

Rayat Shikshan Sanstha's

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

Syllabus under Autonomy

For

B. Sc. III Botany

Academic Year 2020 – 2021

Rayat Shikshan Sanstha's
Yashavantrao Chavan Institute of Science, Satara
(Autonomous)
Syllabus introduced from June 2020
Bachelor of Science (B. Sc.) Part - III: Botany

Semester: V
Theory Paper IX (BBT 501) Genetics and Plant Breeding

Learning Objectives:

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

Total Lectures 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]

- 2.1 Linkage: Definition, Linkage groups, types, Coupling and Repulsion Phase, significance in plant breeding

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

- 2.3 Quantitative inheritance:
- a] Polygene inheritance – Concept, examples
 - 1] Kernel colour in wheat and
 - 2] Ear length in Maize along with latest updates
 - b] Population genetics – Hardy-Weinberg's Law

Unit - III: Variation in Chromosome Number and Structure [11]

- 3.1 Chromosome number – Euploidy, Aneuploidy and Polyploidy
- 3.2 Chromosomal structure – Deletion, Duplication, Inversion and Translocation
- 3.3 Mutation – Spontaneous and Induced mutation. Types of mutagen – Physical and Chemical, Significance of mutations in plant breeding.

Unit - IV: Plant Breeding [11]

- 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
- 4.3 Multiple Allelism – Introduction, Definition, Self-incompatibility in plants, significance in plant breeding

Learning Outcomes

After completion of Unit - I students are able to:

1. Explain genetic basis of inheritance.
2. Explain the extra chromosomal inheritance.

After completion of Unit - II students are able to:

1. Explain the concept of linkage and recombination.
2. Describe the concept of quantitative inheritance.

After completion of Unit - III students are able to:

1. Define concepts regarding chromosome structure and variation.
2. Explain the concept of mutation and its importance in crop improvement.

After completion of Unit - IV students are able to:

1. Understand the concept of plant breeding and its significance.
2. Explain different methods of plant breeding.

References

1. Cell Biology, Genetics, Evolution and Ecology. Verma, P.S., Agarwal, V.K. S. Chand and Company Ltd., New Delhi (2001)
2. Cytogenetics and Plant Breeding, Singh BD, Cytogenetics and Plant Breeding, Kalyani Publications, New Delhi (2010))
3. Cytogenetics, Gupta PK, Rastogi Publications, Meerut (2018)
4. Genetics, Gupta PK, Rastogi Publications, Meerut (1997)
5. Genetics, Singh BD, Kalyani Publications, New Delhi (2009)
6. Genetics: Principles and Analysis, Hartl DL, Jones EW (4th Edition), Jones & Barlett Publishers, Massachusetts, USA (1998)
7. Plant Breeding: Principles and Methods, Singh BD, Kalyani Publications, New Delhi. (2018)
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10. Principles of Plant Breeding, Allard AW, Wiley Publications, (2010)
11. A text Book of Plant Breeding: A dynamic View Designed for Under Graduate Courses of Indian Universities, Singh BD, (3rd Edn.), Kalyani Publications, New Delhi (2011)

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

Semester - V
Theory Paper X (BBT 502) Microbiology,
Plant Pathology and Mushroom Cultivation Technology

Learning Objectives:

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

Total Lectures 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]

- 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 [15]

- 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),
 - i] 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

[10]

- 4.1 Introduction, History, General life cycle of mushrooms, Economic importance of mushrooms. Types of Mushrooms: Non-edible (Poisonous) mushrooms and Edible (Non-poisonous) - Button, Oyster, 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:

After completion of unit - I student able to:

- 1. Understands knowledge about microbes and different Microbial techniques.
- 2. Understand the different application of microbes in industries.

After completion of unit - II student able to:

- 1. Understands the knowledge about microbial genetics.
- 2. Explain the application of microbial genetics.

After completion of unit - III student able to:

- 1. Understand knowledge about plant pathology and plant diseases.
- 2. Describe the management practices of different plant diseases.

After completion of unit - IV student able to:

1. Understands knowledge about mushroom cultivation, storage and its economic importance.
2. Develop a pilot plant for mushroom cultivation.

References:

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

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

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

Learning objectives:

1. To impart the basic knowledge of cell as a basic unit of life.
2. To impart the basic knowledge of subcellular organelles.
3. To impart the basic knowledge of cell cycle and cell division.
4. To impart the knowledge of techniques used in biological studies.

Total Lectures 45

Unit - I: Cell as a unit of life [12]

- 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.

Unit - II: Sub Cellular Structures and Cell Membrane [10]

- 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 [10]

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

Unit - IV: Research 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:

After completion of unit - I student able to:

1. Explain cell as a basic unit of life.
2. Explain the ultrastructure of cell.

After completion of unit - II student able to:

1. Define concepts regarding roles of cell organelles.
2. Explain the significance of cell organelles.

After completion of unit - III student able to:

1. Define concepts regarding cell cycle.
2. Explain the concept of cell division and its significance.

After completion of unit - IV student able to:

1. Explain the principle and working of different techniques used in plant sciences.
2. Write answers and brief notes about all the techniques studied.

References

1. Biological Ultrastructure, Engstrom A and JB Finean, 2nd edition Academic Press (1967)
2. Cell and Molecular Biology, De Robertis and De Robertis (VIII), B.I. Waverly Pvt. Ltd., New Delhi (1997)
3. Cell and Molecular Biology, Dupraw EJ, Academic Press, London (1970)
4. Cell Biology, Lewis J, Sarup and Sons, New Delhi (2004)
5. Cell Biology, Powar CB, Himalaya Publishing House, New Delhi (2004)
6. Elements of Molecular Biology, Sandhya Mitra, McMillan India Ltd., Delhi (1988)
7. Genes, Lewin B, Pearson Education, Inc., Upper Saddle River, NT (2004)
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9. Microscope photometry. Horst Piller, Springer (1977).
10. Molecular Biology of Cell, Alberts B et al., (6th Edn) Garland Science, Taylor and Francis, New York. (2014)
11. Molecular Biology of the Gene, Watson et al., (V) Pearses Educatias, Inc., India (2004)
12. Molecular Biology, Turner PC et al, Viva Books, Pvt. Ltd., New Delhi (2002)
13. Molecular Cell Biology, Charlothe JAAddison, Wesley Publ. Company (1986)
14. Text book of Biotechnology, Verma PS and Agarwal VK, S. Chand and Company Ltd., New Delhi (2009)
15. Text Book of Experimental Biology, Aneja KR, New Age International Publishers (2017)
16. The Cell Cycle, John PCL Cambridge University Press. (1981)
17. The Cell: Molecular Approach, Cooper GM and Housemen RE (7th Edn.), (2015)

