study of the photomicrography technique and submission of photomicrograph. 3. Study of cell structure in Onion, <i>Hydrilla</i> leaf and <i>Spirogyra</i> filament. 4. Study of cell division (mitosis/ meiosis) and preparation of permanent cytological slides. 5. Study of separation of biomolecules using paper chromatography/ Column Chromatography. 6. Use of dialysis to separate smaller molecules from larger 	

	<p>molecules.</p> <ol style="list-style-type: none"> 7. Micrometry technique. 8. Isolation of mitochondria from plants. 9. Study of Beer and Lambert's Law. 10. Visit to Instrumentation laboratory (CFC) and submission of report. 	
Section-II	Practical's based on theory paper BBT 506	
	<ol style="list-style-type: none"> 1. Poster presentation on defined topics. 2. Technical writing on topics assigned. 3. Study of adulterants by morphological, microscopic and physical methods of the following drugs: a) Black pepper b) Turmeric c) Cinnamon d) Saffron 4. Organoleptic study of Tulsi, Ginger, Methi and Amla 5. Study of microchemical and phytochemical tests for characterization of drug yielding plants. (any four: alkaloids, glycosides, tannins, terpenoids, saponins, steroids, flavonoids, carbohydrates) 6. Estimation of total phenolic content from suitable plant material. 7. Estimation of total alkaloid content from suitable plant material. 8. Estimation of total flavonoid content from suitable plant material. 9. Determination of antioxidant activity by suitable method. 10. Visit to Herbal Industry and submission of report. 	

Learning Outcomes: The students should be able to.....

1. Produce of different types of solutions.
2. Apply the basic cytological and anatomical techniques.
3. Understand the scientific writing and communication skills.
4. Identify basic pharmacological techniques.

- Understand the phytochemical analysis.

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Practical SECC Paper I (SECCBP 510) Practical's based on Basic Numerical Skills

Learning objectives: The students will be able to....

- Give practical knowledge to students about applications of mathematics in biological sciences.
- Give the practical knowledge about use of computers in solving the mathematical applications in biological sciences.

Section	SEMESTER – V	No. of hours per unit/ Credits 45
Section –I	(SECCBP 510) Practical's based on Basic Numerical Skills	
	<ol style="list-style-type: none"> Calculations of percent (%), molar (M), normal (N) and PPM solutions. Preparation of standard curves. Use of Excel Software for solving mathematical problems related to Addition, Subtraction, Division and Multiplication. Use of Excel Software for solving mathematical problems related to percentage and Average. 	

Learning Outcomes: The students should be able to.....

- Understand the molar (M), normal (N) and PPM solutions

2. Apply Excel Software to solve mathematical problems like percentage and Average.

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Theory Paper XIII (BBT 601) Plant Biochemistry and Molecular Biology

Learning objectives: The students will be able to....

1. Impart knowledge of carbohydrates.
2. Impart the basic knowledge of lipids.
3. Impart basic knowledge of proteins.
4. Impart the knowledge of Molecular biology.

Unit	SEMESTER – VI (BBT 601) Plant Biochemistry and Molecular Biology	No. of hours per unit/ Credits 45
Unit-I:	Carbohydrates	11
	1.1 Introduction, broad classification and properties of carbohydrates. 1.2 Isomerism: definition, types of isomers: epimers, anomers and enantiomers with suitable examples. 1.3 Structure of monosaccharides (pentose and hexose), oligosaccharides (sucrose and lactose), and polysaccharides (starch and cellulose) 1.4 Functions of carbohydrates in biological system	
Unit- II	Lipids	12
	2.1 Introduction and Classification of Lipids 2.2 Structure and properties of saturated fatty acids (Stearic and Palmitic acid) and unsaturated fatty acids (Oleic acid, Linoleic and Linolenic acids) 2.3 Beta Oxidation: Gluconeogenesis and its role in mobilization of fatty	

	acids during seed germination 2.4 Significance of Lipids in plants.	
Unit – III	Proteins	11
	3.1 Introduction, structure, properties and classification of amino acids	
	3.2 Brief outline of biosynthesis of amino acids - proline	
	3.3 General structure, classification of proteins	
	3.4 Protein biosynthesis in eukaryotes	
3.5 Significance of proteins in plants.		
Unit – IV	Nucleic Acids	11
	4.1 Composition and structure of nucleotides	
	4.2 DNA as carrier of genetic information (early experiments)	
	4.3 DNA: Watson and Crick Model, forms of DNA (A, B and Z)	
	4.4 DNA replication in eukaryotes	
	4.5 RNA: types, structure and role of RNA	
4.6 Regulation of gene expression- Lac Operon, Tryptophan Operon		

Learning Outcomes: The students should be able to.....

