

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

**Syllabus under Autonomy**  
**For**  
**B. Sc. III (Botany)**

**Academic Year 2024 - 2025**

**Sadguru Gadge Maharaj College, Karad (Autonomous)**

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

1. TITLE: Botany

2. YEAR OF IMPLEMENTATION: 2024 - 2025

3. PREAMBLE:

The B. Sc. III Botany course under autonomy will be effective from the academic year 2024 -2025. 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: NEP 1.0

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	
		PaperNo. & Paper Code	Title of Paper	No. of lectures per week	Credits		No. of lectures Per week	Credits
1.	Botany DSC (Com.)	Paper IX: NBBT22-501	Genetics and Plant Breeding	02	02	Practical Paper V BBP 508 (based on NBBT 22-501 and 502)	10	04
		Paper X: NBBT 22-502	Microbiology, Plant Pathology and Mushroom Cultivation Technology	02	02			
		Paper XI: NBBT 22-503	Cytology and Techniques in Biology	02	02			
2.	Botany DSE (Elect.)	Paper XII: NBBT 22-22-504	Advanced Botanical Skills and Horticulture I	02	02	Practical Paper VI BBP 509 (based on NBBT 22-503 and 504)	10	04
		Paper XII: NBBT 22-505	Advanced Botanical Skills and Biofertilizers-I	02	02	Practical Paper VI BBP 509 (based on NBBT 22-503 and 505)		
		Paper XII: NBBT 22-506	Advanced Botanical Skills and Herbal Technology I	02	02	Practical Paper VI BBP 509 (based on NBBT 22-503 and 506)		
3.	AECC	I	III	02	02			

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

Sr. No.	Subject Title	Theory				Paper No. & Paper Code	Practical	
		PaperNo. & Paper Code	Title of Paper	No. of lectures per week	Credits		No. of lectures Per week	Credits
1.	Botany DSC (Comp.)	Paper XIII: NBBT 22-601	Plant Biochemistry and Molecular Biology	06	06	Practical Paper VIIIBBP 608 (based on NBBT 22-601 and 602)	10	04
		Paper XIV: NBBT 22-602	Bioinformatics, Biostatistics and Economic Botany					
		Paper XV: NBBT 22-603	Plant Biotechnology and Paleobotany					
2.	Botany DSE (Elect.)	Paper XVI: NBBT 22-604	Advanced Botanical Skills and Horticulture II	06	06	Practical Paper VIIIIBBP 609 (based on NBBT 22-603 and 604)	10	04
		Paper XVI: NBBT 22-605	Advanced Botanical Skills and Biofertilizers II			Practical Paper VIIIIBBP 609 (based on NBBT 22-603 and 605)		
		Paper XVI: NBBT 22-606	Advanced Botanical Skills and Herbal Technology II			Practical Paper VIIIIBBP 609 (based on NBBT 22-603 and 606)		
3.	AECC		IV	02	02			

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

**B. Sc. III Semester I**

Paper IX (NBBT22- 501): Genetics and Plant Breeding.

Paper X (NBBT22- 502): Microbiology, Plant Pathology and Mushroom Cultivation Technology.

Paper XI (NBBT22- 503): Cytology and Techniques in Biology.

Paper XII (NBBT22- 504): Advanced Botanical Skills and Horticulture- I.

Paper XII (NBBT22- 505): Advanced Botanical Skills and Biofertilizers- I

Paper XII (NBBT 22- 506): Advanced Botanical Skills and Herbal  
Technology-I

Practical Paper VI NBBP22- 605(I)(based on NNBBT 22- 22-501 and NNBBT 22- 22-  
502)

Practical Paper VI NBBP22- 605(II) (based on NNBBT 22-22- 503 and NNBBT 22-22-504)

Practical Paper VI NBBP22- 605(II) (based on NNBBT 22-22- 503 and NNBBT 22-22-505)

Practical Paper VI NBBP22- 605(II) (based on NNBBT 22-22- 503 and NNBBT 22-22-506)

Ability Enhancement Compulsory Course Paper III

**B. Sc. III Semester II**

Paper XII: NBBT 22- 601 Plant Biochemistry and Molecular Biology

Paper XIV: NBBT 22- 602 Bioinformatics, Biostatistics and Economic

Botany Paper XV: NBBT 22- 603 Plant Biotechnology and Paleobotany

Paper XVI: NBBT 22- 604 Advanced Botanical Skills and Horticulture -II

Paper XVI: NBBT 22- 605 Advanced Botanical Skills and Biofertilizers- II

Paper XVI: NBBT 22- 606 Advanced Botanical Skills and Herbal Technology II

Practical Paper VI NBBP 22- 605(III) (based on NBBT 22- 601 and 602)

Practical Paper VI NBBP22- 605 (IV) (based on NBBT 22- 603 and 604)

Practical Paper VI NBBP 22- 605 (IV) (based on NBBT 22- 603 and 605)

Practical Paper VI NBBP 605 (IV) (based on NBBT 22- 603 and 606)

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 Equipment's:

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

**Rayat Shikshan Sanstha's**  
**Sadguru Gadage Maharaj College, Karad (Autonomous)**  
**Department of Botany**  
**Course Structure & Evaluation Pattern: B.Sc. III Botany**  
**(w.e.f. June 2024)**

Sem.	Paper No.	Paper Code	Credits	Title of Paper	Evaluation Scheme (Marks)			Grand Total Marks
					CCE	SEE	Total	
V	IX	NBBT22-501	02	Genetics and Plant Breeding	10	40	50	200
	X	NBBT22-502	02	Microbiology, Plant Pathology and Mushroom Cultivation Technology	10	40	50	
	XI	NBBT22-503	02	Cytology and Techniques in Biology	10	40	50	
	XII	NBBT22-504	02	Advanced Botanical Skills and Horticulture I	10	40	50	
VI	XIII	NBBT22-601	02	Plant Biochemistry and Molecular Biology	10	40	50	200
	XIV	NBBT22-602	02	Bioinformatics, Biostatistics and Economic Botany	10	40	50	
	XV	NBBT22-603	02	Plant Biotechnology and Paleobotany	10	40	50	
	XVI	NBBT22-604	02	Advanced Botanical Skills and Horticulture II	10	40	50	
		NBBP22-605	02	Practical-VI	200			200
			02	Practical-VI				
			02	Practical-VI				
			02	Practical-VI				
		<b>Total</b>	<b>24</b>	<b>Total</b>			<b>600</b>	

SEE- Semester End Examination, CCE- College Compressive Evaluation

Nature of question paper and evaluation scheme:

- ❖ Evaluation Scheme
- Separate passing for Theory, Practical and internal examination is mandatory.