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

Semester - V: Theory Paper XII (BBT 504)
Advanced Botanical Skills and Horticulture I

Learning Objectives

1. To impart the knowledge of advanced skills required in plant sciences.
2. To impart the importance of intellectual property rights and scientific writing and its presentation.
3. To impart the basic knowledge of Horticulture.
4. To impart the basic knowledge of nursery management.

Total Lectures 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: 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 [11]

- 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, storage, transportation 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 [11]

- 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:

After completion of unit I student able to:

- 1. Understand the basics of IPR.
- 2. Understand the importance of IPR.

After completion of unit II student able to:

- 1. Communicate the experimental data to scientific community.
- 2. Write an effective article or their project reports effectively.

After completion of unit III student able to:

1. Understand the basics of horticulture and its applications.
2. Explain the branches of horticulture.

After completion of unit IV student able to:

1. Understand the techniques used in nursery management.
2. Develop a small-scale nursery on their own.

References:

1. Floriculture in India, Randhawa GS, Mukhopadhyay A, Allied Publishers, (1986)
2. Floriculture: Fundamentals & Practices, Laurie A, Ries VC, (2003)
3. Fundamentals of Horticulture, Edmond M, Andres, McGraw Hill Book Co., New Delhi (1957)
4. Gardening in India, Bose TK, Mukherjee D, Oxford & IBH Publishing Co., New Delhi (1972)
5. Gardening in India, Lancaster P, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi (1997)
6. Intellectual Property Rights: Unleashing the Knowledge Economy, Ganguli P, Tata McGraw-Hill (2001)
7. Intellectual Property: Patents, Trademarks and Copyright in a Nutshell, Miller AR, Davis MH, West Group Publishers, (2000)
8. Introduction to Horticulture, Kumar N, Rajalakshmi Publications, Nagercoil (1997)
9. Plant Propagation, Sandhu MK, Wile Eastern Ltd., Bangalore (1989)
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12. Textbook on intellectual property rights, Acharya NK, Asia Law House, (2001)
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Bachelor of Science (B. Sc.) Part - III: Botany

Semester - V
Theory Paper XII (BBT 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 importance of intellectual property rights and scientific writing and its presentation.
3. To impart the basic knowledge of biofertilizers.
4. To impart the basic knowledge of biocontrol.

Total Lectures 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
- 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 [11]

- 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 [11]

- 4.1 Bio-control: Introduction, sources and advantages.
- 4.2 Important commercial products – Source, preparation and uses of Pyrethrins, Azadirachtin, Nicotine, *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

After completion of unit I student able to:

1. Understand the basics of IPR.
2. Understand the importance of IPR.

After completion of unit II student able to:

1. Communicate the experimental data to scientific community.
2. Write an effective article or their project reports effectively.

After completion of unit III student able to:

1. Understand the basics and importance of biofertilizers.
2. Understand the applications of biofertilizers.

After completion of unit IV student able to:

1. Understand the basics and importance of biocontrol.
2. Understand the applications of biocontrol.

References:

1. Biofertilizer Technology, Marketing and Usage - A Source Book-cum-glossary, Motsara IMR, Bhattacharyya P, Srivastava B, FDCO, New Delhi (1995)
2. Biofertilizers in Agriculture and Forestry, Subba Rao NS, Oxford and IBH Publ. Co., New Delhi (1993)
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4. Biological Control of Insect Pest Suppression, Coppel HC, Martin JW, Springail, (1977)
5. Biological Suppression of Insect Pests, Gautam RD, Kalyani Publisher, New Delhi (2006)
6. Biology and Biochemistry of Nitrogen fixation, Dilworth MJ, Glenn AR, Elsevier, Amsterdam (1991)
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15. Understanding Trips: Managing Knowledge in Developing Countries, Guru M, Rao MB, Sage Publications (2003)

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

Learning Objectives:

1. To impart the knowledge of advanced skills required in plant sciences.
2. To impart the importance of intellectual property rights and scientific writing and its presentation.
3. To impart the basic knowledge of herbal medicines.
4. To impart the basic knowledge of pharmacognosy.

Total Lectures 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

- 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. (journals)
- 2.4 Plagiarism: Introduction to copyright, academic misconduct/plagiarism

Unit - III: Herbal Medicines [11]

- 3.1 Definition, Importance of herbal medicines
- 3.2 Classification of crude drugs – Taxonomical (Morphological, Anatomical) 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 [11]

- 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

After completion of unit I student able to:

1. Understand the basics of IPR.
2. Understand the importance of IPR.

After completion of unit II student able to:

1. Communicate the experimental data to scientific community.
2. Write an effective article or their project reports.

After completion of unit III student able to:

1. Understand the basics of herbal medicines.
2. Explain general phytoextraction methods.

After completion of unit IV student able to:

1. Understand the basics and applications of pharmacognosy.
2. Explain the drug evaluation methods.

References:

1. Ethnobotany in India, Maheshwari JK, Kunkel G, Bhandari MM, Duke J, Scientific Publishers, Jodhpur, Rajasthan(1993)
2. Fundamentals of Food Processing, Packaging, Labelling and Marketing, Anmol Publications, Pune (2014)
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4. Indian Materia Medica, Nadkarni KM (Vol. I and II), Popular Prakashan, Mumbai (2002)
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Bachelor of Science (B. Sc.) Part - III: Botany

Semester - V
Theory Paper I (SECCBT 507) Basic Numerical Skills

Learning Objectives:

1. To impart the basic knowledge of mathematics.
2. To impart the knowledge of application of mathematics in biological studies.
3. To impart the knowledge of basic statistical applications in biological studies.
4. To impart the knowledge of use of logarithms, factorials, matrices and venn diagram in biology.