1. Describe the concept plant biochemistry and carbohydrates, classification and their significance.
2. Study concepts regarding molecular biology and explain the lipids synthesis, oxidation and biological significance.
3. Understand structure, properties and classification of amino acids and explain the general classification of protein and their synthesis.
4. Understand concepts of nucleic acids and their types and write answers and brief notes about plant biochemistry and molecular biology.

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Theory paper XIV (BBT 602) Bioinformatics, Biostatistics and Economic Botany

Learning objectives: The students will be able to....

1. Imbibe different bioinformatics databases and tools.
2. Impart the knowledge of Bioinformatics tools in biological research.
3. Impart use biostatistics concepts in their academics and research.
4. Impart economic aspects of plants and their use in day-to-day life.

Unit	SEMESTER - VI (BBT 602) Bioinformatics, Biostatistics and Economic Botany	No. of hours per unit/ Credits
Unit-I	Bioinformatics	14
	1.1 Introduction, Aim, Scope and Branches of Bioinformatics 1.2 Biological Databases: Classification Format and Retrieval system of Biological Database, National Center for Biotechnological Information (NCBI), Basic Local Alignment Search Tool (BLAST) 1.3 Protein Information Resource (PIR) - Concept, Resources, Databases and Data Retrieval 1.4 Genome Information Resources (GIR) – Concept, Resources, Databases 1.5 Applications of Bioinformatics- BLAST, Molecular Phylogeny (Concept, Methods, Analysis and Consistency, use of MEGA 6 software)	
	Biostatistics	11

Unit -II	<p>2.1. Introduction, definition, terminology.</p> <p>2.2. Collection and presentation of data- Types of data, techniques of data collection- Census method, sampling method- simple random, stratified and systematic sampling. Classification, tabulation, graphical representation- Histogram and polygon.</p> <p>2.3. Measures of central tendency and Dispersion- Arithmetic mean, Mode, Median, Range, Deviation, Mean deviation, Standard Deviation, Coefficient of Variation.</p> <p>2.4. Statistical methods for testing the hypothesis- i) Students' T-test; ii) Chi-square test.</p>	
Unit – III	<p style="text-align: center;">Economic Botany: Cereals, Legumes and Oils</p> <p>3.1 Origin of Cultivated Plants - Concept of centres of origin, their importance with reference to Vavilov's work.</p> <p>3.2 Cereals: Origin, Botanical Name, Morphology, Sources and Economic importance of Jowar and Wheat.</p> <p>3.3 Legumes: Origin, Botanical Name, Morphology, Sources and Economic importance of Gram and Pigeon Pea.</p> <p>3.4 Oils and Fats: Origin, Botanical Name, Morphology, Parts used and uses of Ground nut and soybean.</p>	10
Unit – IV	<p style="text-align: center;">Economic Botany: Spices, Beverages and Fibers</p> <p>4.1 Spices and Condiments - Origin, Botanical Name, Morphology, Parts used and uses of Ginger and Chilly</p> <p>4.2 Beverages – Origin, Botanical Name, Morphology, Parts used and uses of Tea ,coffee & <i>Garcinia</i></p> <p>4.3 Fibre yielding Plants - Origin, Botanical Name, Morphology, Parts used and uses of Cotton, <i>Agave</i> and Hemp</p>	10

Learning Outcomes: The students should be able to.....

1. Apply different bioinformatics databases and tools in biological research.
2. Understand Biostatistics and do data collection, analysis and use of different statistical programmes in their research work.

3. Study the centers of origin of crop plants and explain the different classes of economically important crop plants.
4. Understand the significance of economically important crops with their representative examples and learn the scope of economic uses of the plants.

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Theory Paper XV (BBT 603) Plant Biotechnology and Paleobotany

Learning Objectives: The students will be able to....