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Syllabus introduced from June 2024**

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

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**Semester V**

**Theory Paper IX (NBBT 22- 501) Genetics and Plant Breeding**

**Learning Objectives**

1. To impart the basic knowledge of plant genetics.
2. To impart the knowledge of crop improvement.
3. To understand the phenomenon of linkage and crossing over.

**Unit I- Mendelism and extra chromosomal inheritance**

**08**

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

**Unit II- Linkage, Recombination and Quantitative inheritance**

**08**

2.1 Linkage: Definition, Linkage groups, types, Coupling and Repulsion Phase, significance

2.2 Recombination (Crossing over): Definition, types, mechanism of crossing over, significance

2.3 Quantitative inheritance:

a) Multiple Allelism – Introduction, Definition, Self-incompatibility in plants

b) Polygene inheritance – Concept, examples 1) Kernel colour in wheat and  
2) Ear length in Maize

c) Population genetics – Hardy-Weinberg's Law



### **Unit III- Variation in Chromosome Number and Structure**

**07**

3.1 Chromosome number – Euploidy and Aneuploidy

3.2 Chromosomal structure – Deletion, Duplication, Inversion and Translocation

3.3 Mutation – Spontaneous and Induced mutation. Types of mutagen – Physical and Chemical, Significance.

### **Unit IV Plant Breeding**

**07**

4.1 Introduction, Definition, Aims and objectives

4.2 Methods of Plant Breeding

- a) Introduction and Acclimatization
- b) Selection – i) Mass Selection; ii) Pure Line Selection; iii) Clonal Selection
- c) Hybridization techniques in Self and Cross pollinated crops
- d) Male Sterility and its significance
- e) Mutation Breeding – Gamma garden

### **Learning Outcomes**

1. The students should be able to explain genetic basis of inheritance.
2. The students should be able to define concepts regarding development of variation and population genetics.
3. The students should be able to define concepts regarding chromosome structure and variation.
4. The students should be able to write answers and brief notes about plant breeding.

## References

1. Allard, A.W., (2010) Principles of Plant Breeding. Wiley Publications **(Unit IV)**
2. Chahal, G.S., Gosal, S.S., (2010) Principles and Procedures of Plant Breeding: Biotechnological and Conventional Approaches. Narosa Publishing Co., New Delhi **(Unit III)**
3. Gardener, J., Simmons, H.J., Snustad, D.P. (1991) Principles of Genetics (8<sup>th</sup> Edition). John Wiley & Sons, New York. **(Unit I, II)**
4. Gupta P.K., (1997) Genetics. Rastogi Publications. Shivaji Road, Meerut. **(Unit I, II)**
5. Gupta, P.K., (2018) Cytogenetics. Rastogi Publications, Meerut. **(Unit III)**
6. Hartl, D.L., Jones, E.W. (1998) Genetics: Principles and Analysis (4<sup>th</sup> Edition) Jones & Barlett Publishers. Massachusetts. USA. **(Unit I, II)**
7. Singh, B.D., (2009) Genetics. Kalyani Publications, New Delhi. **(Unit III)**
8. Singh, B.D., (2010) Cytogenetics and Plant Breeding. Kalyani Publications, New Delhi. **(Unit IV)**
9. Singh, B.D., (2011) A text Book of Plant Breeding: A dynamic View Designed for Under Graduate Courses of Indian Universities. 3<sup>rd</sup> Edition. Kalyani Publications, New Delhi. **(Unit IV)**
10. Singh, B.D., (2018) Plant Breeding: Principles and Methods. Kalyani Publications, New Delhi. **(Unit IV)**
11. Verma, P.S., Agarwal, V.K. (2001) Cell Biology, Genetics, Evolution and Ecology. S. Chand Publications. **(Unit I, II)**

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

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**Semester V**

**Theory Paper X (NBBT 22- 502)**

**Microbiology, Plant Pathology and Mushroom Culture Technology**

**Learning Objectives**

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

**Unit I- Microbiology**

**07**

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**

**07**

2.1 Bacterial genome.

2.2 Recombination in Bacteria - Transformation and Transduction

2.3 DNA and RNA viruses

2.4 Importance of microbial genetics

### **Unit III- Plant Pathology**

**08**

- 3.1 Concept and Importance of Plant Pathology, General symptoms of plant diseases
- 3.2 Transmission of Pathogen- Air, Seed, Soil and Water.
- 3.3 Methods of plant disease management: Physical, Mechanical, Chemical and Biological.
- 3.4 Role of quarantine in plant disease management.
- 3.5 Study of Plant Diseases w.r.t. Pathogen, Symptoms and Management.
  - 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)

### **Unit IV- Mushroom cultivation technique**

**08**

- 4.1 Introduction, History, Economic importance of mushrooms. Types of Mushrooms: Poisonous mushrooms and Edible (Non-poisonous) - Button, Oyster, Straw, Shiitake and Black ear mushrooms.
- 4.2. Cultivation Technology: Preparation of spawn, Sterilization and preparation of mushroom bed, Spawning, Factors affecting quality of mushroom beds, Harvesting of mushrooms.
- 4.3 Storage: Short Term (Refrigeration), Long Term Storage (Canning, Pickles, Papads) and Drying in Salt Solutions
- 4.4 Nutritional Value: Proteins, Carbohydrates, Mineral Elements, Vitamins, Crude Fibre Content of Mushrooms. Medicinal value of Mushrooms.