Total lectures 20

Unit - I: Basics of Mathematics **[8]**

- 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

Unit - II: Fractions, Decimal System and Roots **[3]**

- 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

Unit - III: Probability, Average and Percentage [3]

- 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 [6]

- 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

Learning Outcomes:

- 1. After completion of unit I students are able to understand the basic mathematical concepts.
- 2. After completion of unit II students are able to define concepts of mathematics.
- 3. After completion of unit III students are able to apply mathematical concepts in his academics.
- 4. After completion of unit IV students are able to formulate and solve problems in plant science using mathematical concepts.

References

- 1. Mathematics, Class IX, NCERT, Delhi
- 2. Mathematics, Class X, NCERT, Delhi
- 3. Mathematics, Class XI, NCERT, Delhi
- 4. Mathematics, Class XII, NCERT, Delhi

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

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

Learning objectives:

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

Practicals based on Theory paper BBT 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* / *Cyanotis*.
5. Detection of meiotic anomalies in chromosomes in *Tradescantia*.
6. Preparation of idiogram by using karyotype or chromosomal photographs.
7. Methods of emasculation
8. Breeding techniques in a) Malvaceae b) Fabaceae c) Poaceae
9. Study of World map to show Vavilov's centers of origin of cultivated plants.
10. Visit to Krishi Vidyan Kendra/ Seed Company and submission of visit reports.

Practicals based on theory paper BBT 502

11. Preparation and sterilization of culture media – PDA (slants and plates).
12. Isolation and separation of soil fungi by serial dilution method.
13. Methods of inoculation - slants and plates.
14. Study of different types of stains: Cotton blue, Dien's stain, Gram's stain and other stains.
15. Study of plant diseases - Grassy Shoot disease of Sugarcane.

16. Citrus Canker and Yellow Vein Mosaic of Bhendi.
17. Study of plant diseases - White Rust of Crucifers and Early leaf spot (Tikka) disease of ground nut.
18. Seed treatment by dipping and seed dressing.
19. Demonstration of Mushroom Cultivation.
20. Demonstration of Harvesting and Storage of mushrooms.
21. Submission of local plant /crop diseases (any ten).

Learning Outcomes:

1. After completion of practical 1 to 3 students are able to solve problems on genetics.
2. After completion of practical 4 to 6 students are able to perform basic cytological techniques.
3. After completion of practical 7 and 8 students are able to perform techniques in plant breeding.
4. After completion of practical 9 students are able to identify the centres of origin of cultivated plants.
5. After completion of practical 10 students are able to know actual working in seed companies and research centers.
6. After completion of practical 11 to 14 students are able to perform microbial techniques (culture media, soil dilution, inoculation and staining).
7. After completion of practical 15 to 17 students are able to identify plant diseases, symptoms and causal organism.
8. After completion of practical 18 students are able to do the seed treatments by seed dipping and seed dressing methods.
9. After completion of practical 19 and 20 students are able to do the mushroom cultivation as pilot experiments.
10. After completion of practical 21 students are able to collection and identification of plant pathological specimens in fields.

References:

1. Biochemical Methods, Sadasivam and Manickam, New Age International Publishers, New Delhi
2. Modern Practical Botany, Pandey BP, Vol. I, S. Chand and Company Ltd., New Delhi (2011)
3. Modern Practical Botany, Pandey BP, Vol. II, S. Chand and Company Ltd., New

- Delhi (2011)
4. Practical Botany for Advanced Level and Intermediate Students, Wallis CJ (5th Edn.), William Heinemann Medical Books Ltd. (1966)
 5. Practical Botany, Bendre A, Rastogi Publications, Meerut (2010)
 6. Practical research methods, Dawson C, UBS Publishers, New Delhi (2002)

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

Semester: V
Practical Paper VI BBP 509 (based on BBT 503 and 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.

Practicals based on theory paper BBT 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 *Allium* peel, *Hydrilla* leaf and *Spirogyra* 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 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.

Practicals based on theory paper BBT 504

11. Study of budding technique – Patch and T-budding
12. Study of layering technique – Air layering
13. Study of Grafting technique – Whip and Approach

14. Garden implements (Any five) – Garden shear, sickle, cutter, shovel, budding knife, secateurs, water can, pruning scissors, sprayer, spade
15. Study of ornamental plants – Rose, Gerbera, Marigold
16. Study of hedge and edge plants.
17. Study of indoor plants.
18. Poster presentation on defined topics.
19. Technical writing on topics assigned.
20. Visit to nursery (Separate handwritten report to be submitted by student)

Learning Outcomes:

1. After completion of practical 1 students are able to prepare different types of solution used for the experiments in plant sciences.
2. After completion of practical 2 to 4 students are able to perform the basic cytological and anatomical techniques.
3. After completion of practical 5 and 6 students are able to perform separation techniques.
4. After completion of practical 7 students are able to find out dimensions of micro-preparations.
5. After completion of practical 8 and 9 students are able to isolate mitochondria from plant samples and principle of UV-VIS spectrophotometer.
6. After completion of practical 10 students are able to know the principles and working instruments used in plant science research.
7. After completion of practical 11 to 13 students are able to perform different horticultural practices.
8. After completion of practical 14 students are able to know different garden implements.
9. After completion of practical 15 to 17 students are able to know different groups of garden plants.
10. After completion of practical 18 and 19 students are able to understand the scientific writing and communication skills.
11. After completion of practical 20 students are able to know actual working of commercial nurseries.

References:

1. Biochemical Methods, Sadasivam and Manickam, New Age International Publishers, New Delhi

2. Modern Practical Botany, Pandey BP, Vol. I, S. Chand and Company Ltd., New Delhi (2011)
3. Modern Practical Botany, Pandey BP, Vol. II, S. Chand and Company Ltd., New Delhi (2011)
4. Practical Botany for Advanced Level and Intermediate Students, Wallis CJ (5th Edn.), William Heinemann Medical Books Ltd. (1966)
5. Practical Botany, Bendre A, Rastogi Publications, Meerut (2010)
6. Practical research methods, Dawson C, UBS Publishers, New Delhi (2002)

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

Semester - V
Practical Paper VI BBP 509 (based on BBT 503 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

Practicals based on theory paper BBT 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 *Allium* peel, *Hydrilla* leaf and *Spirogyra* 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 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.