1. Impart the basic knowledge of Plant Biotechnology.
2. Impart the knowledge of Paleobotany.

Unit	SEMESTER - VI (BBT 603) Plant Biotechnology and Paleobotany	No. of hours per unit/ Credits 45
Unit-I	Plant Biotechnology and Plant Tissue Culture	12
	1.1 Introduction, History, Scope and Importance 1.2 Biotechnology in India 1.3 Plant Tissue Culture: Principles (Totipotency, cellular differentiation and competency), Culture media, and specific laboratory conditions 1.4 Types of tissue culture: Micropropagation, Anther culture, Embryo culture, Organ culture, Callus culture, Cell suspension culture, Protoplast culture, Somatic Embryogenesis, Somaclonal variation	
Unit-II	Recombinant DNA Technology	11
	2.1 Introduction, principle and enzymes involved in recombinant DNA technology 2.2 Cloning vectors: a) Prokaryotic - Plasmid, Lambda phage and Cosmid; b) Eukaryotic-YAC [Yeast Artificial Chromosomes] 2.3 Blotting techniques: Southern blotting and Northern Blotting	

	2.4 DNA fingerprinting: DNA marker – RAPD, ISSR, RFLP 2.5 Polymerase chain reactions (PCR) 2.6 DNA sequencing – Sanger’s dideoxy method	
Unit -III	Genetic Engineering	11
	3.1 Introduction. 3.2 Method of Gene transfer - <i>Agrobacterium</i> mediated, direct gene transfer by Electroporation, Microinjection, Micro-projectile bombardment in crop biotechnology. 3.3 Reporter genes, selectable marker genes 3.4 Transgenic plants – (Any 2) Bt cotton, Bt Brinjal, Golden rice, recently introduced plants	
Unit – IV	Palaeobotany	11
	4.1 Introduction, General account. 4.2 Study of following genera with reference to systematic position, external morphology, and affinities: a) <i>Lyginopteris</i> and b) <i>Enigmocarpon</i> 4.3 Applications of paleobotany: Role of microfossil in oil and coal exploration	

Learning outcomes: The students should be able to.....

1. Discuss the plant tissue culture and biotechnology.
2. Understand recombinant DNA technology and its application in genetic engineering.
3. Describe concept and Discuss scope of paleobotany.

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Theory Paper XVI (BBT 604) Advanced Botanical Skills and Horticulture II

Learning Objectives: The students will be able to....

1. Impart the knowledge of advanced skills required in plant sciences.
2. Impart the importance of protection of traditional knowledge with respect to plants.
3. Impart the basic knowledge of Horticulture and landscape gardening.

Unit	SEMESTER – VI (BBT 604) Advanced Botanical Skills and Horticulture II	No. of hours per unit/ Credits 45
Unit-I	Plant Microtechniques	12
	1.1 Microtechniques: Whole mounts, peel mounts, squash preparations, clearing, maceration and sectioning; Tissue preparation: living vs. fixed, physical vs. chemical fixation, coagulating fixatives, noncoagulant fixatives; tissue dehydration using graded solvent series; Paraffin and plastic infiltration; Preparation of thin and ultrathin sections.	
	1.2 Staining procedures, classification and chemistry of stains. Staining equipment. Reactive dyes and fluorochromes (including genetically engineered protein labeling with GFP and other tags). 1.3 Cytogenetic techniques with squashed plant materials.	
Unit -II	Protection of Traditional Knowledge	11
	2.1 Plant Varieties Protection: Objectives, Justification, International Position, Plant varieties protection in India. Rights of farmers, Breeders	

	<p>and Researchers. National gene bank, Benefit sharing. Protection of Plant Varieties and Farmers' Rights Act, 2001, PBR</p> <p>2.2 Geographical Indications: Objectives, Justification, International Position, Multilateral Treaties, National Level, Indian Position.</p>	
Unit – III	Olericulture and arboriculture	11
	<p>3.1 Olericulture: Introduction; Hydroponics, Cultivation and management of important vegetable crop: Capsicum, Tomato, Cucumber.</p> <p>3.2 Arboriculture: Introduction; Cultivation and management of important timber yielding plants: Teak, Dalbergia, Arjun, Babhul</p>	
Unit – IV	Landscape gardening	11
	<p>4.1 Introduction and principals of landscaping, importance and scope of landscape gardening</p> <p>4.2 Garden elements: major and minor, basic patterns and steps in landscaping</p> <p>4.3 Garden plants: trees, climbers, annuals, palms, ferns, cacti and succulents, criteria for plant selection, propagation of ornamental plants: sexual and vegetative methods, topiary technique</p> <p>4.3 Garden styles and types: Terrace gardening, vertical garden, Lawn cultivation and marketing, Rock garden, water garden, other garden components such as statues, garden benches, pathways and bridges</p> <p>4.4 British gardens, Japanese gardens and their types, gardens for special purpose</p>	

Learning outcomes: The students should be able to.....