### **Learning Outcomes**

1. The student understands knowledge about microbes, Microbial techniques, and Application of microbes in Industry.
2. The student understands the knowledge about microbial genetics and its applications.
3. The student understands knowledge about plant pathology, plant diseases and their management.
4. The student understands knowledge about mushroom cultivation, storage and its economic importance.

## References

1. Agrios. G. N. 1997. Plant Pathology Academic Press London. **(Unit III)**
2. Anonymous, 1991. Economics of mushroom cultivation. National Centre for Mushroom Research and Training, Solan, India. **(Unit IV)**
3. Anonymous, 2011. Cultivation Technology and Technical standards of components of Integrated Button Mushroom Unit, Protected Production under NHB Scheme. National Horticulture Board. **(Unit IV)**
4. Balazs, S. 1985. Mushroom cultivation the past and the present of oyster mushroom. Kerteszetes Szoleszet. **(Unit IV)**
5. Clifton, A. 1958 Introduction to the Bacteria. McGraw Hill Co., New York. **(Unit I)**
6. Cunasekaran P. 1995. Laboratory Manual in Microbiology. New Age International Pvt. Ltd. **(Unit I)**
7. Hackett. P.B. Fuchs. J.A. and Messing J.W. 1988. An Introduction to Recombinant DNA Techniques: Basic Experiments in Gene Manipulation. The Benjamin /Cummings Publishing Co., Inc., Menlo Park California. **(Unit II)**
8. Harris, Bob. Growing Wild Mushrooms: A Complete Guide to Cultivating Edible and Hallucinogenic Mushrooms. Homestead Book Company. Revised edition. **(Unit IV)**
9. Mandahar, C. L. 1998 Introduction to plant Viruses Chand & Ltd., Delhi. **(Unit I)**
10. Mehta P.R. and Verma, Plant Protection. **(Unit III)**
11. Meynell, E and Meynell, G.G. 1970. Theory and Practice in Experimental Bacteriology University Press, Cambridge. **(Unit I)**
12. Old R.W. and Primrose, S.B. 1989. Principles of Gene Manipulation. Blackwell Scientific Publications. Oxford. UK. **(Unit II)**
13. Peicar and Reid, Microbiology. **(Unit I)**
14. Rangswamy, G. and Mahadevan A. 1999. Diseases of Crop Plants in India. **(Unit III)**
15. Suman B C and Sharma V P, 2007. Mushroom Cultivation in India. **(Unit IV)**

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

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**Semester V**

**Theory Paper XI (NBBT22- 503)  
Cytology and Research Techniques in Biology**

**Learning Objectives**

1. To impart the basic knowledge of cell biology.
2. To impart the knowledge of techniques used in biological studies.
3. To impart the knowledge of microorganisms in biological world.

**Unit I- Cell as a unit of life**

**08**

- 1.1 The Cell Theory, Prokaryotic and Eukaryotic cell (Ultrastructure)
- 1.2 Nucleus: Ultrastructure, Nuclear Envelope, Nuclear Pore Complex, DNA Packaging in Eukaryotes.
- 1.3 Mitochondria and Chloroplasts -Ultrastructure and Role.
- 1.4 Ribosomes – Prokaryotic and Eukaryotic.

**Unit II- Sub Cellular Structures and Cell Membrane**

**07**

- 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.

**Unit III- Cell Cycle and Cell division**

**07**

- 3.1 Cell cycle
- 3.2 Cell division: Mitosis and Meiosis with their significance.
- 3.3 Apoptosis and autophagy

4.1 Principles of microscopy, Light, Phase contrast and Electron microscopy (EM)- SEM and TEM.

4.2 Spectrophotometry, Micrometry, Photomicrography, Colorimetry

**Learning Outcomes**

1. The students should be able to explain Ultrastructure of cell.
2. The students should be able to define concepts regarding roles of cell organelles.
3. The students should be able to define concepts regarding cell cycle.
4. The students should be able to write answers and brief notes about all the techniques studied.

**References**

1. Alberts B et al (2014) Molecular Biology of Cell; 6th edition; Garland Science, Taylor and Francis, New York. **(Unit I)**
2. Aneja KR Text Book of Experimental Biology. **(Unit IV)**
3. Charlothe JA (1986): Molecular Cell Biology; Addison. Wesley Publ. Company. **(UnitII)**
4. Cooper GM and RE Housemen (2015) The Cell: Molecular Approach; 7th edition. **(UnitI)**
5. De Robertis and De Robertis (1997) Cell and Molecular Biology (VIII), B.I. Waverly Pvt. Ltd., New Delhi. **(Unit III)**
6. Dupraw EJ (1970) Cell and Molecular Biology, Academic Press, London. **(Unit III)**
7. Engstrom A and JB Finean-Biological Ultrastructure. **(Unit IV)**
8. Horst Piller-Microscope photometry. **(Unit IV)**
9. John PCL (Ed.) (1981) The Cell Cycle, Cambridge University Press. **(Unit III)**
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12. Powar, C.B., (1992) Cell Biology; Himalaya Publishing House. **(Unit I)**
13. Purvis MJ and DC Collier and D Wallis, Laboratory techniques in Botany. **(Unit IV)**
14. SandhyaMitra (1988) Elements of Molecular Biology, McMillan India Ltd., N. Delhi.  
**(Unit I)**
15. Turner PC et al (2002) Molecular Biology (II); Viva Books, Pvt. Ltd., New Delhi. **(UnitII)**
16. Verma and Agarwal- Text book of Biotechnology, S. Chand Publication. **(Unit IV)**
17. Watson et al (2004) Molecular Biology of the Gene (V) Pearses Educatias, Inc India.  
**(Unit II)**



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

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**Semester V**

**Theory Paper XII (NBBT22-504)**

**Advanced Botanical Skills and Horticulture I**

**Learning Objectives:**

- i. To impart the knowledge of advanced skills required in plant sciences.
- ii. To impart the basic knowledge of Horticulture and nursery management.
- iii. To impart the knowledge of IPR.