Practicals based on theory paper BBT 505

11. Poster presentation on defined topics.
12. Technical writing on topics assigned.
13. Study of nitrogen fixing organisms.
14. Media used for biofertilizers, biopesticides and biocontrol agent production.

15. Isolation of *Rhizobium* from root nodules.
16. Estimation of the efficiency of *Rhizobium* through pot culture experiments
17. Mass production of *Verticillium/ Beauveria/ Metarhizium / Nomuraea/ Paecilomyces/ Hirsutella thompsoni/ Trichoderma*
18. Estimating the efficiency of *Trichoderma* through pot culture experiments
19. Methods of application of biofertilizers, Biopesticides and bioagents
20. Quality control tests for the biofertilizers, Biopesticides and bioagents
21. Visit to biofertilizers production company (Separate handwritten report to be submitted by student)

Learning Outcomes:

1. After completion of practical 1 students are able to prepare different types of solution used for the experiments in plant sciences.
2. After completion of practical 2 to 4 students are able to perform the basic cytological and anatomical techniques.
3. After completion of practical 5 and 6 students are able to perform separation techniques.
4. After completion of practical 7 students are able to find out dimensions of micro-preparations.
5. After completion of practical 8 and 9 students are able to isolate mitochondria from plant samples and principle of UV-VIS spectrophotometer.
6. After completion of practical 10 students are able to know the principles and working instruments used in plant science research.
7. After completion of practical 11 and 12 students are able to understand the scientific writing and communication skills.
8. After completion of practical 13 to 20 students are able understand and perform the different techniques used in production and application of biofertilizers and biocontrol agents.
9. After completion of practical 21 students are able to know the actual working of biofertilizer production company.

References:

1. Biochemical Methods, Sadasivam and Manickam, New Age International Publishers, New Delhi
2. Modern Practical Botany, Pandey BP, Vol. I, S. Chand and Company Ltd., New

- Delhi (2011)
3. Modern Practical Botany, Pandey BP, Vol. II, S. Chand and Company Ltd., New Delhi (2011)
 4. Practical Botany for Advanced Level and Intermediate Students, Wallis CJ (5th Edn.), William Heinemann Medical Books Ltd. (1966)
 5. Practical Botany, Bendre A, Rastogi Publications, Meerut (2010)
 6. Practical research methods, Dawson C, UBS Publishers, New Delhi (2002)

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

Semester: V
Practical Paper VI BBP 509 (based on BBT 503 and 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.

Practicals based on theory paper BBT 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 *Allium* peel, *Hydrilla* leaf and *Spirogyra* 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 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.

Practicals based on theory paper BBT 506

11. Poster presentation on defined topics.
12. Technical writing on topics assigned.
13. Study of adulterants by morphological, microscopic and physical methods of the following drugs
 - a] Black pepper
 - b] Turmeric
 - c] Cinnamon
 - d] Saffron

14. Organoleptic study of Tulsi, Ginger, Methi and Amla
15. Study of microchemical and phytochemical tests for characterization of drug yielding plants. (any four: alkaloids, glycosides, tannins, terpenoids, saponins, steroids, flavonoids, carbohydrates)
16. Estimation of total phenolic content from suitable plant material.
17. Estimation of total alkaloid content from suitable plant material.
18. Estimation of total flavonoid content from suitable plant material.
19. Determination of antioxidant activity by suitable method.
20. Visit to Herbal Industry and submission of report.

Learning Outcomes:

1. After completion of practical 1 students are able to prepare different types of solution used for the experiments in plant sciences.
2. After completion of practical 2 to 4 students are able to perform the basic cytological and anatomical techniques.
3. After completion of practical 5 and 6 students are able to perform separation techniques.
4. After completion of practical 7 students are able to find out dimensions of micro-preparations.
5. After completion of practical 8 and 9 students are able to isolate mitochondria from plant samples and principle of UV-VIS spectrophotometer.
6. After completion of practical 10 students are able to know the principles and working instruments used in plant science research.
7. After completion of practical 11 and 12 students are able to understand the scientific writing and communication skills.
8. After completion of practical 13 to 15 students are able to perform basic pharmacological analysis.
9. After completion of practical 16 to 19 students are able to estimate different phytochemical from plant extract.
10. After completion of practical 20 students are able to know actual working of herbal industries.

References:

1. Biochemical Methods, Sadasivam and Manickam, New Age International Publishers, New Delhi
2. Modern Practical Botany, Pandey BP, Vol. I, S. Chand and Company Ltd., New Delhi (2011)

3. Modern Practical Botany, Pandey BP, Vol. II, S. Chand and Company Ltd., New Delhi (2011)
4. Practical Botany for Advanced Level and Intermediate Students, Wallis CJ (5th Edn.), William Heinemann Medical Books Ltd. (1966)
5. Practical Botany, Bendre A, Rastogi Publications, Meerut (2010)
6. Practical research methods, Dawson C, UBS Publishers, New Delhi (2002)

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

Semester: V
Practical SECC Paper I (SECCBP 510) Practicals based on
Basic Numerical Skills

Learning objectives:

1. To give practical knowledge to students about applications of mathematics in biological sciences.
2. To give the practical knowledge about use of computers in solving the mathematical applications in biological sciences.

Practicals

1. Calculations of percent (%), molar (M), normal (N) and PPM solutions.
2. Preparation of standard curves.
3. Use of Excel Software for solving mathematical problems related to Addition, Subtraction, Division and Multiplication.
4. Use of Excel Software for solving mathematical problems related to percentage and Average.
5. Use of excel in preparation of graphs.

Learning outcomes:

1. After completion of practical 1 and 2 students are able to prepare different concentration solutions and standard curves.
2. After completion of practical 3 to 5 students are able to use Microsoft excel for statistical analysis and mathematical calculations.