1. Understand the basic techniques involved in plant sciences.
2. Know the importance of traditional knowledge.
3. Apply horticulture knowledge in nursery and understand its applications.
4. Gain basic knowledge of landscape gardening.

References

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6. Intellectual Property Rights: Unleashing the Knowledge Economy, Ganguli, P., Tata McGraw-Hill. (2001)
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11. Intellectual Property: Patents, Trademarks and Copyright in a Nutshell, Miller, A.R., Davis, M.H., West Group Publishers. (2000)
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Theory Paper XVI (BBT 605) Advanced Botanical Skills and Biofertilizers II

Learning Objectives: The students will be able to....

1. Impart the knowledge of advanced skills required in plant sciences.
2. Impart the importance of protection of traditional knowledge with respect to plants.
3. Impart the basic knowledge of biofertilizers and organic farming.

Unit	SEMESTER - VI (BBT 605) Advanced Botanical Skills and Biofertilizers II	No. of hours per unit/ Credits 45
Unit-I	Plant Microtechniques	12
	1.1 Microtechniques: Whole mounts, peel mounts, squash preparations, clearing, maceration and sectioning; Tissue preparation: living vs fixed, physical vs chemical fixation, coagulating fixatives, noncoagulant fixatives; tissue dehydration using graded solvent series; Paraffin and plastic infiltration; Preparation of thin and ultrathin sections.	
	1.2 Staining procedures, classification and chemistry of stains. Staining equipment. Reactive dyes and fluorochromes (including genetically engineered protein labeling with GFP and other tags). 1.3 Cytogenetic techniques with squashed plant materials.	
Unit -II	Protection of Traditional Knowledge	
	2.1 Traditional Knowledge: Objective, Concept of Traditional Knowledge, Holders, Issues concerning, Bio-Prospecting and Bio-Piracy,	

	<p>Alternative ways, Protectability, need for a Sui-Generis regime, Traditional Knowledge on the International Arena, at WTO, at National level, Traditional Knowledge Digital Library, PBR.</p> <p>2.2 Plant Varieties Protection: Objectives, Justification, International Position, Plant varieties protection in India. Rights of farmers, Breeders and Researchers. National gene bank, Benefit sharing. Protection of Plant Varieties and Farmers' Rights Act, 2001.</p> <p>2.3 Geographical Indications: Objectives, Justification, International Position, Multilateral Treaties, National Level, Indian Position.</p>	11
Unit – III	Biofertilizers used in agriculture	11
	<p>3.1: Introduction, Importance, Isolation and mass multiplication of –</p> <p>a) Bacterial fertilizers: <i>Azotobacter</i>, <i>Azospirillum</i>,</p> <p>b) Phosphorus solubilizing bacteria, Potash mobilizing bacteria</p> <p>c) Blue green Algal: Cyanobacteria (BGA) – <i>Nostoc</i>, <i>Anabaena</i>.</p> <p>d) Higher plants: <i>Azolla</i>, Legumes</p>	
Unit – IV	Mycorrhizal association and organic farming	11
	<p>4.1 Mycorrhizal association, types of mycorrhizal association, taxonomy, occurrence and distribution, phosphorus nutrition, growth and yield – colonization of VAM – isolation and inoculum production of VAM, and its influence on growth and yield of crop plants.</p> <p>4.2 Organic farming – Green manuring and organic fertilizers, recycling of biodegradable municipal, agricultural and Industrial wastes – bio compost making methods, types and method of vermicomposting – field Application.</p>	

Learning outcomes: The students should be able to.....

1. Apply basic techniques in plant sciences.
2. Know the importance of traditional knowledge.
3. Understand the basics, importance and applications of biofertilizers and organic farming.

References

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2. Practical research methods. Dawson, C. UBS Publishers, New Delhi. (2002)
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Theory Paper XVI (BBT 606) Advanced Botanical Skills and Herbal Technology II

Learning Objectives: The students will be able to....