**Unit I- Intellectual Property Rights**

**08**

- 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**

**07**

- 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
- 2.2 . Scientific writing: Numbers, units, abbreviations and nomenclature used in scientific writing, writing references, scientific writing and ethics

2.3 . Data presentation: PowerPoint presentation, Poster presentation

2.4 . Plagiarism: Introduction to copyright-academic misconduct/plagiarism

### **Unit III- Introduction to Horticulture and Floriculture**

**08**

3.1 . Introduction, Importance and divisions of horticulture

3.2. Floriculture: Introduction; a) Cultivation and management of important cut flowers: Rose, Gerbera; b) Flower arrangement, packing and marketing of cut flowers

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

### **Unit IV- Nursery management**

**07**

4.1 . Definition, objectives and scope, Infrastructure for nursery

4.2 . Propagation practices: Sexual and Asexual propagation

a) Sexual – Seed sowing and transplantation of seedlings, advantages and disadvantages of sexual propagation

b) Vegetative – i) Cutting – Definition, stem cutting (hard wood and soft wood cutting), use of PGR's for rooting

ii) Layering – Definition, Simple layering, Air layering

iii) Grafting – Definition, Whip grafting, Approach grafting

iv) Budding – Definition, T-budding, Patch budding

c) Propagation of specialized vegetative structure - Bulbs, Corms, Tubers, Rhizomes

#### **Learning outcomes:**

- i. The students would be able to understand the basics and importance of IPR.
- ii. The students would be able to communicate the experimental data to scientific community.
- iii. The students would be able to understand the basics of horticulture and its applications.
- iv. The students would be able to understand the techniques used in nursery management.

## References

1. Acharya, N.K., (2001) Textbook on intellectual property rights, Asia Law House. **(Unit I)**
2. Bose, T.K., Mukherjee, D., (1972) Gardening in India. Oxford & IBH Publishing Co., New Delhi. **(Unit IV)**
3. Dawson, C. (2002) Practical research methods. UBS Publishers, New Delhi. **(Unit II)**
4. Edmond, M., Andres, Fundamentals of Horticulture. McGraw Hill Book Co., New Delhi. **(Unit III)**
5. Ganguli, P., (2001) Intellectual Property Rights: Unleashing the Knowledge Economy, Tata McGraw-Hill. **(Unit I)**
6. Guru, M., Rao, M.B., (2003) Understanding Trips: Managing Knowledge in Developing Countries, Sage Publications. **(Unit I)**
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**Bachelor of Science (B. Sc.) Part – III: Botany**

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**Semester V**

**Theory Paper XII (NBBT 22- 505) Advanced Botanical Skills and Biofertilizers - I**

**Learning Objectives**

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

**Unit I Intellectual Property Rights**

**08**

- 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**

**07**

- 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
- 2.2 Scientific writing: Numbers, units, abbreviations and nomenclature used in scientific writing, writing references, scientific writing and ethics
- 2.3 Data presentation: PowerPoint presentation, Poster presentation, Presentation of data in research articles.

2.4 Plagiarism: Introduction to copyright, academic misconduct/plagiarism

### **Unit III Introduction of Biofertilizers**

**07**

3.1 Introduction, History, types and importance of biofertilizers

3.2 Classification of biofertilizers (based on microorganisms used in biofertilizers production)

3.3 Nitrogen cycle in nature and its importance

3.4 Process of nodule formation, Role of Nif and Nod gene in Biological Nitrogen Fixation

3.5 Enzyme nitrogenase and its component

3.6 Biochemistry of nitrogen fixation

3.7 Isolation and mass multiplication of – *Rhizobium*

### **Unit IV Biocontrol**

**08**

4.1 Bio-control: Introduction, sources and advantages.

4.2 Important commercial products – Source, preparation and uses of Pyrethrins, Azadirachtin, *Trichoderma*, *Trichogramma*

4.3 Strategies of marking and Registration with CIB of bioagents and biopesticides

4.4 Importance of *Verticillium/ Beauveria/ Metarhizium/ Nomuraea/ Paecilomyces/ Hirsutella thompsoni* as biopesticides and their mass production

### **Learning outcomes**

- i. The students would be able to understand the basics and importance of IPR.
- ii. The students would be able to communicate the experimental data to scientific community.
- iii. The students would be able to understand the basics, importance and applications of biofertilizers.
- iv. The students would be able to understand the basics, importance and applications of biocontrol.

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**Semester V**

**Theory Paper XII (NBBT 22-506)**

**Advanced Botanical Skills and Herbal Technology I**

**Learning Objectives:**

- i. To impart the knowledge of advanced skills required in plant sciences.
- ii. To impart the basic knowledge of herbal technology.
- iii. To acquire more information about IPR.

**Unit I Intellectual Property Rights**

**08**

- 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**

**07**

- 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.
- 2.2 Scientific writing: Numbers, units, abbreviations and nomenclature used in scientific writing,



writing references, scientific writing and ethics.