References

5. Mathematics, Class IX, NCERT, Delhi
6. Mathematics, Class X, NCERT, Delhi

7. Mathematics, Class XI, NCERT, Delhi
8. Mathematics, Class XII, NCERT, Delhi

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

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

Learning objectives:

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

Total lecture 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:

After completion of unit I students are able to:

- 1. Explain concepts of plant biochemistry.
- 2. Explain the carbohydrates, classification and their significance.

After completion of unit II students are able to:

- 1. Define concepts regarding molecular biology
- 2. Explain the lipids synthesis, oxidation and biological significance.

After completion of unit III students are able to:

1. Define concepts regarding structure, properties and classification of amino acids.
2. Explain the general classification of protein and their synthesis.

After completion of unit IV students are able to:

1. Explain the concepts of nucleic acids and their types.
2. Write answers and brief notes about plant biochemistry and molecular biology.

References:

1. Biochemistry Simplified Textbook of Biochemistry for Medical Students, Manjeshwar PR, Paras Medical Publishers (2018).
2. Biochemistry, Voet D, Wiley Science Ltd. (2018)
3. Cell Biology, Genetics, Molecular Biology, Evolution and Ecology, Verma PS and Agarwal VK, S. Chand & Company Ltd., New Delhi (2004)
4. Cell Biology, Lewis J, Sarup and Sons, New Delhi (2004)
5. Cell Biology, Powar CB, Himalaya Publishing House, New Delhi (1992)
6. Elements of Molecular Biology, Mitra S, McMillan India Ltd., New Delhi (1980)
7. Essentials of Biochemistry, Ahmad M, Merit Publisher Multan Ltd. (2008)
8. Fundamentals of Biochemistry, Jain JL, Jain S and Jain N, S. Chand & Company Ltd., New Delhi (1979).
9. Molecular Biology of Cell, Alberts B, et al., (6th Edn.), Garland Science, Taylor (2014)
10. Principles of Biochemistry, Lehninger AL (4th Edn.), WH Freeman Ltd. (2004)
11. The Cell: Molecular Approach, Cooper GM and Housemen RE (7th Edn.), (2015)

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

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

Learning objectives:

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

Total lectures 45

Unit - 1: 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)

Unit - II: Biostatistics**[11]**

- 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**[10]**

- 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**[10]**

- 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:**After completion of unit I students are able to:**

1. Know the basics of bioinformatics tools and databases.
2. Use of different bioinformatics databases and tools in biological research.

After completion of unit II students are able to:

1. Know the basics of Biostatistics.
2. Do data collection, analysis and use of different statistical programmes in their research work.

After completion of unit III students are able to:

1. Explain the centers of origin of crop plants.
2. Explain the different classes of economically important crop plants.

After completion of unit IV students are able to:

1. Describe the significance of economically important crops with their representative examples.
2. Learn the scope of economic uses of the plants.

References:

1. A Text book of Economic Botany, Sambamurthy A.V.S.S. and Subramanyam NS, Wiley Eastern Ltd., New Delhi (1989)
2. Economic Botany - Plants in Our World, Simpson BB and Conner-Ogorzaly M, McGraw Hill, New York (1986)
3. Economic Botany in Tropics, Kocchar SL, (2nd Edn.), Mac Millan India Ltd., New Delhi (1998)
4. Genetics, Gupta PK, Rastogi Publications, Meerut (1997)
5. Hill's Economic Botany, Sharma OP, Tata McGraw Hill Publishing Company Ltd., New Delhi (1996)
6. Introduction to Bioinformatics, Attwood TK, Perry-Smith DJ, and Phukan S, Pearson Education (2008)
7. Introduction to Bioinformatics, Sundara Rajan S and Balaji R, Himalaya Publishing House, New Delhi (2005)
8. Statistical Methods for Biologists, Deshmukh SD, Vision Publications (2008)

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

Semester: VI
Theory Paper XV (BBT 603) Plant Biotechnology and Paleobotany

Learning Objectives:

1. To impart the basic knowledge of Plant Biotechnology.
2. To impart the basic knowledge of plant tissue culture.
3. To impart the basic concepts of recombinant DNA technology and genetic engineering.
4. To impart the knowledge of Paleobotany.

Total lectures 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, Embryo culture, Organ culture, Callus culture, Cellsuspension 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 - *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 – (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] *Lyginopteris* and
 - b] *Enigmocarpon*
- 4.3 Applications of paleobotany: Role of microfossil in oil and coal exploration

Learning outcomes:

After completion of unit I students are able to:

- 1. Know the basics of biotechnology.
- 2. Know the basics of plant tissue culture and its importance in plant biotechnology.

After completion of unit II students are able to:

- 1. Know the basics of recombinant DNA technology.
- 2. Know the basic techniques used in rDNA technology.

After completion of unit III students are able to:

1. Know the different technologies used to generate transgenic crop plants.
2. Know the significance of genetic engineering for mankind.

After completion of unit IV students are able to:

1. Learn the concept and scope of paleobotany.
2. Know some fossil plant genera.

References:

1. A Text book of Biotechnology, Dubey RC, S. Chand and Company Ltd., New Delhi (2005)
2. An Introduction to Palaeobotany, Arnold CA, Tata McGraw-Hill, New Delhi (1972)
3. Biotechnology, Singh BD, Kalyani Publishers, New Delhi (2010)
4. Elements of Biotechnology, Gupta PK, (2nd Edn.), Rastogi Publications, Meerut
5. Introduction to Plant Tissue Culture, Razdan MK, (2nd Edn.), Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi
6. Palaeobotany and the Evolution of Plants, Wilson NS and Rothwell GW (2nd Edn.), Cambridge University Press, UK (1983)
7. Plant Tissue Culture, Kalyan Kumar De, New Central Book Agency (P) Ltd., New Delhi
8. Practical Biotechnology and Plant Tissue Culture, Nagar S and Adhav M, S. Chand and Company Ltd., New Delhi
9. Studies in Palaeobotany, Andrews HN, John Wiley & Sons Limited, Canada (1961)

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

Semester: VI
Theory Paper XVI (BBT 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 olericulture and arboriculture.
4. To impart the basic knowledge of landscape gardening.