1. Impart the knowledge of advanced skills required in plant sciences.
2. Impart the basic knowledge of herbal technology.

Unit	SEMESTER - VI (BBT 606) Advanced Botanical Skills and Herbal Technology II	No. of hours per unit/ Credits 45
Unit-I	Plant Microtechniques	12
	1.1 Microtechniques: Whole mounts, peel mounts, squash preparations, clearing, maceration and sectioning; Tissue preparation: living vs fixed, physical vs chemical fixation, coagulating fixatives, noncoagulant fixatives; tissue dehydration using graded solvent series; Paraffin and plastic infiltration; Preparation of thin and ultrathin sections.	
	1.2 Staining procedures, classification and chemistry of stains. Staining equipment. Reactive dyes and fluorochromes (including genetically engineered protein labeling with GFP and other tags). 1.3 Cytogenetic techniques with squashed plant materials.	
Unit- II	Protection of Traditional Knowledge	11
	2.1 Traditional Knowledge: Objective, Concept of Traditional Knowledge, Holders, Issues concerning, Bio-Prospecting and Bio-Piracy,	

	<p>Alternative ways, Protectability, need for a Sui-Generis regime, Traditional Knowledge on the International Arena, at WTO, at National level, Traditional Knowledge Digital Library, PBR.</p> <p>2.2 Plant Varieties Protection: Objectives, Justification, International Position, Plant varieties protection in India. Rights of farmers, Breeders and Researchers. National gene bank, Benefit sharing. Protection of Plant Varieties and Farmers' Rights Act, 2001.</p> <p>2.3 Geographical Indications: Objectives, Justification, International Position, Multilateral Treaties, National Level, Indian Position.</p>	
Unit – III	Herbal cosmetology	11
	<p>3.1 Plant antioxidants: Antioxidants, Vitamins (C and E)</p> <p>3.2 Applications of herbs in cosmetics: Shampoo (<i>Sapindus laurifolius</i>, <i>Acacia concinna</i>), hair dye (<i>Lawsonia inermis</i>), facemask (<i>Santalum album</i>), bath oil (<i>Rosa indica</i>), perfume (<i>Jasminum sambac</i>).</p> <p>3.3 Herbal nutraceuticals</p>	
Unit – IV	Plant Pharmaceuticals	11
	<p>4.1 Concept and advantages, Types of pharmaceutical products: Churna, Asava and Arishta, Drug plants with reference to botanical source, active principles and medicinal uses of <i>Adathoda</i>, <i>Tinospora</i> and <i>Asparagus</i>.</p> <p>4.2 Manufacture of Churna (<i>Triphala churna</i>), Arishta (Ashokarishta) and Asava (Kumariasava).</p> <p>4.3 Phytochemistry - active principles and methods of their testing - identification and utilization of the medicinal herbs; <i>Catharanthus roseus</i> (cardiotonic), <i>Withania somnifera</i> (drugs acting on nervous system), <i>Boswellia serrata</i> (anti-rheumatic) and <i>Centella asiatica</i> (memory booster).</p>	

Learning outcomes: The students should be able to.....

1. Understand the basic techniques involved in plant sciences.
2. Know the importance of traditional knowledge.
3. Describe the basics of herbal cosmetology and nutraceuticals.
4. Understand the plant pharmaceuticals and phytochemistry of important medicinal plants.

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Theory Paper II (SECCT 607) Entrepreneurship Development

Learning Objectives: The students will be able to....

1. Identification of opportunities for development
2. Learn the mechanism of finance and fund raising
3. Understand the importance of marketing for better business opportunities
4. Study the plant based industrial sector in India and abroad.

Unit	SEMESTER - VI (SECCT 607) Entrepreneurship Development	No. of hours per unit/ Credits
	Entrepreneurship Development	
Unit-I:	Introduction to entrepreneurship, Identification of opportunities for entrepreneurship, Concept of different occupations: - business, employment and profession. Functions of an entrepreneur. Business idea and plan, Types of businesses / ownerships – Sole Proprietorship, Partnership, Private limited company, Public limited company, Joint stock Company, Co-operative society.	5
	Business Finance & Accounts	
Unit-II	Preparation of project report for business, Sources of finance – government and nongovernment agencies, Working capital, Cash flow, Fund flow, Preparation of basics of financial statements,	05

	costing and pricing, Policies and incentives.	
Unit – III	Enterprise Management and Modern Trends	05
	Small business management and entrepreneurship, Woman entrepreneurship, Features of small business firms, Process of management in small business, Concept of data and information, Information as a commodity, Study of marketing strategy and marketing mix, Decision-making models, Types of decisions, Decision Support Systems, Introduction to e-commerce, types – B2B, B2C, C2B, C2C.	
Unit – IV	Entrepreneurship opportunities in Plant Sciences	05
	Plant based industries in India and abroad both in food and non- food sectors, Import and export regulations of plant based products, Case study on successful as well as unsuccessful small scale plant based industries in India.	