2.3 Data presentation: Power point presentation, Poster presentation, Presentation of data in research articles.

2.4 Plagiarism: Introduction to copyright, academic misconduct/plagiarism.

### **Unit III Herbal Medicines**

**08**

3.1 Definition, Importance of herbal medicines.

3.2 Classification of crude drugs – Taxonomical, Morphological and Chemical.

3.3 Identification, authentication, collection, processing and storage of medicinal plants.

3.4 Introduction to general methods of extraction, isolation and purification of phytoconstituents.

### **Unit IV Pharmacognosy**

**07**

4.1 Pharmacognosy: Introduction and Definition.

4.2 Medicinal uses of Tulsi, Ginger, Methi, Amla.

4.3 Adulteration of drugs of natural origin: Evaluation by Morphological, Microscopic, Chemical, Physical, Chromatographical, Spectrophotometric techniques.

### **Learning outcomes:**

- i. The students would be able to understand the basics and importance of IPR.
- ii. The students would be able to communicate the experimental data to scientific community.
- iii. The students would be able to understand the basics of herbal medicines.
- iv. The students would be able to understand the basics and applications of pharmacognosy.

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**Semester V**

**Practical Paper V NBBP 22- 605 (I) (Based on NBBT 22- 501 and NBBT 22- 502)**

**Learning objectives**

- a. To give practical knowledge to students about different concepts in genetics.
- b. To give the practical knowledge about various processes in plant breeding.
- c. To impart the knowledge of Microbial techniques (culture media, soil dilution, inoculation and staining).
- d. To impart the knowledge of plant diseases, symptoms and causal organism.

**Experiments based on Theory paper NBBT 22- 501**

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 *Allium* / *Cynotis*.
5. Detection of meiotic anomalies in chromosomes in *Rhoeo*.
6. Preparation of karyotypes – idiograms by using chromosomal photographs.
7. Methods of emasculation.
8. Breeding techniques in a) Malvaceae b) Fabaceae c) Poaceae.
9. Visit to Krishi Vidnyan Kendra/ Seed Company and submission of visit reports.

### **Experiments based on theory paper NBBT 22- 502**

1. Preparation and sterilization of culture media –PDA (slants and plates).
2. Isolation and separation of soil fungi by serial dilution method.
3. Methods of inoculation - on slants and plates.
4. Study of different types of stains: Cotton blue and Gram's stain.
5. Study of plant diseases - Grassy Shoot disease of Sugarcane.
6. Citrus Canker and Yellow Vein Mosaic of Bhendi.
7. Study of plant diseases - White Rust of Crucifers and Early leaf spot (Tikka) disease of ground nut.
8. Demonstration of Mushroom Cultivation.
9. Demonstration of Harvesting and Storage of mushrooms.
10. Submission of local plant diseases /crop diseases (any ten).

### **Learning Outcomes**

1. The students understand the knowledge about genetic problems.
2. The students understand the knowledge about basic techniques in cytology.
3. The students understand the knowledge about basic techniques of karyotype.
4. The students understand the knowledge about basic techniques in genetics and plant breeding.
5. The student understands knowledge about Microbial techniques (culture media, soil dilution, inoculation and staining).
6. The student understands the knowledge about plant diseases, symptoms and causal organism.
7. The student understands knowledge about collection and identification of plant pathological specimens in fields.
8. The student understands knowledge about seed treatment by seed dipping and seed dressing.

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**Semester V**

**Practical Paper VI NBBP 605 (II) (Based on NBBT 22- 503 and NBBT 22- 504)**

**Learning objectives:**

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

**Experiments based on Theory paper NBBT 22- 503**

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 *Nostoc*, Onion and *Hydrilla* leaf filament.
4. Study of mitosis and preparation of permanent cytological slides.
5. Study of meiosis and preparation of permanent cytological slides.
6. Use of dialysis to separate smaller molecules from larger molecules.
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.

### **Experiments based on theory paper NBBT 22- 504**

1. Demonstration of patent filing.
2. Technical writing and plagiarism checking.
3. Study of budding technique – Patch and T-budding.
4. Study of layering technique – Air layering.
5. Study of grafting technique – Whip and Approach.
6. Garden implements (Any five) – Garden shear, sickle, cutter, shovel, budding knife, secateurs, water can, pruning scissors, sprayer, spade.
7. Study of ornamental plants – Rose, *Gerbera*, Marigold.
8. Study of hedge and edge plants.
9. Study of indoor plants.
10. Visit to nursery. (Separate handwritten report to be submitted by student).

### **Learning Outcomes**

1. The students understand the preparation of different types of solutions.
2. The students understand the basic cytological and anatomical techniques.
3. The students understand the different horticultural practices.
4. The students understand the scientific writing and communication skills.

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**Semester V**

**Practical Paper VI NBBP22- 509 (II) (Based on NBBT 22- 503 NBBT 22- and 505)**

**Learning objectives**

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

**Experiments based on Theory paper NBBT 22- 503**

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, *Hydrilla* leaf and *Spirogyra* filament.
4. Study of mitosis and preparation of permanent cytological slides.
5. Study of meiosis and preparation of permanent cytological slides.
6. Use of dialysis to separate smaller molecules from larger molecules.
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.

**Experiments based on theory paper NBBT 22- 505**

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 *Rhizobium* from root nodules.
6. Estimating the efficiency of *Rhizobium* through pot culture experiments
7. Mass production of *Verticillium/ Beauveria/ Metarhizium/ Nomuraea/ Paecilomyces/ Hirsutella thompsoni/ Trichoderma*
8. Estimating the efficiency of *Trichoderma* 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**

1. The students understand the preparation of different types of solutions.
2. The students understand the basic cytological and anatomical techniques.
3. The students understand the different techniques used in production and application of biofertilizers and biocontrol agents.
4. The students understand the scientific writing and communication skills.



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**Semester V**

**Practical Paper VI NBBP 22-605 (Based on NBBT 22- 503 and NBBT 22- 506)**

**Learning objectives**

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

**Experiments based on Theory paper NBBT 22- 503**

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, *Hydrilla* leaf and *Spirogyra* filament.
4. Study of mitosis and preparation of permanent cytological slides.
5. Study of meiosis and preparation of permanent cytological slides.
6. Use of dialysis to separate smaller molecules from larger molecules.
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.