Total lectures 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, 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: Olericulture and arboriculture [11]

- 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 [11]

- 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, annuals, palms, ferns, cacti and succulents, criteria for plant selection, propagation of ornamental plants: sexual and vegetative methods, topiary technique
- 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
- 4.4 British gardens, Japanese gardens and their types, gardens for special purpose

Learning outcomes:

After completion of unit I students are able to:

1. Understand the basic micro techniques involved in plant sciences.
2. Understand the staining techniques used in plant sciences.

After completion of unit II students are able to:

1. Understand the importance of traditional knowledge.
2. Understand different protection acts for traditional knowledge.

After completion of unit III students are able to:

1. Understand the basics of olericulture and its applications.
2. Understand the basics of arboriculture and its applications.

After completion of unit IV students are able to:

1. Gain basic knowledge of landscape gardening.
2. Gain basic knowledge of plants used in landscape gardening.

References:

1. Complete Home Gardening, DeJ SC, Agrobias, Jodhpur, India (2003)
2. Floriculture in India, Randhawa GS and Mukhopadhyay A, Allied Publishers (1986)
3. Fundamentals of Horticulture, Edmond M Andres, McGraw-Hill Book Co., New Delhi
4. Gardening in India, Bose TK and Mukherjee D, Oxford & IBH Publishing Co., New Delhi (1972)
5. Gardening in India, Lancaster P, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi (1997)
6. Horticultural Science, Jules J, (3rd Edn.), WH Freeman and Co., USA (1979)
7. Horticulture and Gardening, Khan MR, Nirali Prakashan, Pune, India (1995)
8. Intellectual property rights in the WTO and developing countries, Watal J, Oxford University Press, Oxford
9. Intellectual Property Rights: Unleashing the Knowledge Economy, Ganguli P, Tata McGraw-Hill Book Co., New Delhi (2001)
10. Intellectual Property: Patents, Trademarks and Copyright in a Nutshell, Miller AR and Davis MH, West Group Publishers (2000)
11. Introduction to Horticulture, Kumar N, Rajalakshmi Publications, Nagercoil (1997)
12. Plant microtechnique and microscopy, Ruzin SE, Oxford University Press, New York, USA (1999)
13. Practical research methods, Dawson C, UBS Publishers, New Delhi (2002)
14. Scientific writing for agricultural research scientists – a training reference manual, Stapleton P, Yondeowei A, Mukanyange J and Houten H, West Africa Rice Development Association, Hong Kong (1995)
15. Textbook on intellectual property rights, Acharya NK, Asia Law House (2001)
16. Understanding Trips: Managing Knowledge in Developing Countries, Guru M and Rao MB, Sage Publications (2003)

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

Semester: VI
Theory Paper XVI (BBT 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.
4. To impart the basic knowledge of organic farming.

Total lectures 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, 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 [11]

- 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 [11]

- 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 – bio compost making methods, types and method of vermicomposting – field Application.

Learning outcomes:

After completion of unit I students are able to:

1. Understand the basic micro techniques involved in plant sciences.
2. Understand the staining techniques used in plant sciences.

After completion of unit II students are able to:

1. Understand the importance of traditional knowledge.
2. Understand different protection acts for traditional knowledge.

After completion of unit III students are able to:

1. Understand the basics, importance and applications of biofertilizers
2. Explain the process of mass multiplication of biofertilizers.

After completion of unit IV students are able to:

1. Understand the basics, importance and applications of organic farming.
2. Explain the importance of mycorrhizal association.

References:

1. Bio-fertilizers and organic farming, Vayas S and Modi HA, Akta Prakashan, Nadiad (1998)
2. Glossary of Indian medicinal plants, Chopra RN, Nayar SL and Chopra IC, CSIR, New Delhi (1956)
3. Intellectual property rights in the WTO and developing countries, Watal J, Oxford University Press, Oxford
4. Intellectual Property Rights: Unleashing the Knowledge Economy, Ganguli P, Tata McGraw-Hill Book Co., New Delhi (2001)
5. Intellectual Property: Patents, Trademarks and Copyright in a Nutshell, Miller AR and Davis MH, West Group Publishers (2000)
6. Plant microtechnique and microscopy, Ruzin SE, Oxford University Press, New York, USA (1999)
7. Practical research methods, Dawson C, UBS Publishers, New Delhi (2002)
8. Scientific writing for agricultural research scientists – a training reference manual, Stapleton P, Yondeowei A, Mukanyange J and Houten H, West Africa Rice Development Association, Hong Kong (1995)
9. Soil Microbiology, SubhaRao NS, Oxford & IBH Publishers, New Delhi (2000)
10. Textbook on intellectual property rights, Acharya NK, Asia Law House (2001)
11. The indigenous drugs of India, Dey and Raj Bahadur Kanny, Lall, International Book Distributors (1984)
12. Understanding Trips: Managing Knowledge in Developing Countries, Guru M and Rao MB, Sage Publications (2003)
13. Vermiculture and Organic Farming, Sathe TV, Daya publishers, India (2004)

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

Semester: VI
Theory Paper XVI (BBT 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 importance of protection of traditional knowledge with respect to plants.
3. To impart the basic knowledge of herbal cosmetology.
4. To impart the basic knowledge of plant pharmaceuticals.

Total lectures 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-Propecting 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 [11]

- 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 [11]

- 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:

After completion of unit I students are able to:

1. Understand the basic micro techniques involved in plant sciences.
2. Understand the staining techniques used in plant sciences.

After completion of unit II students are able to:

1. Understand the importance of traditional knowledge.
2. Understand different protection acts for traditional knowledge.