Learning Outcomes: The students should be able to.....

1. Get the idea about IP rights
2. Avail the financial and marketing skill
3. Prepare the proposal for small scale industry.
4. Identify opportunities in the plant based industrial sector.

Recommended Books:

1. Entrepreneurship. Alpana Trehan Wiley India
2. A complete guide to successful Entrepreneurship, G. N. Pandey Vikas Publishers India

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Practical Paper VII BBP 608 (based on BBT 601 and 602)

Learning objectives: The students will be able to....

1. Give practical knowledge to students about different concepts in plant biochemistry.
2. Give the practical knowledge about concepts in molecular biology.
3. Give practical knowledge about the bioinformatics and biostatistics applications in plants sciences.
4. Give practical knowledge about the economic uses of the plants around them.

Section	SEMESTER - VI	No. of hours per unit/ Credits
Section-I:	Practical's based on Theory paper BBT 601	
	1-2. Qualitative test for sugars, proteins and lipids in plant material 3. Estimation of sugars by DNSA method 4. Estimation of proteins by Lowry's method 5. Determination of fatty acid value of oil sample 6. Separation and identification of amino acids by TLC (Thin Layer Chromatography). 7. Isolation of genomic DNA 8. Estimation of genomic DNA 9. Estimation of carotene and anthocyanin pigments	

	10. Visit to molecular biology laboratory and report submission.	
Section-II	Practical's based on theory paper BBT 602	
	<ol style="list-style-type: none"> 1. Study of biological databases NCBI, DDBJ, EMBL and UniProt 2. Nucleotide sequence retrieval from NCBI database 3. Study of molecular phylogeny using Mega 6 software. 4. Study of measures of central tendency, frequency distribution of given data and its graphical representation 5. Determination of Standard deviation and standard error of the given data. 6. Study of Botanical Name, Morphology, Parts used and Economic importance of Jowar and Wheat. 7. Study of Botanical Name, Morphology, Parts used and Economic importance of Gram and Pigeon pea. 8. Study of Botanical Name, Morphology, Parts used and Economic importance of Ginger, Chilly, Tea and Coffee. 9. Study of Botanical Name. Morphology, Parts used and Economic importance of Groundnut and Soybean. 10. Study of Botanical Name. Morphology, Parts used and Economic importance of Cotton and <i>Agave</i>. 11. Assignment based on Biostatistics/ Bioinformatics 	

Learning Outcomes: The students should be able to.....

1. Analyze the nutritional composition of plants.
2. Perform the isolation and estimation of nucleic acid.
3. Understand the knowledge of separation techniques used in plant sciences.
4. Understand the knowledge of computational biology.
5. Apply knowledge of biostatistics and data analysis in plant sciences.
6. Understand the knowledge of utilization of economically important plants.

References:

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Practical Paper VIII BBP 609 (based on BBT 603 and 604)

Learning objectives: The students will be able to....

1. Give practical knowledge to students about different concepts in plant biotechnology.
2. Give the practical knowledge about various processes in palaeobotany.
3. Give the practical knowledge about microtechniques used in plant sciences.
4. Give the practical knowledge about survey techniques and use of GPS in plant survey.
5. Give the practical knowledge about use traditional plants and horticultural practices.