**Experiments based on theory paper NBBT 22- 506**

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 Avala
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. Visit to Herbal Industry and submission of report.

### **Learning Outcomes**

1. The students understand the preparation of different types of solutions.
2. The students understand the basic cytological and anatomical techniques.
3. The students understand the scientific writing and communication skills.
4. The students understand the basic pharmacological techniques.
5. The students understand the phytochemical analysis.

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**Semester VI**

**Theory Paper XIII (NBBT 22- 601) Plant Biochemistry and Molecular Biology**

**Learning objectives**

1. To impart the basic knowledge of Plant biochemistry.
2. To impart the knowledge of Molecular biology.
3. To impart the knowledge of properties and classification of carbohydrates and proteins.

**Unit I- Carbohydrates**

**07**

- 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**

**08**

- 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.

**Unit III- Proteins**

**07**

- 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.

#### **Unit IV- Nucleic Acids**

**08**

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.

#### **Learning Outcomes**

1. The students should be able to explain concepts of plant biochemistry.
2. The students should be able to define concepts regarding molecular biology
3. The students should be able to define concepts regarding structure, properties and classification of amino acids
4. The students should be able to write answers and brief notes about plant biochemistry and molecular biology.

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**Semester VI**

**Theory paper XIV (NBBT 22- 602) Bioinformatics, Biostatistics and Economic**

**Botany Learning objectives**

1. The students should be able to understand and use bioinformatics databases.
2. The students should be able to understand and use biostatistics concepts in their academics and research.
3. The students should be able to understand the economic aspects of plants and their use in day to day life.

**Unit 1 Bioinformatics**

**07**

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)

**Unit II Biostatistics**

**08**

2.1. Introduction, definition, terminology.

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.

2.3. Measures of central tendency and Dispersion- Arithmetic mean, Mode, Median, Range, Deviation, Mean deviation, Standard Deviation, Coefficient of Variation.

2.4. Statistical methods for testing the hypothesis- i) Students' T-test; ii) Chi-square test.

### **Unit III Economic Botany: Cereals, Legumes and Oils**

**07**

3.1 Origin of Cultivated Plants - Concept of centres of origin, their importance with reference to Vavilov's work.

3.2 Cereals: Origin, Botanical Name, Morphology, Sources and Economic importance of Jowar and Wheat.

3.3 Legumes: Origin, Botanical Name, Morphology, Sources and Economic importance of Gram and Pigeon Pea.

3.4 Oils and Fats: Origin, Botanical Name, Morphology, Parts used and uses of Ground nut and soybean.

### **Unit IV Economic Botany: Spices, Beverages and Fibers**

**08**

4.1 Spices and Condiments - Origin, Botanical Name, Morphology, Parts used and uses of Ginger and Chilly

4.2 Beverages – Origin, Botanical Name, Morphology, Parts used and uses of Tea and coffee.

4.3 Fibre yielding Plants - Origin, Botanical Name, Morphology, Parts used and uses of Cotton and *Agave*.

### **Learning Outcomes**

1. The student will know the basics of databases, their types and their applications in plant sciences.
2. The student will know the basics of Biostatistics and its application in plant sciences.
3. The student will learn the scope of economic uses of the plants.

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**Semester VI**

**Theory Paper XV (NBBT 22- 603) Plant Biotechnology and Paleobotany**

**Learning Objectives:**

1. To impart the basic knowledge of Plant Biotechnology.
2. To impart the knowledge of Paleobotany.
3. To impart the knowledge of genetic engineering.

**Unit I- Plant Biotechnology and Plant Tissue Culture**

**08**

- 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 requirements ( Conditions and instruments).
- 1.4 Types of tissue culture: Micropropagation, Embryo culture, Organ culture, Callus culture, Cell suspension culture, Protoplast culture, Somatic Embryogenesis, Somaclonal variation.

**Unit II- Recombinant DNA Technology**

**07**

- 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**

**08**

3.1 Introduction.

3.2 Method of Gene transfer - *Agrobacterium* mediated, direct gene transfer by Electroporation, Microinjection, Micro-projectile bombardment in crop biotechnology.

3.3 Reporter genes, selectable marker genes.

3.4 Transgenic plants – *Bt* cotton, Golden rice.

### **Unit IV- Paleobotany**

**07**

4.1 Form, Genera and Nomenclature.

4.2 Study of following genera with reference to systematic position, external morphology, and affinities: a) *Lyginopteris* and b) *Enigmocarpon*.

4.3 Applications of paleobotany: Role of microfossil in oil and coal exploration.

### **Learning outcomes**

1. The student will know the basics of plant tissue culture and biotechnology.
2. The student will know the basics of recombinant DNA technology and genetic engineering.
3. The student will learn the concept and scope of paleobotany.

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**Semester VI**

**Theory Paper XVI (NBBT 22- 604) Advanced Botanical Skills and Horticulture - II**

**Learning Objectives**

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

**Unit I- Plant microtechniques**

**08**

1.1 Microtechniques:

- a) Mounting Techniques: Whole mounts, peel mounts, squash preparations.
- b) Maceration and sectioning.
- c) Microtomy techniques: 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 Techniques:

- a) Microbial stains- Introduction, Preparation and importance.
- b) Molecular stains- Introduction, Preparation and importance.
- c) Plant related stains- Introduction, Preparation and importance.

**Unit II- Protection of Traditional Knowledge**

**08**

2.1 Traditional Knowledge: Objective, Concept of Traditional Knowledge, Bio-Prospecting and Bio-Piracy, Traditional Knowledge Digital Library.

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.

2.3 Geographical Indications: Objectives, Justification, International Position, Multilateral Treaties, National Level, Indian Position, Geo tagging.