After completion of unit III students are able to:

1. Understand the basics of herbal cosmetology.
2. Understand the basics of nutraceuticals.

After completion of unit IV students are able to:

1. Understand the plant pharmaceuticals.
2. Understand the phytochemistry of important medicinal plants.

References:

1. Ayurvedic Useful Plants in India, Drury CH, Asiatic Publishing House, New Delhi (2006)
2. Ethnobotany in India, Maheshwari JK, Kunkel G, Bhandari MM and Duke J, Scientific Publishers, Jodhpur, Rajasthan (1993)
3. Fundamentals of food processing, packaging, labeling and marketing, Chowdhary V, Anmol Publications, Pune (2014)
4. Herbal Medicine and Botanical Medical Aids, Hoffmann F and Manning M, Viva Books, New Delhi (2009)
5. Indian Materia Medica, Nadkarni KM (Vol I and II) Popular Prakashan, Mumbai (2002)
6. Intellectual property rights in the WTO and developing countries, Watal J, Oxford University Press, Oxford
7. Intellectual Property Rights: Unleashing the Knowledge Economy, Ganguli P, Tata McGraw-Hill Book Co., New Delhi (2001)
8. Intellectual Property: Patents, Trademarks and Copyright in a Nutshell, Miller AR and Davis MH, West Group Publishers (2000)
9. Medicinal and Aromatic Plants: Agricultural, Commercial, Ecological, Legal, Pharmacological and social aspects, Bogers RJ, Craker LE and Lange D, Springer (2006)
10. Medicinal Plants of India, Deshmukh LP, Oxford Book Co., New Delhi (2013)
11. Plant microtechnique and microscopy, Ruzin SE, Oxford University Press, New York, USA (1999)
12. Practical research methods, Dawson C, UBS Publishers, New Delhi (2002)
13. Scientific writing for agricultural research scientists – a training reference manual, Stapleton P, Yondeowei A, Mukanyange J and Houten H, West Africa Rice Development Association, Hong Kong (1995)
14. Textbook on intellectual property rights, Acharya NK, Asia Law House (2001)
15. Tribal medicine, Pal DC and Jain SK, Naya Prakash Publication, New Delhi (1998)
16. Understanding Trips: Managing Knowledge in Developing Countries, Guru M and Rao MB, Sage Publications (2003)

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

Semester: VI
Theory Paper II (SECCT 607) Entrepreneurship Development

Learning Objectives:

1. Identification of opportunities for development
2. To learn the mechanism of finance and fund raising
3. To understand the importance of marketing for better business opportunities
4. To study the plant based industrial sector in India and abroad.

Total lectures 20

Unit - I: Entrepreneurship Development [05]

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.

Unit - II : Business Finance & Accounts [05]

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, 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 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:

1. After completion of unit I students are able to get the idea about IP rights?
2. After completion of unit II students are able to avail the financial and marketing skill
3. After completion of unit III students are able to prepare the proposal for small scale industry.
4. After completion of unit IV students are able to identify opportunities in the plant based industrial sector.

Recommended Books:

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

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

Semester: VI
Practical Paper VII BBP 608 (based on BBT 601 and 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.

Practicals based on Theory paper BBT 601

- 1-2. Qualitative test for sugars, proteins and lipids in suitable 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.

Practicals based on theory paper BBT 602

11. Study of biological databases NCBI, DDBJ, EMBL and UniProt
12. Nucleotide sequence retrieval from NCBI database
13. Study of molecular phylogeny using Mega 6 software.
14. Study of measures of central tendency, frequency distribution of given data and its graphical representation

15. Determination of Standard deviation and standard error of the given data.
16. Study of Botanical Name, Morphology, Parts used and Economic importance of Jowar and Wheat.
17. Study of Botanical Name, Morphology, Parts used and Economic importance of Gram and Pigeon pea.
18. Study of Botanical Name, Morphology, Parts used and Economic importance of Ginger, Chilly, Tea and Coffee.
19. Study of Botanical Name, Morphology, Parts used and Economic importance of Groundnut and Soybean.
20. Study of Botanical Name, Morphology, Parts used and Economic importance of Cotton and *Agave*.
21. Assignment based on Biostatistics/ Bioinformatics

Learning Outcomes:

1. After completion of practical 1 to 5 students are able to analyse the nutritional composition of plants.
2. After completion of practical 6 students are able to perform separation techniques used in plant sciences.
3. After completion of practical 7 and 8 students are able for isolation and estimation of nucleic acid.
4. After completion of practical 9 students are able to estimate pigments in plants.
5. After completion of practical 10 students are able to know the working in molecular biology research laboratory.
6. After completion of practical 11 to 13 and 21 students are able to handle computational biology tools used in plant science research.
7. After completion of practical 14, 15 and 21 students are able to do use statistical software's for data analysis in plant sciences.
8. After completion of practical 16 to 20 students are able to know the utilization of economically important plants.
9. After completion of practical 21 students are able to know the applications of statistical / bioinformatics tools for data analysis in plant sciences.

References:

1. Biochemical Methods, Sadasivam and Manickam, New Age International Publishers, New Delhi

2. Modern Practical Botany, Pandey BP, Vol. I, S. Chand and Company Ltd., New Delhi (2011)
3. Modern Practical Botany, Pandey BP, Vol. II, S. Chand and Company Ltd., New Delhi (2011)
4. Practical Botany for Advanced Level and Intermediate Students, Wallis CJ (5th Edn.), William Heinemann Medical Books Ltd. (1966)
5. Practical Botany, Bendre A, Rastogi Publications, Meerut (2010)
6. Practical research methods, Dawson C, UBS Publishers, New Delhi (2002)

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

Semester: VI
Practical Paper VIII BBP 609 (based on BBT 603 and 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.

Practicals based on theory paper BBT 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

Practicals based on theory paper BBT 604

11. To study microtechniques used in plant study (Whole mount, peel mounts, squash preparations, clearing, maceration and sectioning).
12. Study of preparation of permanent slides.
13. Plant material sectioning using microtome and double staining technique.
14. Preparation of different stains used in study of plant material.
15. Use of GPS in positioning of plants.
16. Survey and documentation of traditional medicinal plants.
17. Survey and documentation of traditional edible plants.
18. Study of vegetable crops with respect to cultivation and management practices.
19. Study of timber yielding plants with respect to cultivation and management practices.
20. Visit to landscape garden and submission of report.