Section	SEMESTER - VI BBP 609 (based on BBT 603 and 604)	No. of hours per unit/ Credits 45
Section-I	Practical's based on theory paper BBT 603	
	<ol style="list-style-type: none"> 1. Preparation of plant tissue culture medium (MS). 2. Demonstration of techniques of <i>in vitro</i> culture using suitable ex-plant. 3. Isolation of plant genomic DNA and its spooling. 4. Separation of DNA using Agarose gel electrophoresis 5. Isolation of Protoplast. 6. Study of steps in genetic engineering for the production of Golden rice with the help of photographs./ Study of genetic transformation methods 	

	<p>7. Identification of types of fossils – i) Impression ii) Compression iii) Petrification v) Coal.</p> <p>8. Identification of <i>Lyginopteris</i></p> <p>9. Identification of <i>Enigmocarpon</i></p> <p>10. Visit to tissue culture laboratory and report submission</p>	
Section-II	Practical's based on theory paper BBT 604	11
	<p>1. study microtechniques used in plant study (Whole mount, peel mounts, squash preparations, clearing, maceration and sectioning).</p> <p>2. Study of preparation of permanent slides.</p> <p>3. Plant material sectioning using microtome and double staining technique.</p> <p>4. Preparation of different stains used in study of plant material.</p> <p>5. Use of GPS in positioning of plants.</p> <p>6. Survey and documentation of traditional medicinal plants.</p> <p>7. Survey and documentation of traditional edible plants.</p> <p>8. Study of vegetable crops with respect to cultivation and management practices.</p> <p>9. Study of timber yielding plants with respect to cultivation and management practices.</p> <p>10. Visit to landscape garden and submission of report.</p>	

Learning Outcomes: The students should be able to.....

1. Understand the knowledge of preparation of MS medium, basic sterilization techniques and aseptic conditions.
2. Perform the basic micropropagation protocol through various plant material (explants).
3. Demonstrate isolation, purification and estimation genomic DNA using spectrophotometric method and agarose gel electrophoresis.
4. Understand the knowledge and significance of advanced crop improvement technology.
5. List the of fossil plants.

6. Prepare the different microscopic slides of plant material and staining techniques.
7. Understand the use of GPS in field surveys and documentation of traditional uses of plants.
8. Understand the cultivation and management practices of economically important plants.

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Practical Paper VIII BBP 606 (based on BBT 603 and 605)

Learning objectives: The students will be able to.....

1. Give practical knowledge to students about different concepts in plant biotechnology.
2. Give the practical knowledge about various processes in palaeobotany.
3. Give the practical knowledge about microtechniques used in plant sciences.
4. Give the practical knowledge about survey techniques and use of GPS in plant survey.
5. Give the practical knowledge of mass multiplication and application of biofertilizers in agriculture.

Section	SEMESTER - VI BBP 606 (based on BBT 603 and 605)	No. of hours per unit/ Credits 45
Section-I:	<p style="text-align: center;">Practical's based on theory paper BBT 603</p> <ol style="list-style-type: none"> 1. Preparation of plant tissue culture medium (MS). 2. Demonstration of techniques of <i>in vitro</i> culture using suitable ex-plant. 3. Isolation of plant genomic DNA and its spooling. 4. Separation of DNA using Agarose gel electrophoresis 5. Isolation of Protoplast. 6. Study of steps in genetic engineering for the production of Golden rice with the help of photographs./ Study of genetic transformation 	

	<p>methods</p> <p>7. Identification of types of fossils – i) Impression ii) Compression iii) Petrification v) Coal.</p> <p>8. Identification of <i>Lyginopteris</i></p> <p>9. Identification of <i>Enigmocarpon</i></p> <p>10. Visit to tissue culture laboratory and report submission</p>	
Section-II	Practical's based on theory paper BBT 605	
	<p>1. To study microtechniques used in plant study (Whole mount, peel mounts, squash preparations, clearing, maceration and sectioning).</p> <p>2. Study of preparation of permanent slides.</p> <p>3. Plant material sectioning using microtome and double staining technique.</p> <p>4. Preparation of different stains used in study of plant material.</p> <p>5. Use of GPS in positioning of plants.</p> <p>6. Survey and documentation of traditional medicinal plants.</p> <p>7. Survey and documentation of traditional edible plants.</p> <p>8. Study of mass multiplication of biofertilizers.</p> <p>9. Study of effect of biofertilizers on growth of plants.</p> <p>10. Isolation, identification and characterization of VAM fungi.</p>	

Learning Outcomes: The students should be able to.....

1. Understand the knowledge of preparation of MS medium, basic sterilization techniques and aseptic conditions.
2. Perform the basic micropropagation protocol through various plant material (explants).
3. Demonstrate isolation, purification and estimation genomic DNA using spectrophotometric method and agarose gel electrophoresis.
4. Understand the knowledge and significance of advanced crop improvement technology.
5. List the fossil plants.