### **Unit III- Olericulture and arboriculture**

**07**

3.1 Olericulture: Introduction; Cultivation and management of important vegetable crop: *Capsicum*, Tomato.

3.2 Arboriculture: Introduction; Cultivation and management of important timber yielding plants: Teak, *Dalbergia*.

### **Unit IV- Landscape gardening**

**07**

4.1 Introduction and principals of landscaping, importance and scope of landscape gardening.

4.2 Garden elements: major and minor, basic patterns and steps in landscaping.

4.3 Garden plants: trees, climbers, palms, ferns, cacti and succulents, propagation of ornamental plants.

4.4 Special types of Garden: Terrace gardening, vertical garden Rock garden, and water garden. Other garden components such as statues, garden benches, pathways and bridges. Lawn cultivation and management.

### **Learning outcomes**

1. The students would be able to understand the basic techniques involved in plant sciences.
2. The students would be able to understand the importance of traditional knowledge.
3. The students would be able to understand the basics of horticulture and its applications.
4. The students would be able to gain basic knowledge of landscape gardening.

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

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**Semester VI**

**Theory Paper XVI (NBBT 22- 605) Advanced Botanical Skills and Biofertilizers-II**

**Learning Objectives**

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

**Unit I- Plant microtechniques**

**08**

- 1.1 Microtechniques: Whole mounts, peel mounts, squash preparations, clearing, maceration and sectioning; Tissue preparation: living vs fixed, physical vs chemical fixation, coagulating fixatives, non-coagulant 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 mother tags).
- 1.3 Cytogenetic techniques with squashed plant materials.

**Unit II- Protection of Traditional Knowledge**

**07**

- 2.1 Traditional Knowledge: Objective, Concept of Traditional Knowledge, Holders, Issues concerning, Bio-Prospecting and Bio-Piracy, 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.
- 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.

2.3 Geographical Indications: Objectives, Justification, International Position, Multilateral Treaties, National Level, Indian Position.

### **Unit III- Biofertilizers used in agriculture**

**08**

3.1: Introduction, Importance, Isolation and mass multiplication of –

- a) Bacterial fertilizers: *Azotobacter*, *Azospirillum*,
- b) Phosphorus solubilizing bacteria, Potash mobilizing bacteria
- c) Blue green Algal: Cyanobacteria (BGA) – *Nostoc*, *Anabaena*.
- d) Higher plants: *Azolla*, Legumes.

### **Unit IV- Mycorrhizal association and organic farming**

**07**

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.

4.2 Organic farming – Green manuring and organic fertilizers, recycling of biodegradable municipal, agricultural and Industrial wastes – biocompost making methods, types and method of vermicomposting – field Application.

### **Learning outcomes**

1. The students would be able to understand the basic techniques involved in plant sciences.
2. The students would be able to understand the importance of traditional knowledge.
3. The students would be able to understand the basics, importance and applications of biofertilizers and organic farming.

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**Semester VI**

**Theory Paper XVI (NBBT 22- 606) Advanced Botanical Skills and Herbal Technology-II**

**Learning Objectives**

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

**Unit I- Plant microtechniques**

**08**

- 1.1 Microtechniques: Whole mounts, peel mounts, squash preparations, clearing, maceration and sectioning; Tissue preparation: living vs fixed, physical vs chemical fixation, coagulating fixatives, non-coagulant 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**

**07**

- 2.1 Traditional Knowledge: Objective, Concept of Traditional Knowledge, Holders, Issues concerning, Bio-Prospecting and Bio-Piracy, 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.
- 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.
- 2.3 Geographical Indications: Objectives, Justification, International Position, Multilateral Treaties, National Level, Indian Position.

### **Unit- III Herbal cosmetology**

**07**

3.1 Plant antioxidants: Antioxidants, Vitamins (C and E)

3.2 Applications of herbs in cosmetics: Shampoo (*Sapindus laurifolius*, *Acacia concinna*), hair dye (*Lawsonia inermis*), facemask (*Santalum album*), bath oil (*Rosa indica*), perfume (*Jasminum sambac*).

3.3 Herbal nutraceuticals.

### **Unit IV- Plant Pharmaceuticals**

**08**

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 *Adathoda*, *Tinospora* and *Asparagus*.

4.2 Manufacture of Churna (*Triphala churna*), Arishta (Ashokarishta) and Asava (Kumariasava).

4.3 Phytochemistry - active principles and methods of their testing - identification and utilization of the medicinal herbs; *Catharanthus roseus* (cardiotonic), *Withania somnifera* (drugs acting on nervous system), *Boswellia serrata* (anti-rheumatic) and *Centella asiatica* (memory booster).

### **Learning outcomes**

1. The students would be able to understand the basic techniques involved in plant sciences.
2. The students would be able to understand the importance of traditional knowledge.
3. The students would be able to understand the basics of herbal cosmetology and nutraceuticals.
4. The students would be able to understand the plant pharmaceuticals and phytochemistry of important medicinal plants.

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**Semester VI**

**Practical Paper VII NBBP22- 605 (II) (Based on NBBT 22- 601 and NBBT 22- 602)**

**Learning objectives**

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

**Experiments based on Theory paper NBBT 22- 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.

**Experiments based on theory paper NBBT 22- 602**

1. Study of biological databases NCBI, DDBJ, EMBL and UniProt.

2. Nucleotide sequence retrieval from NCBI database.
3. Measures of central tendency of given data.
4. Study of frequency distribution 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 *Agave*.
11. Assignment based on Biostatistics/ Bioinformatics.

### **Learning Outcomes**

1. The students understand to analyze the nutritional composition of plants.
2. The students understand the isolation and estimation of nucleic acid.
3. The students understand the knowledge of separation techniques used in plant sciences.
4. The students understand the knowledge of computational biology.
5. The students understand the knowledge of biostatistics and data analysis in plant sciences.
6. The students understand the knowledge of utilization of economically important plants.