Learning Outcomes:

1. After completion of practical 1 and 2 students are able to do *in vitro* culture of plants.
2. After completion of practical 3 and 4 students are able to do the isolation and estimation of genomic DNA.
3. After completion of practical 5 and 6 students are able to gain the knowledge and significance of advanced crop improvement technology.
4. After completion of practical 7 to 9 students are able to understand the knowledge of fossil plants.
5. After completion of practical 10 students are able to know the working of commercial plant tissue culture laboratory.
6. After completion of practical 11 to 14 students are able to prepare the different microscopic slides of plant material and staining techniques.
7. After completion of practical 15 to 17 students are able to understand the use of GPS in field surveys and documentation of traditional uses of plants.
8. After completion of practical 18 and 19 students are able to understand the cultivation and management practices of economically important plants.
9. After completion of practical 20 students are able to see plan the landscape garden.

References:

1. Biochemical Methods, Sadasivam and Manickam, New Age International Publishers, New Delhi

2. Modern Practical Botany, Pandey BP, Vol. I, S. Chand and Company Ltd., New Delhi (2011)
3. Modern Practical Botany, Pandey BP, Vol. II, S. Chand and Company Ltd., New Delhi (2011)
4. Practical Botany for Advanced Level and Intermediate Students, Wallis CJ (5th Edn.), William Heinemann Medical Books Ltd. (1966)
5. Practical Botany, Bendre A, Rastogi Publications, Meerut (2010)
6. Practical research methods, Dawson C, UBS Publishers, New Delhi (2002)

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Semester : VI
Practical Paper VIII BBP 606 (based on BBT 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.

Practicals based on theory paper BBT 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

Practicals based on theory paper BBT 605

11. To study microtechniques used in plant study (Whole mount, peel mounts, squash preparations, clearing, maceration and sectioning).
12. Study of preparation of permanent slides.
13. Plant material sectioning using microtome and double staining technique.
14. Preparation of different stains used in study of plant material.
15. Use of GPS in positioning of plants.
16. Survey and documentation of traditional medicinal plants.
17. Survey and documentation of traditional edible plants.
18. Study of mass multiplication of biofertilizers.
19. Study of effect of biofertilizers on growth of plants.
20. Isolation, identification and characterization of VAM fungi.

Learning Outcomes:

1. After completion of practical 1 and 2 students are able to do *in vitro* culture of plants.
2. After completion of practical 3 and 4 students are able to do the isolation and estimation of genomic DNA.
3. After completion of practical 5 and 6 students are able to gain the knowledge and significance of advanced crop improvement technology.
4. After completion of practical 7 to 9 students are able to understand the knowledge of fossil plants.
5. After completion of practical 10 students are able to know the working of commercial plant tissue culture laboratory.
6. After completion of practical 11 to 14 students are able to prepare the different microscopic slides of plant material and staining techniques.
7. After completion of practical 15 to 17 students are able to understand the use of GPS in field surveys and documentation of traditional uses of plants.
8. After completion of practical 18 to 20 students are able to do isolation, characterization and multiplication of organisms used as biofertilizers.

References:

1. Biochemical Methods, Sadasivam and Manickam, New Age International Publishers, New Delhi
2. Modern Practical Botany, Pandey BP, Vol. I, S. Chand and Company Ltd., New

- Delhi (2011)
3. Modern Practical Botany, Pandey BP, Vol. II, S. Chand and Company Ltd., New Delhi (2011)
 4. Practical Botany for Advanced Level and Intermediate Students, Wallis CJ (5th Edn.), William Heinemann Medical Books Ltd. (1966)
 5. Practical Botany, Bendre A, Rastogi Publications, Meerut (2010)
 6. Practical research methods, Dawson C, UBS Publishers, New Delhi (2002)

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

Semester: VI
Practical Paper VIII BBP 609 (based on BBT 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.

Practicals based on theory paper BBT 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

Practicals based on theory paper BBT 606

11. To study microtechniques used in plant study (Whole mount, peel mounts, squash preparations, clearing, maceration and sectioning).

12. Study of preparation of permanent slides.
13. Plant material sectioning using microtome and double staining technique.
14. Preparation of different stains used in study of plant material.
15. Use of GPS in positioning of plants.
16. Survey and documentation of traditional medicinal plants.
17. Survey and documentation of traditional edible plants.
18. Estimation of antioxidant activity of plant material (lemon and orange fruits)
19. Preparation of herbal cosmetics using plants (plants studied in theory).
20. Preparation of Churna, Arishta and Asava.
21. Visit to local plant pharmaceutical industry and submission of visit report.

Learning Outcomes:

1. After completion of practical 1 and 2 students are able to do *in vitro* culture of plants.
2. After completion of practical 3 and 4 students are able to do the isolation and estimation of genomic DNA.
3. After completion of practical 5 and 6 students are able to gain the knowledge and significance of advanced crop improvement technology.
4. After completion of practical 7 to 9 students are able to understand the knowledge of fossil plants.
5. After completion of practical 10 students are able to know the working of commercial plant tissue culture laboratory.
6. After completion of practical 11 to 14 students are able to prepare the different microscopic slides of plant material and staining techniques.
7. After completion of practical 15 to 17 students are able to understand the use of GPS in field surveys and documentation of traditional uses of plants.
8. After completion of practical 18 to 20 students are able to know the importance of herbal drugs and cosmetics and they are able to prepare them.
9. After completion of practical 21 students are able to know the working of plant pharmaceutical industry.

References:

1. Biochemical Methods, Sadasivam and Manickam, New Age International Publishers, New Delhi
2. Modern Practical Botany, Pandey BP, Vol. I, S. Chand and Company Ltd., New Delhi (2011)

3. Modern Practical Botany, Pandey BP, Vol. II, S. Chand and Company Ltd., New Delhi (2011)
4. Practical Botany for Advanced Level and Intermediate Students, Wallis CJ (5th Edn.), William Heinemann Medical Books Ltd. (1966)
5. Practical Botany, Bendre A, Rastogi Publications, Meerut (2010)
6. Practical research methods, Dawson C, UBS Publishers, New Delhi (2002)

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Semester: VI
Practical Paper SECCBP 610 (based on SECCBT 607)

Course Work: Industrial training [25]
15 Days internship program and report writing.