6. Prepare the different microscopic slides of plant material and staining techniques.
7. Understand the use of GPS in field surveys and documentation of traditional uses of plants.
8. Understand the techniques used for mass multiplication of biofertilizers and their effect on plant growth.
9. Understand the techniques of isolation and identification of VAM fungi and their potential use in agriculture.

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Practical Paper VIII BBP 609 (based on BBT 603 and 606)

Learning objectives: The students will be able to.....

1. Give practical knowledge to students about different concepts in plant biotechnology.
2. Give the practical knowledge about various processes in palaeobotany.
3. Give the practical knowledge about microtechniques used in plant sciences.
4. Give the practical knowledge about survey techniques and use of GPS in plant survey.
5. Give the practical knowledge of plants used in pharmaceuticals and nutraceuticals.

Section	SEMESTER - VI BBP 609 (based on BBT 603 and 606)	No. of hours per unit/ Credits 45
Section-I:	Practical's based on theory paper BBT 603	
	<ol style="list-style-type: none"> 1. Preparation of plant tissue culture medium (MS). 2. Demonstration of techniques of <i>in vitro</i> culture using suitable ex-plant. 3. Isolation of plant genomic DNA and its spooling. 4. Separation of DNA using Agarose gel electrophoresis 5. Isolation of Protoplast. 6. Study of steps in genetic engineering for the production of Golden rice with the help of photographs./ Study of genetic transformation methods 	

	<p>7. Identification of types of fossils – i) Impression ii) Compression iii) Petrification v) Coal.</p> <p>8. Identification of <i>Lyginopteris</i></p> <p>9. Identification of <i>Enigmocarpon</i></p> <p>10. Visit to tissue culture laboratory and report submission</p>	
Section-II	Practical's based on theory paper BBT 606	
	<p>1. To study microtechniques used in plant study (Whole mount, peel mounts, squash preparations, clearing, maceration and sectioning).</p> <p>2. Study of preparation of permanent slides.</p> <p>3. Plant material sectioning using microtome and double staining technique.</p> <p>4. Preparation of different stains used in study of plant material.</p> <p>5. Use of GPS in positioning of plants.</p> <p>6. Survey and documentation of traditional medicinal plants.</p> <p>7. Survey and documentation of traditional edible plants.</p> <p>8. Estimation of antioxidant activity of plant material (lemon and orange fruits)</p> <p>9. Preparation of herbal cosmetics using plants (plants studied in theory).</p> <p>10. Preparation of Churna, Aristha and Asava.</p> <p>11. Visit to local plant pharmaceutical industry and submission of visit report.</p>	

Learning Outcomes: The students should be able to.....

1. Understand the knowledge of preparation of MS medium, basic sterilization techniques and aseptic conditions.
2. Perform the basic micropropagation protocol through various plant material (explants).
3. Demonstrate isolation, purification and estimation genomic DNA using spectrophotometric method and agarose gel electrophoresis.

4. Understand the knowledge and significance of advanced crop improvement technology.
5. List the fossil plants.
6. Prepare the different microscopic slides of plant material and staining techniques.
7. Understand the use of GPS in field surveys and documentation of traditional uses of plants.
8. Understand the use of GPS in field surveys and documentation of traditional uses of plants.
9. Prepare herbal cosmetics.
10. Prepare Ayurvedic drugs such as Churna, Arishta and Asava.

Rayat Shikshan Sanstha's
Yashavantrao Chavan Institute of Science, Satara
(Autonomous)
Syllabus introduced from June 2023
Bachelor of Science (B. Sc.) Part - III: Botany
Semester VI

Practical Paper SECCBP 610 (based on SECCBT 607)

Learning objectives: The students will be able to.....

1. Give the practically Expose to a work environment, common practices, employment opportunities and work ethics in their relevant field.

Section	SEMESTER - VI SECCBP 610 (based on SECCBT 607)	No. of hours per unit/ Credits 45
Section	Course Work: Industrial training (25)	
	15 Days internship program and report writing	

Learning Outcomes: The students should be able to.....

1. Participate in the projects in industries during his or her industrial training.
2. Describe use of advanced tools and techniques encountered during industrial training and visit.
3. Interact with industrial personnel and follow engineering practices and discipline prescribed in industry.
4. Develop awareness about general workplace behavior and build interpersonal and team skills.
5. Prepare professional work reports and presentations.