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**Semester VI**

**Practical Paper VIII NBBP22- 605 (IV) (based on NBBT 22- 603 and NBBT 22- 604)**

**Learning objectives**

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

**Experiments based on theory paper NBBT 22- 603**

1. Preparation of plant tissue culture medium (MS).
2. Demonstration of inoculation of explants on suitable medium (MS).
3. Study of Southern blotting technique.
4. Study of PCR.
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.
7. Identification of types of Fossils- Impression, Compression, Petrification and Coal.
8. Identification of *Lyginopteris*.
9. Identification of *Enigmocarpon*.
10. Visit to tissue culture laboratory and report submission.

### **Experiments based on theory paper NBBT 22- 604**

1. To study microtechniques used in plant study (Whole mount, peel mounts, squash preparations, maceration and sectioning).
2. Study of preparation of permanent slides (Cytological/Microbial).
3. Preparation of different stains used in study of plant material.
4. Use of GPS in positioning of plants.
5. Study and documentation of traditional knowledge of medicinal plants (Any two).
6. Study and documentation of traditional knowledge of local plants (Any two).
7. Study of vegetable crops with respect to cultivation and management practices.
8. Study of timber yielding plants with respect to cultivation and management practices.
9. Visit to landscape garden and submission of report.

### **Learning Outcomes**

1. The students understand the knowledge of preparation of MS medium, basic sterilization techniques and aseptic conditions.
2. The students should be able to perform the basic micropropagation protocol through various plant material (explants).
3. The students understand the knowledge of isolation, purification and estimation genomic DNA using spectrophotometric method and agarose gel electrophoresis.
4. The students understand the knowledge and significance of advanced crop improvement technology.
5. The students understand the knowledge of fossil plants.
6. The students will be able prepare the different microscopic slides of plant material and staining techniques.
7. The students understand the use of GPS in field surveys and documentation of traditional uses of plants.
8. The students understand the cultivation and management practices of economically important plants.



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**Semester VI**

**Practical Paper VIII NBBP22- 605 (based on NBBT 22- 603 and 605)**

**Learning objectives**

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

**Experiments based on theory paper NBBT 22- 603**

1. Preparation of plant tissue culture medium (MS).
2. Demonstration of techniques of *in vitro* 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.
7. Identification of types of fossils – i) Impression ii) Compression iii) Petrification v) Coal.
8. Identification of *Lyginopteris*.
9. Identification of *Enigmocarpon*.
10. Visit to tissue culture laboratory and report submission

### **Experiments based on theory paper NBBT 22- 605**

1. To study microtechniques used in plant study (Whole mount, peel mounts, squash preparations, clearing, maceration and sectioning).
2. Study of preparation of permanent slides. (Cytological/Microbial).
3. Preparation of different stains used in study of plant material.
4. Use of GPS in positioning of plants.
5. Survey and documentation of traditional medicinal plants.
6. Survey and documentation of traditional edible plants.
7. Study of mass multiplication of biofertilizers.
8. Study of effect of biofertilizers on growth of plants.
9. Isolation, identification and characterization of VAM fungi.

### **Learning Outcomes**

1. The students understand the knowledge of preparation of MS medium, basic sterilization techniques and aseptic conditions.
2. The students should be able to perform the basic micropropagation protocol through various plant materials (explants).
3. The students understand the knowledge of isolation, purification and estimation genomic DNA using spectrophotometric method and agarose gel electrophoresis.
4. The students understand the knowledge and significance of advanced crop improvement technology.
5. The students understand the knowledge of fossil plants.
6. The students will be able prepare the different microscopic slides of plant material and staining techniques.

7. The students understand the use of GPS in field surveys and documentation of traditional uses of plants.
8. The students understand the techniques used for mass multiplication of biofertilizers and their effect on plant growth.
9. The students understand the techniques of isolation and identification of VAM fungi and their potential use in agriculture.

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**Semester VI**

**Practical Paper VIII NBBP22- 605 (IV) (based on NBBT 22- 603 and**

**606) Learning objectives**

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

**Experiments based on theory paper NBBT 22- 603**

1. Preparation of plant tissue culture medium (MS).
2. Demonstration of techniques of *in vitro* 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.
7. Identification of types of fossils – i) Impression ii) Compression iii) Petrification v) Coal.
8. Identification of *Lyginopteris*.
9. Identification of *Enigmocarpon*.
10. Visit to tissue culture laboratory and report submission.

### **Experiments based on theory paper NBBT 22- 606**

1. To study microtechniques used in plant study (Whole mount, peel mounts, squash preparations, clearing, maceration and sectioning).
2. Study of preparation of permanent slides.
3. Plant material sectioning using microtome and double staining technique.
4. Preparation of different stains used in study of plant material.
5. Use of GPS in positioning of plants.
6. Survey and documentation of traditional medicinal plants.
7. Survey and documentation of traditional edible plants.
8. Estimation of antioxidant activity of plant material (lemon and orange fruits)
9. Preparation of herbal cosmetics using plants (plants studied in theory).
10. Preparation of Churna, Arishta and Asava.
11. Visit to local plant pharmaceutical industry and submission of visit report.

### **Learning Outcomes**

1. The students understand the knowledge of preparation of MS medium, basic sterilization techniques and aseptic conditions.
2. The students should be able to perform the basic micropropagation protocol through various plant material (explants).
3. The students understand the knowledge of isolation, purification and estimation genomic DNA using spectrophotometric method and agarose gel electrophoresis.
4. The students understand the knowledge and significance of advanced crop improvement technology.
5. The students understand the knowledge of fossil plants.
6. The students will be able prepare the different microscopic slides of plant material and staining techniques.

7. The students understand the use of GPS in field surveys and documentation of traditional uses of plants.
8. The students will be able to prepare herbal cosmetics.
9. The students will be able to prepare ayurvedic drugs such as Churna, Arishta and Asava.